UTILIZATION OF DRY SOLID WASTE IN BRICKS

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Abstract: **There is an increasing demand on building materials especially in the recent years because of increasing population. The main challenge is to convert wastes to useful construction materials. Recycling of waste as raw material alternatives, may reduce the exhaustion of the natural resources and waste disposal costs. Bricks are commonly used building material around the world. Conventional bricks are produced from clay with high temperature kiln firing which emits nearly 1 ton of CO_2. For environmental protection and sustainable development, extensive research has been conducted on production of bricks from waste materials. The waste materials to be filled in the landfill is greatly reduced and thereby saving the environment. This project emphasizes on the use of waste materials like Flyash, marble dust, rice husk ash, quarry dust and egg shell powder replacing clay in bricks. The bricks are manufactured and tested as per IS standards.**

Keywords: waste materials, clay, environmental protection, kilns, hydraulic compression

I.INTRODUCTION

Brick is one of the oldest and commonly used building materials. In 8000 BC, the dried-clay bricks were used for the first time. The fired clay bricks were used as early as 4500 BC. The worldwide annual production of bricks and demand for bricks is continuously increasing in the recent years. Conventional bricks are produced from clay with high temperature kiln firing. The high temperature kiln firing not only consumes significant amount of energy, but releases large quantity of greenhouse gases. Clay bricks, on average, have an embodied energy of approximately 2.0 kWh and release about 0.41 kg of carbon dioxide (CO_2) per brick. The process of brick making has not changed since many centuries except some minor refinements. There have been hardly any efforts in the country to improve the brick-making process for enhancing the quality of bricks. The main reason for this attitude is that the production of bricks has been largely remained confined to the unorganized small sector. Some of the large mechanized brick plants came up in the past but they failed for some reason or other. The result is that the construction industry is largely dependent on the small sector which is unable to deliver high quality bricks in view of rising fuel cost, outdated technology and lower efficiency of production. Environmental concerns are also being raised against uncontrolled extraction of clay. The main concern is land degradation. Therefore, clay should be replaced in bricks with some other suitable materials.

Various attempts were made to incorporate various waste material in bricks production such as natural fibers, textile laundry wastewater sludge, foundry sand, granite sawing waste, perlite, processed waste tea, sewage sludge, structural glass waste, PC and TV waste, fly ash, sugarcane bagasse ash, organic residue, steel dust, bottom ash, rice husk ash, silica fume, marble and granite waste, municipal solid incineration fly ash slag.

II. MATERIALS USED

A. Clay

Clay soils are compounds of silica and alumina. Calcareous clays have calcium carbonate and will burn to a yellow or cream color. Non-calcareous typically contain feldspar and iron oxides, and will burn to a brown, pink or red, depending on the amount of iron oxide. The silica in the clay, when fired at 900-1200 degrees C, will turn to a glassy phase. This process, called vitrification, will turn the clay to a crystalline structure. Clay was replaced with the following materials such as fly ash, rice husk ash, marble dust, egg shell powder, quarry dust, cement.

B. Fly ash

Fly ash or pulverized fuel ash (PFA) is the residue from the combustion of pulverized coal collected by mechanical or electrostatic separators from the flue gases or power plants. It constitutes about 75% of the total ash produced. Fly ash is puzzolanic in nature, and contains less than 7% lime. The puzzolanic *property* coupled with lime reactivity makes it very suitable for cementitious / binding applications

C. Rice husk ash

Combustion of rice hulls affords rice husk ash. This ash is a potential source of amorphous reactive silica, which has a variety of applications in materials science. The amount of silica increases with increase in burning temperature. This ash is also a very good thermal insulation material and maintains temperature.

D. Marble Dust

The marble dust is a Very fine powder obtained during cutting or dressing of marble. 25% marble mass becomes marble dust. It is also used as an admixture, increases cohesiveness to the mixture and enhances good binding.

E. Egg Shell Powder

It is obtained by grinding of egg shells. Egg shell Contains lot of calcium and its chemical composition is similar to limestone It offers high density, compressive strength and durability.

F. Quarry dust

It is a byproduct of quarrying of rocks. It used as a substitute for fine aggregate and the construction cost reduces and in addition it increases the strength to a little.

G. Cement

Cement is a powdery substance made by calcining lime and clay.Cement is a great binding material and hence it is used in small quantity in the bricks for binding the waste materials.

III. CASTING OF BRICKS

Bricks made of waste materials were cast by means of hydraulics compression technique. The following steps were involved in the casting of bricks.The waste materials that were used in the manufacture of bricks were collected from various places and is shown in the Table I and the collected materials are shown in the Fig.1

TABLE I

MATERIALS COLLECTED

MATERIALS	PLACE OF COLLLECTION
Fly ash	Local dealer from Rajaplayam
Egg shell powder	Schools and hotels
Rice husk ash	Rice mills
Marble dust	Mandeep Marbles& Stones Private Limited, Madurai
Quarry dust	Local dealers from Rajapalayam
Cement	Local dealers from Rajapalayam

Fig1. Mixture of materials used

The collected materials are put in the mixer and water was added till it attains proper consistency. Comparatively for all the trials the quantity of water added was 3 to 4 litres for a weight of 21kg of materials. The weight of one brick was estimated to be around 3.5kg so that 6 bricks weigh around 21kg.The materials were allowed to mix in the pan mixer for 10 to 15 minutes until a uniform mixture was obtained. The mixed raw materials are taken to the compression machine through conveyor belt for casting and compaction. The pan mixer in which materials were mixed is shown in Fig.2

Figure 2: Cylindrical pan mixer

The bricks were produced finally from hydraulics pressing machine which runs at a rate of 2200Psi. The bricks were of size 23 x 11 x 7 cm. The produced bricks are taken and then stacked for curing for a period of at least 21 days to ensure good strong brick. The bricks were cast in five trials of various proportions as shown in Table II

TABLE II:
PROPORTION OF MATERIALS USED IN BRICK

MATERIALS	TRIAL 1 %	TRIAL 2 %	TRIAL 3 %
Flyash	40	40	40
Marble dust	10	10	10
Cement	5	5	5
RHA	2	2	2
ESA	3	5	10
Quarry dust	40	38	33

IV. RESULT AND DISCUSSION

The various tests were conducted and the results are shown in table. The bricks were tested for their compressive strength after 21 days of curing. The bricks were tested in the compression testing machine by providing two iron plates. The water absorption is found by immersing the brick

for 24 hours at room temperature. The difference between the dry and wet weight is calculated in percentage.

TABLE III
TEST RESULTS

TYPE OF TEST	TRIAL1	TRIAL 2	TRIAL 3
Weight	Around 3 Kg	Around 3 Kg	Around 3 Kg
Compressive strength	7.2 N/ mm^2	7.8 N/ mm^2	8.45 N/ mm^2
Water absorption	5.12 %	5.28 %	5.41 %
Efflorescence	Nil	Nil	Nil
Shape	Even	Even	Even
Structure	No pores/ honey comb	No pores/ honey comb	No pores/ honey comb
Soundness	Produces cling sound	Produces cling sound	Produces cling sound

The graph plotted with the compressive strength values is shown in Fig.3

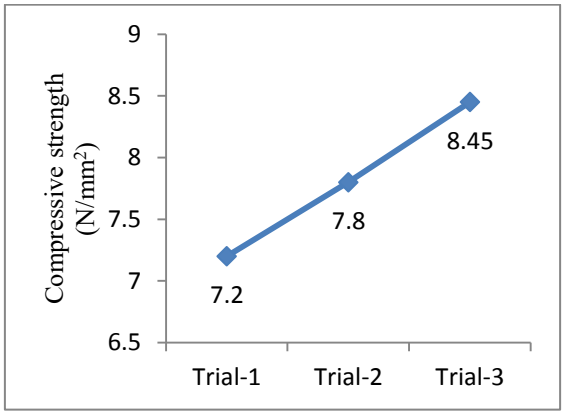

Fig 3. Compressive strength chart

The graph plotted with the water absorption values is shown in Fig.4

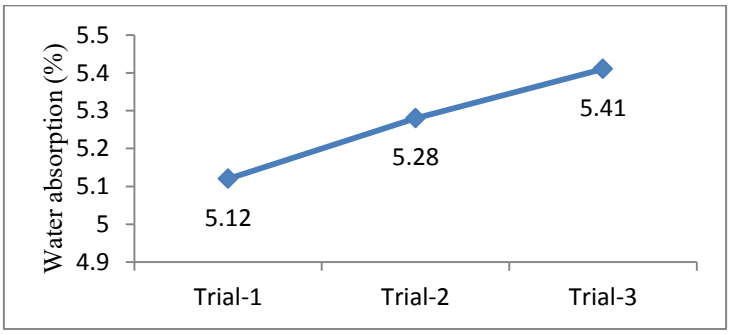

Figure 4: Water absorption chart

V.CONCLUSION

1. The compressive strength of the brick increases with increasing percentage of egg shell powder and decreasing percentage of quarry dust.
2. The maximum compressive strength value obtained is 8.45 N/mm^2.
3. The water absorption value is less than 7% for all the trials.
4. The optimum proportion of waste materials is fly ash 40 %, marble dust 10%, cement 5%, RHA 2%, Egg shell powder 10%, quarry dust 33%.

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THERMAL CONDUCTIVE CONCRETE USING SLAGS

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Abstract **- This paper examines the thermal conductivity of concrete. The thermal conductivity is increased by the addition of copper slag and steel slag. Many hit and trial methods have been done to identify the correct mix proportion of slag in concrete and also to find the compressive strength of the concrete. From the experiments that have been done, it has been inferred that 20% replacement of weight of concrete by slag is suitable without any compromise on strength. Thermal studies have been conducted on the controlled concrete M30 with and without adding slag separately. The results have been studied and have been found that the induction concrete attained high temperature faster than the normal concrete and the heat retaining capacity was also found to be much more than the normal concrete. The main application of this induction concrete is de-icing and anti-icing in bridge decks and highways**.

I. INTRODUCTION

Concrete bridge decks are prone to ice accumulation. The use of road salts and chemicals for deicing is an effective method for ice removal, but causes damage to concrete and corrosion of reinforcing steel in concrete bridge decks. This problem is a major concern to transportation officials and public works due to rapid degradation of existing concrete pavements and bridge decks. The use of insulation materials for ice control and electric or thermal heating for deicing have been attempted and met limited success. Conductive concrete may be defined as a cementitious composite that contains a certain amount of thermally conductive components to attain stable and relatively high thermal conductivity. When power supply is given to the light weight iron element which is embedded in concrete, heat is induced in it.

This is based on the principle of thermal conductivity. In physics, thermal conductivity (often denoted k, λ, or κ) is the property of a material to conduct heat. It is evaluated primarily in terms of Fourier's Law for heat conduction. Heat transfer occurs at a lower rate across materials of low thermal conductivity than across materials of high thermal conductivity. Correspondingly, materials of high thermal conductivity are widely used in heat sink applications and materials of low thermal conductivity are used as thermal insulation. The thermal conductivity of a material may depend on temperature. The reciprocal of thermal conductivity is called thermal resistivity.

Ongoing IRC research is now focused on optimizing conductive concrete formulations for the best combination of strength, electrical properties, and production methods at the lowest possible cost, leading ultimately to commercial development and widespread use.

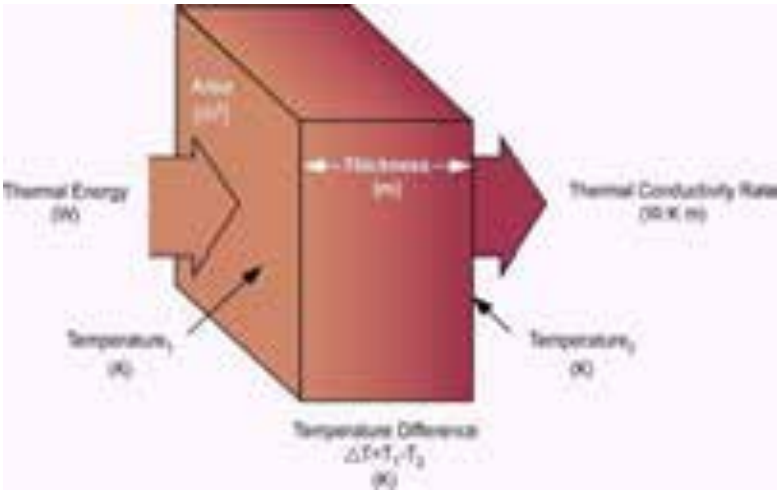

Fig 1 Principle of thermal conductivity

II. OBJECTIVES AND SCOPE

The main objective of this thesis is to prepare a conductive concrete mix specifically for cold regions, for deicing and anti-icing application and to increase the thermal conductivity of concrete by incorporating steel slag and copper slag in the concrete mix. The thermal conductivity of the copper and steel slag along with the concrete has been studied.

III. MATERIALS BACKGROUND

A.Copper Slag

Copper slag is a by-product of copper extraction by smelting. During smelting, impurities become slag which floats on the molten metal. Slag that is quenched in water produces angular granules which are disposed of as waste or utilized as discussed below Copper slag is one of the materials that is considered as a waste material that could have a promising future in construction industry as partial substitute of either cement or aggregates. Studies are already being carried out to increase the output by using copper slags and other materials as composites. From this project, it is evident that copper slag can be used to enhance the characteristics when used with other materials. Hence, it has a huge potential to be used for industrial applications.

Fig-2 Copper slag

TABLE I
PROPERTIES OF COPPER SLAG

Name	Thermal conductivity (W/mK)	Cost (Per Ton) (Rs.)
Copper slag	385	200/tonne

B.Steel Slag

Steel slag, a by-product of steel making, is produced during the separation of the molten steel from impurities in steel-making furnaces. The slag occurs as a molten liquid melt and is a complex solution of silicates and oxides that solidifies upon cooling.

Fig-3 Steel slag

TABLE 2
PROPERTIES OF STEEL SLAG

Name	Thermal Conductivity (W/mK)	Cost (Per Ton) Rs.
STEEL SLAG	50.2	650

IV. EXPERIMENTAL PROGRAMME

C.Compressive Strength Test

In order to find the compressive strength of concrete, specimens of size 15cm x 15cm x 15cm were casted for various proportions. The test were performed with a 2000kN compression testing which provided essentially fixed end condition to the bottom and the top was free end. Specimen end plates provide a uniform load distribution over the cross section. The cube was generally loaded at the rate of 99.9kN/s. Near and after failure, the load was manually controlled to allow visual observation. The load was applied to the specimen up to failure mode.

Fig-4 Compressive strength machine

From the experimental result, it has been found that the concrete cube which was formed by replacing 20% by weight of the concrete showed satisfiable results. The comparative study of the various mix proportions are tabulated.

TABLE 3

COMPRESSION TEST RESULTS

Mix proportion	Copper slag in %	Steel slag in %	Peak load in kN
M30	_	_	667.25
10% replacement	5	5	511.5
	7.5	2.5	545.3
20% replacement	10	10	634.25
	15	5	659.5
30% replacement	15	15	640.7
	22.5	7.5	602.6

Cracks are formed in the 30% replaced concrete cube, even though it has achieved the nearer strength as that of the 20% replaced concrete.

D. Thermal Study

After finding the correct mix proportion with the required strength, thermal studies were conducted on the concrete cubes .The temperature of the cubes were raised to about 10 degree Celsius from room temperature. It was

found that the concrete cube with the addition of slag attained the temperature 64.4 degree Celsius 13 minutes earlier than the concrete cube without the addition of the slag. After the supply of electricity is stopped the heat retaining capacity of the cubes were also found .From that it was inferred that the heat retaining capacity of the concrete with the addition of the slag was 2 hours more than that of the normal concrete. Graphs were drawn between the temperature and the time and results were found.

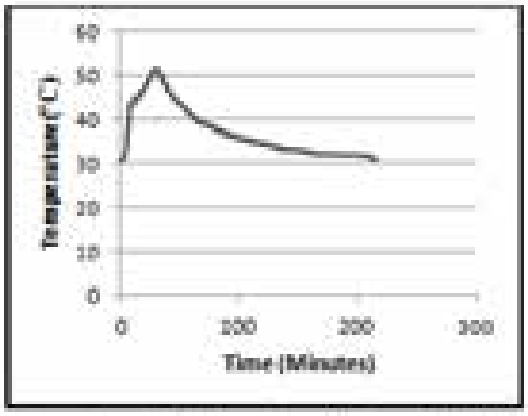

Fig-5 Experimental results of temperature V/s time graph (M30 concrete)

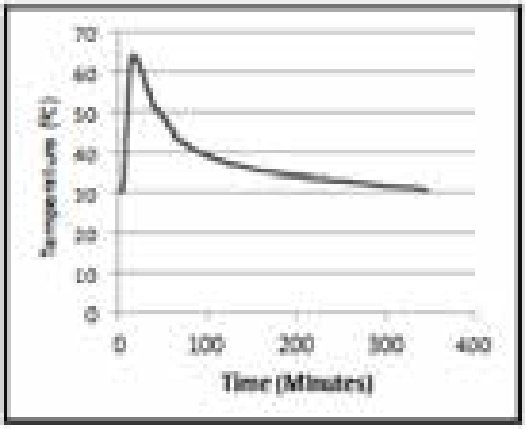

Fig-6 Experimental results of temperature V/s time graph (20% replaced concrete)

V.APPLICATIONS

- Conductive concrete has the potential to address a wide variety of applications, including grounding, heating, cathodic protection of reinforcing steel in concrete structures such as bridges and parking garages, and electromagnetic shielding.
- Electrical heating using conductive concrete has excellent potential for domestic and outdoor environments, especially for de-icing of parking garages, sidewalks, driveways, highway bridges, and airport runways.

VI.CONCLUSIONS

The thermal conductivity of copper and steel slag are studied. The heat retaining capacity of the conductive concrete proved to be a valuable asset for its de-icing and anti-icing applications. Research is also being made to implement the conductive concrete in the steam power plants.

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EXPERIMENTAL STUDY ON HYBRID FIBRE REINFORCED GEOPOLYMER CONCRETE

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***Abstract*: The main aim of this project is to reduce the emission of CO_2 into the atmosphere by means of eliminating the usage of cement. This study focus on experimentally determining the mechanical properties of Hybrid Fibre Reinforced Geopolymer Composites (HFRGPC) which consists of GGBS, fly ash, alkaline liquids, glass and polypropylene fibres. The molarity of sodium hydroxide solution is fixed as 10 M .Glass fibre with varying percentage (0.02% and 0.03%) is adopted in this study. And then the polypropylene fibre ratio is fixed as 30 percentage of glass fibre. The addition of fibre changes the brittle behavior of concrete to ductile with significant increase in tensile strength and toughness. For curing, the temperature was fixed at room temperature for 24 hours. The specimens were tested for the ages of 14 and 28 days and they were tested for compressive strength and split tensile strength. HFRGPC showed increase in compressive strength of about 17.32 % of GPC and increase in tensile strength of 45.28% of GPC when compared with Geopolymer concrete(GPC).**

Keywords: GGBS, fly ash, glass, polypropylene fibres

I. INTRODUCTION

The global use of concrete is second only to water. The applications of concrete in the area of infrastructure, habitation, and transportation have greatly prompted the development of civilization, economic progress, stability and the quality of life. However, due to raw materials, some inherent disadvantages of Portland cement are still difficult to overcome. There are two major drawbacks with respect to sustainability. About 1.5 tonne of raw materials is needed in the production of every tonne of Portland cement, at the same time about one tonne of carbon dioxide (CO_2) is released into the environment during the production. In order to overcome this, recent development in concrete technology provided a path for the development of environmental friendly inorganic alumina-silicate polymer called Geopolymer which is synthesized from materials of geological origin or by-product materials such as fly ash, silica fume, metakaoline, that are rich in silicon and aluminium.

A. Geopolymer

Davidovits proposed that an alkaline liquid could be used to react with the silicon (Si) and the aluminum (Al) in source materials such as fly ash, silica fume and rice husk ash to produce binder sand the alkaline liquid used can be Sodium or Potassium based. Because the chemical reaction that takes place in this case is a polymerization process he coined the term „Geopolymer‟ to represent these binders. The polymerization process involves a fast chemical reaction under a highly alkaline condition of Si-Al minerals resulting in a three-dimensional polymeric chain and ring structure consisting of Si-O-Al-O bonds in amorphous form (Davidovits, 1994). However, a small proportion of calcium-rich source materials such as slag may be included in the source material in order to accelerate the setting time and to alter the curing regime adopted for the geopolymer mixture.

The objective of the study is as follows

- To replace cement with byproducts such as fly ash and Ground Granulated Blast furnace Slag (GGBS).
- To obtain the optimum hybrid fibre content in Geopolymer Concrete (GPC).
- To compare the mechanical properties of GPC specimen with Hybrid Fibre Reinforced Geopolymer Concrete (FRGPC) specimen.

II. CONSTITUENTS OF GEOPOLYMER CONCRETE

Although geopolymer concrete can be made using various source materials, the present study used class F fly ash and GGBS.

Following materials are generally used to produce GPC and HFRGPC:-

1. Fly Ash (FA)
2. Coarse and Fine aggregate
3. Alkaline liquids
4. Ground Granulated Blast furnace Slag (GGBS)
5. Glass fibre
6. Polypropylene fibre
7. Superplasticizer

B. Flyash

Low-calcium, Class F, obtained from the silos of Mettur Thermal Power Plant in Tamil Nadu is used as source material. It is refractory and alkaline in nature, having fineness 2.98

C. Coarse and Fine aggregate (CA and FA)

Aggregates are inert mineral material used as filler in concrete which occupies 70 -85 % volume. Sand passing through 4.75mm IS sieve conforming to grading zone II of IS 383:1970 was used. Its specific gravity is 2.74. Locally available stone aggregate of size 20 mm passing and retained in 16 mm, was used and the specific gravity and fineness modulus for the same are 2.74 and 2.47as per IS: 2386- 1968 Part III. Both the Aggregates compiled with the requirements of IS: 383-1970

D. Super plasticizer

In order to achieve the desired workability, a naphthalene based super plasticizer was used as the water reducer. In this project Conplast SP-430 was used as super plasticizer.

E. Sodium hydroxide

The sodium hydroxide with 97-98% purity, in flake or pellet form, is commercially available. The solids must be dissolved in water to make a solution with the required concentration. The concentration of sodium hydroxide solution can vary in the range between 8 Molar to 16 Molar. The mass of NaOH solids in a solution varies depending on the concentration of the solution. For instance, NaOH solution with a concentration of 10 Molar consists of 10x40 = 400 grams of NaOH solids per litre of the solution, where 40 is the molecular weight of NaOH.

F. Sodium silicate

Sodium silicate is also known as water glass or liquid glass, available in liquid (gel) form. In present investigation sodium silicate 2.0 (ratio between Na_2O to SiO_2) is used.

G. Ground Granulated Blast furnace Slag (GGBS)

In order to accelerate the setting time of fresh geopolymer concrete and to facilitate room-temperature curing, a small proportion of calcium-rich source material blast furnace slag is added to the mixture with fineness of 2.7. Ground granulated blast furnace slag (GGBS) is a by-product from the blast-furnaces used to make iron.

H. Glass Fibre

Glass fibre are made of silicon oxide with addition of small amounts of other oxides. Glass fibres are characteristic for their high strength, good temperature and corrosion resistance, and low price. Alkali resistant E-glass fibres of 7 mm length, 0.014 mm nominal diameter and density of 2650 kg/m^3 were used.

Fig.1: Glass fibre

Fig.2: Polypropylene fibre

I. Polypropylene Fibre

A fibrillated Polypropylene fibre of aspect ratio 40 is used for the study.

III. PREPARATION OF ALKALINE LIQUIDS

Sodium hydroxide pellets are taken and dissolved in the water at the rate of 10 molar concentrations. It is strongly recommended that the sodium hydroxide solution must be prepared 24 hours prior to use and also if it exceeds 36 hours it terminate to semi solid liquid state. So the prepared solution should be used within this time.

IV. MIX DESIGN

So far no standard mix design is available for GPC, since they are new class of construction material. So trial and error method is adapted. To arrive the mix proportion for the present study, the density of GPC is adopted as 2400 kg/m^3(same as that of conventional concrete).Total aggregate is taken as 77% of density (fine aggregate 30% and coarse aggregate 70%) , from which the aggregate quantity is calculated. From the previous literature the alkaline to fly ash ratio is taken as 0.4 from which the mass of fly was found. In order to find out the quantity of alkaline solution the ratio of Na_2SiO_3 to NaOH is taken as 2.5. In order to facilitate ambient curing an optimum replacement of 50% of GGBS in fly ash is adapted. The molarity of NaOH is fixed as 10M throughout the mix. Extra water is taken as 15% and the Super plasticizer as 3% of (Flyash+GGBS).The quantity per m^3 is shown in the table below.

TABLE 1
QUANTITY PER m^3

Materials (kg/m^3)	GPC	HFRGPC 1 (0.02% Glass fibre)	HFRGPC 2 (0.03%Glass fibre)
Flyash	197.15	197.15	197.15

GGBS		197.15	197.15	197.15
FA		555.00	555.00	555.00
CA		1293.0	1293.00	1293.00
Alkaline Solution	NaoH	45.14	45.14	45.14
	Na_2Sio_3	112.85	112.85	112.85
Glass fibre		0	0.53	0.79
Polypropylene fibre		0	0.159	0.237
Extra water		59.15	59.15	59.15
Super plasticizer		11.83	11.83	11.83

V. CASTING OF SPECIMENS

Cubes of size 150x150x150 mm, cylinders of 300 mm height and 150 mm diameter and prisms of size 500x100x100 mm were casted to carry out the compression, tensile and flexural strength respectively. The fresh mix was placed in the mould and compacted using needle vibrator. After demoulding they were kept in the room temperature for 14 and 28 days curing.

VI. TESTING

J. Compression Test

The compression test was carried out in the CTM (Compression Testing Machine) 2000KN capacity. The load is applied at a uniform rate till failure.The compression test values are tabulated in Table 2.

TABLE 2
COMPRESSIVE STRENGTH OF SAMPLES

Specimen	Days	Nos.	Compressive strength (N/mm^2)	Average Compressive Strength (N/mm^2)
GPC	14	1	41.76	41.58
		2	42.04	
		3	40.94	
	28	1	51.07	48.80
		2	47.80	
		3	47.50	
HFRGPC 1 0.02% Glass fibre	14	1	38.45	44.24
		2	49.60	
		3	44.58	
	28	1	58.00	57.25
		2	58.20	
		3	55.56	
HFRGPC 2 0.03% Glass fibre	14	1	39.55	43.43
		2	40.59	
		3	50.15	
	28	1	51.29	50.75
		2	45.36	
		3	55.61	

TABLE 3
TENSILE STRENGTH OF SAMPLES

Specimen	Days	Nos.	Tensile strength (N/mm^2)	Average Tensile Strength (N/mm^2)
GPC	14	1	2.14	2.27
		2	2.11	
		3	2.55	
	28	1	2.87	2.65
		2	2.44	
		3	2.63	
HFRGPC 1 0.02% Glass fibre	14	1	3.29	3.36
		2	3.24	
		3	3.54	
	28	1	4.04	3.85
		2	3.95	
		3	3.54	
HFRGPC 2 0.03% Glass fibre	14	1	2.55	2.69
		2	2.63	
		3	2.88	
	28	1	3.14	3.08
		2	3.29	
		3	3.30	

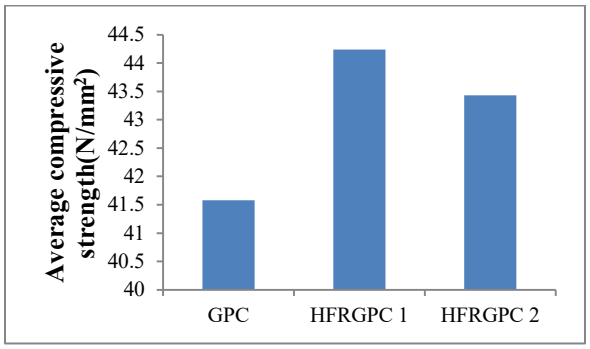

Fig.3: Comparison of compressive strength (14 days)

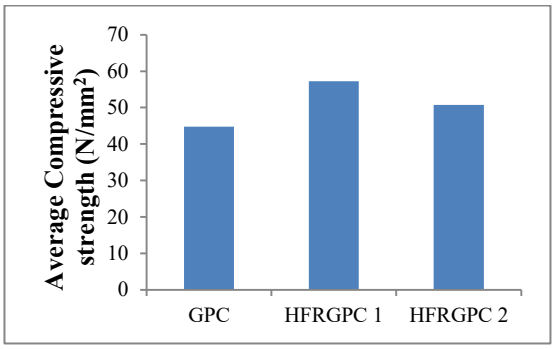

Fig.4: Comparison of compressive strength (28 days)

K. Split Tensile Test

The influence of the fibre on the concrete was found out by conducting the split tensile test. The test was carried out in the CTM (Compression Testing Machine) of 2000KN capacity. The test values are tabulated below

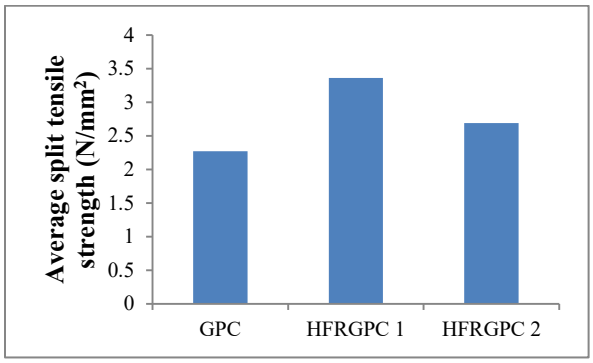

Fig.5: Comparison of split tensile strength (14 days)

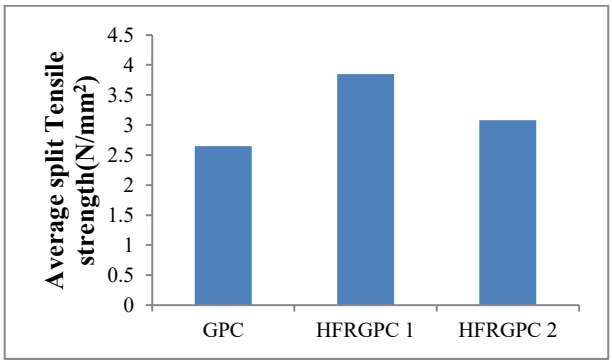

Fig.6: Comparison of split tensile strength (28 days)

VII. RESULTS AND DISCUSSION

The following conclusions could be drawn from the present investigation:

- Inclusion of glass and polypropylene fibre shows considerable increase in compressive and Split tensile strength of GPC with respect to GPC without fibre.
- The increase in compressive strength was found to be 6.39% at 14 days and 17.32% at 28 days for HFRGPC 1 and 4.49% at 14 days and 3.99% at 28 days for HFRGPC 2 when compared with Geopolymer concrete.
- The increase in split tensile strength was found to be 48.0% at 14 days and 45.28% at 28 days for HFRGPC 1 and 18.6% at 14 days and 16.23% at 28 days for HFRGPC 2 when compared with geopolymer concrete.
- 12.8% increase in compressive strength for HFRGPC 1 when compared with HFRGPC 2.
- 25% increase in split tensile strength for HFRGPC 1 when compared with HFRGPC 2
- From the results obtained it can be concluded that with the increase in glass fibre content there is a decrease in compression and split tensile strength.

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LABORATORY STUDY OF POROSITY AND STRENGTH PROPERTIES OF PERVIOUS CONCRETE

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Abstract: **The main aim of this project is to check the properties of pervious concrete without using any admixtures. Pervious concrete is a special type of concrete with high porosity used for concrete flat work applications that allow water from precipitation and other sources to pass directly through, thereby reducing the runoff from a site and allowing ground water recharge. This paper mainly focus on compressive strength, flexural strength, split tensile strength and porosity of pervious concrete. Consider to investigate the result of compressive strength, "cube" of size 150mm x 150mm x 150mm, for split tensile strength and "cylinder" of size 300mm x150mm are prepared and tested should be carried out at a regular interval of 7 ,14 and 28 days. Different concrete mix proportion such as 1:5, 1:4.5 , 1:3.2 and with size of coarse aggregate such as 12.5mm should be used to check the properties of pervious concrete.**
Keywords: Aggregates, Mix Proportion, Compressive strength, Porosity, Curing.

I. INTRODUCTION

Pervious concrete which is also known as the no-fines, porous ,gap-graded, and permeable concrete and enhance porosity concrete has been found to be a reliable storm water management tool. By definition, pervious concrete is a mixture of coarse aggregate, cement, water, little or no sand (fine aggregate) ,with or without admixtures. It has just enough cementitious paste to coat the coarse aggregate particles while preserving the interconnectivity of the voids.It consists of 15% to 35% voids, allowing for quick drainage.In late 1940s and early 1950s ,the no-fines concrete had been used for the construction of high rise buildings due to its light weight.Pervious concrete can be used in a wide range of applications, although its primary use is in pavements which are in: residential roads, alleys and driveways, low volume pavements, low water crossings, sidewalks and pathways, parking areas, tennis courts, slope stabilisation, sub-base for conventional concrete pavements etc. Pervious concrete has a lower compressive strength and a lower unit weight (approximately 70% of conventional concrete). However, pervious concrete has a greater advantage in many regards.

II.AIM AND OBJECTIVES

The aim of this research work is to study the properties of no-fines concrete with different mix proportion by varying aggregate-cement ratio. The main aim behind this research work was to produce a concrete block without fine aggregate particle which would result in lower density with sufficient strength thereby reducing production cost. The objectives are as follows:

- To investigate the performance characteristics of the pervious concrete such as Compressive strength and flexural strength, split tensile strength.
- To determine the effect of mix type on the engineering properties of thepervious concrete.

III. EXPERIMENTAL STUDY

Number of no-fines concrete mixes was prepared by varying aggregate-cement ratio and water-cement ratio were a/c ratio of 1:5, 4.5:1 & 3.2 :1 , w/c ratio of 0.4 and coarse aggregate of 12.5mm down size has been used in this study. Mixing of concrete was carried in concrete mixer for thorough mixing.

Firstly dry mix of coarse aggregate and cement was carried for about 1.5minutes and later calculated water was added to the dry mix and mixed for about 3minutes in the mixer. After thorough mixing, concrete mixture is then placed over a tray and then concrete was transferred into cube of size 150mm x150mmx150mm ,cylinder of size 300mm x 150mm and beam of size 500mmx100mmx100mm. Concrete specimens were de-molded after 24 hours and is cured by means of gunny bag curing. Then these cube and beam specimens were tested for compressive strength and flexural strength respectively at the age of 7 days, 14days and 28 days.

IV. MATERIALS AND METHODOLOGY

Constituent materials used for the study were cement, coarse aggregate, fine aggregate and water. Properties of the material used in this study are mentioned below.

- Cement: Ordinary Portland Cement of 53 grade was used in this study. The properties of cement are given below.
- Coarse aggregate: Crushed angular aggregate of 12.5mm down size obtained from local quarry was used in this study and its properties are given below.
- Water: Tap water available in concrete laboratory was used for mixing and curing of concrete .

TABLE 1
PHYSICAL PROPERTIES OF MATERIALS

S.No	Properties	Cement	Coarse aggregate
1.	Consistency	36%	-
2.	Initial setting time	35 minutes	-
3.	Final setting time	230 minutes	-
4.	Specific gravity	3.15	2.7
5.	Water absorption	-	0.5%
6.	Soundness	4 mm	-
7.	Fineness modulus	-	7.67%

V. CASTING OF SPECIMEN

Cubes of size 150x150x150mm, cylinder of size 300mm x 150mm and beams of size 500x100x100 mm were casted to carry out the compression, split tensile strength and flexural strength respectively. The fresh mix was placed in the mould . After demoulding they were cured by means of gunny bag curing for 7, 14 and 28 days respectively.

VI. TESTING OF CONCRETE

A. Compression Test

The compression test was studied in the CTM (Compression Testing Machine) 2000KN capacity. The load is applied at a uniform rate till failure.The compression test values are tabulated below:

TABLE 2
COMPRESSIVE STRENGTH OF SAMPLES

Size Of Aggregate	Mix Type	W/C Ratio	Compressive Strength	
			7 Days	28 Days
12.5	5:1	0.4	2.4	4.59
	4.5:1	0.4	3.91	6.12
	3.2:1	0.4	5.91	10.08

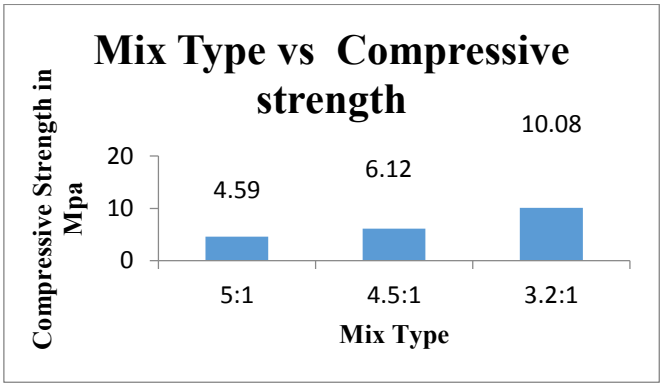

Fig 1.Mix Type vs Compressive Strength

B. Split Tensile Strength

The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete.The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack.

$$\text{Split tensile strength (T)} = 2P/\pi DL$$

TABLE 3
SPLIT TENSILE STRENGTH OF SAMPLES

Size of Aggregate	Mix Type	W/C Ratio	Split Tensile Strength at the end of 28 Days
12.5	5:1	0.4	0.58
	4.5:1	0.4	0.654
	3.2:1	0.4	0.94

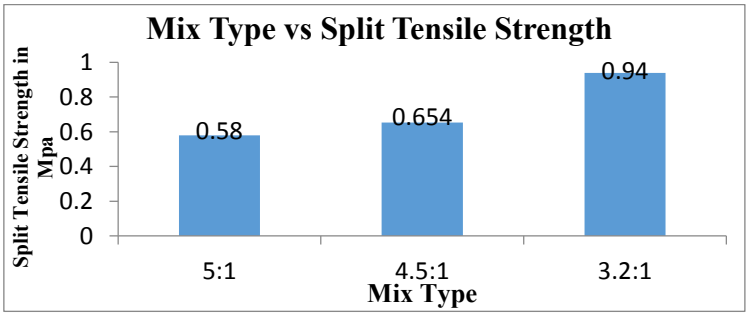

Fig 2.Mix Type vs Split Tensile Strength

C.Porosity

The porosity test was carried out at 28 day of age. The open porosity was measured as the percentage of pore volume or void space within the concrete that can contain water

$$v_r = [1 - \frac{w_2 - w_1}{\rho_w X\ vol}]\ 100\%$$

TABLE 4
POROSITY OF SAMPLES

Mix Type	Size of Aggregate (mm)	Weight of dry specimen(w_1)	Weight of saturated specimen(w_2)	Porosity in %
5:1	12.5	8.94	11.37	28
4.5:1		8.64	11.13	26.2
3.2:1		9.65	12.26	22.67

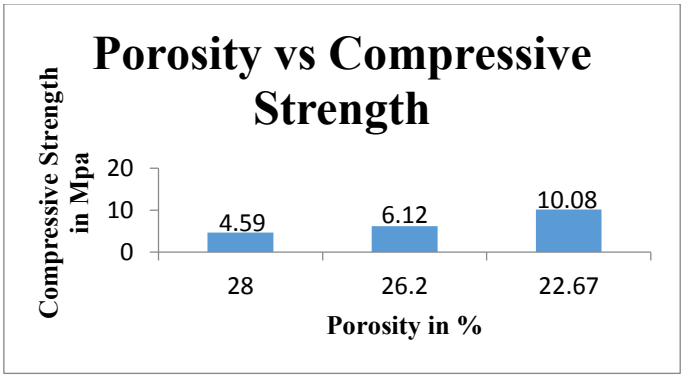

Fig 3.Porosity vs Compressive Strength

VII. RESULT &DISCUSSION

The following conclusion are based on the experimental study on no-fines concrete.

- From this study, for building application aggregate-cement ratio of 3.2 :1 without fines aggregate mix at 0.4 w/c ratio is recommended whose 28 day Compressive Strength was found to be 10.08 N/mm2.
- Strength properties of investigated no-fines concrete are found to be lower than that of conventional concrete but are sufficient enough for structural use such as sidewalks, roadways, tennis courts and low traffic areas.
- A decreases in porosity of the pervious concrete mixtures were found to be increasing in compressive strength. A reduction in compressive strength were observed when the pre sizes in the mixture were higher.

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Experimental investigation on waste glass powder as partial replacement of cement in concrete

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***Abstract*— Cement manufacturing industry is one of the carbon dioxide emitting sources besides deforestation and burning of fossil fuels. The global warming is caused by the emission of greenhouse gases, such as CO_2, to the atmosphere .Among the greenhouse gases; CO_2 contributes about 65% of global warming. The global cement industry contributes about 7% of greenhouse gas emission to the earth's atmosphere. In order to address environmental effects associated with cement manufacturing, there is a need to develop alternative binders to make concrete. Efforts have been made in the concrete industry to use waste glass as partial replacement of coarse or fine aggregates and cement. In this study, finely powdered waste glass is used as a partial replacement of cement in concrete and compared it with conventional concrete. This work examines the possibility of using Glass powder as a partial replacement of cement for new concrete. Glass powder was partially replaced as 5%, 10%, 15%, 20%, 25%and 30% and tested for its Compressive, Tensile and Flexural strength up to 28 days of age and were compared with those of conventional concrete. From the results obtained, it was found that 10% replacement of cement with glass powder as optimum;**

Keywords—powdered glass; workability, alkalinity, split tensile, pozzolanic

I. INTRODUCTION

A. Glass

Glass is a widely used manufactured product in our life in various forms such as sheet glass, bottles, glassware etc. Glass is an amorphous material with high silica content(SiO_2) i.e.72% waste glass when grounded to very fine powder (600 micron) reacts with alkali in cement (Pozzolana reaction) &cementations product that help to contribute to the strength development [Veena et al,2014].Since glass is a non-bio-degradable product, ideal for recycling. The physical and chemical properties of glass powder is mentioned in table I, II and III

B. Recycling of Glass

An enormous quantity of waste glass is generated all around the world. The land filling of waste glass is undesirable, since it is a non-biodegradable it is less environmental friendly. Use of recycled materials in construction is the most attractive option because of the large quantity due to widespread sites of construction. Thus there is a need of utilizing waste glass. There is huge potential for using waste glass in the concrete construction sector. Waste glasses when reused in making concrete products can decrease the cost of construction.

II. OBJETIVE OF THE WORK

The main objective of this research is to assess the properties of concrete when the cement was partially replaced by the waste glass powder of size less than 75μm.

a) To find the optimum replacement percentage of waste glass powder as the partial replacement of cement in concrete production.

b) To determine the strength characteristics of concrete like flexural strength, compressive strength and split tensile strength.

III. MATERIALS AND METHOD

C. Cement

In this research, locally available cement which is of the Ordinary Portland Cement type (53 grade) was used conforming to IS 8112 throughout the work.

D. Water

Water used was potable, fresh, colorless, odorless, and tasteless water that is free from organic matter of any type conforming to IS3025.

E. Fine Aggregates

The locally available sand confirming to zone II having the specific gravity 2.48 was used for this study. The coarse aggregate used for this research is 20mm size with specific gravity 2.8. The tests were done as per Indian Standard Specifications IS: 2386.

F. Waste Glass Powder

Waste glass locally available and it has been collected and made in to glass powder. Before adding glass powder in the concrete it has to be powdered to required size. In this experiments glass powder (GLP) having particle size less than 75µm was used.

Fig: 1 Waste Glass Powder

TABLE I
PHYSICAL PROPERTIES OF GLASS POWDER

S.No	Physical Properties of Glass Powder	
1	Specific gravity	2.6
2	Fineness Passing 150µm	99.5
3	Fineness Passing 90µm	98

TABLE II
CHEMICAL PROPERTIES OF GLASS POWDER

S.No	Chemical Properties of Glass Powder	
1	pH	10.25
2	Colour	Grayish white

TABLE III
CHEMICAL COMPOSITION OF GLASS POWDER

S. No	Chemical Properties of Glass Powder	% by mass
1	SiO_2	67.330
2	Al_2O_3	2.620
3	Fe_2O_3	1.420
4	TiO_2	0.157
5	CaO	12.450
6	MgO	2.738
7	Na_2O	12.050
8	K_2O	0.638
9	ZrO_2	0.019
10	ZnO	0.008
11	SrO	0.016
12	P_2O_5	0.051
13	NiO	0.014
14	CuO	0.009
15	Cr_2O_3	0.022

G. Experimental plan

Experiments were conducted on concrete prepared by partial replacement of cement by waste glass powder of particle size 75µm.The cement was replaced by waste glass powder as 5%,10%, 15%, 20%, 25% and 30%. Three specimens were prepared and tested for each replacement of cement.

H. Mix Design

The concrete mix design was prepared as per IS 456:2000 and IS 10262:2009. The grade of concrete used for this study is M35. The mixture was prepared with the cement content of 413.33 kg/m^3 with w/c ratio of 0.45. The mix proportion of materials is 1:1.63:2.94.Chemical admixture was not used here. The partial Replacement of cement by using glass powder is mention in table IV.

TABLE IV
PARTIAL REPLACEMENT OF CEMENT BY USING GLASS POWDER

S. No.	% of Replacement	Cement Kg/m^3	Glass powder Kg/m^3	Fine aggregate Kg/m^3	Coarse aggregate Kg/m^3
1	0%	413.33	-	673.712	1215
2	5%	389.33	20.67	673.712	1215
3	10%	372	41.33	673.712	1215
4	15%	351.33	62	673.712	1215
5	20%	330.66	82.67	673.712	1215
6	25%	310	103.34	673.712	1215
7	30%	289.33	124	673.712	1215

IV DURABILITY TEST

The concrete prepared with various percentage replacement of the cement such as 5%, 10%, 15%, 20%, 25% and 30%was cured under normal condition as per IS recommendation and were tested at 28 days for determining the compressive, tensile and flexural strength and also compared with the test results of conventional concrete

I. Compressive Strength

The specimen cubes of size 150mm x 150mmx 150mm were casted and the compressive strength test was carried out as per IS: 516 – 1959 AT 28th day using compression testing machine. The results obtained from the test have been tabulated in Table V. Compressive Strength of M35 Grade V/S % Of Glass Powder is mentioned in figure 2

TABLE V
COMPRESSIVE STRENGTH OF CONCRETE

Sl.no.	Percentage replacement of cement with glass powder	Number of cubes	Compressive strength N/mm^2
1	0	3	35.52
2	5	3	38.28

3	10	3	40.25
4	15	3	34.62
5	20	3	34.25
6	25	3	32.82
7	30	3	31.26

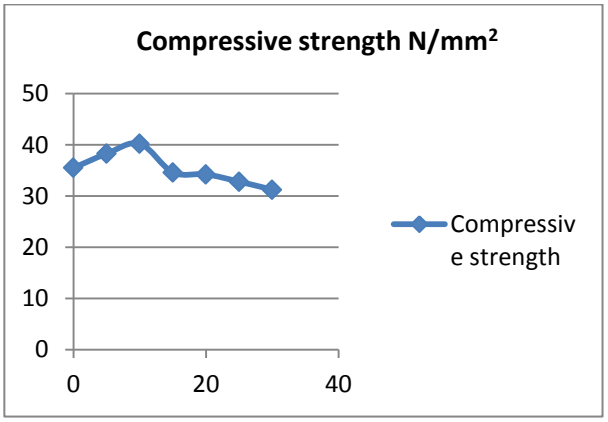

Fig 2: Compressive Strength of M35 Grade V/S % of Glass Powder

J. Tensile Strength

The specimen cylinders of diameter 150mm and height 300mm were casted and the tensile strength test was carried out as per IS: 516 – 1959 AT 28th day using compression testing machine. The results obtained from the test have been tabulated in Table VI. Tensile Strength of M35 Grade V/S % Of Glass Powder is mentioned in figure 3

TABLE VI
TENSILE STRENGTH OF CONCRETE

Sl.no.	Percentage replacement of cement with glass powder	Number of cylinders	Tensile strength N/mm^2
1	0	3	5.99
2	5	3	9.79
3	10	3	10.98
4	15	3	8.08
5	20	3	7.79
6	25	3	7.23
7	30	3	6.59

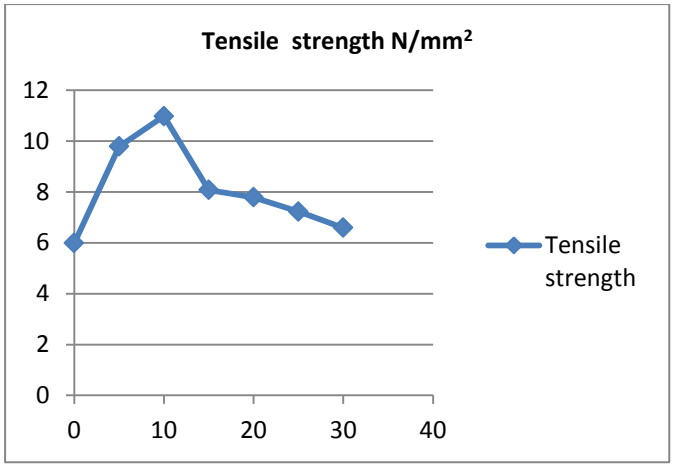

Fig 3: Tensile Strength of M35 Grade V/S % Of Glass Powder

K. Flexural Strength

The prism of size 100mm x 100mm x 500mm were casted and the flexural strength test was carried out as per IS: 516 – 1959 AT 28th day using compression testing machine. The results obtained from the test have been tabulated in Table VII. Flexural Strength of M35 Grade V/S % Of Glass Powder is mentioned in figure 4

TABLE VII
FLEXURAL STRENGTH OF CONCRETE

Sl.no.	Percentage replacement of cement with glass powder	Number of prism	Flexural strength N/mm^2
1	0	3	4.8
2	5	3	5.7
3	10	3	6.2
4	15	3	5.4
5	20	3	5.0
6	25	3	4.3
7	30	3	4.0

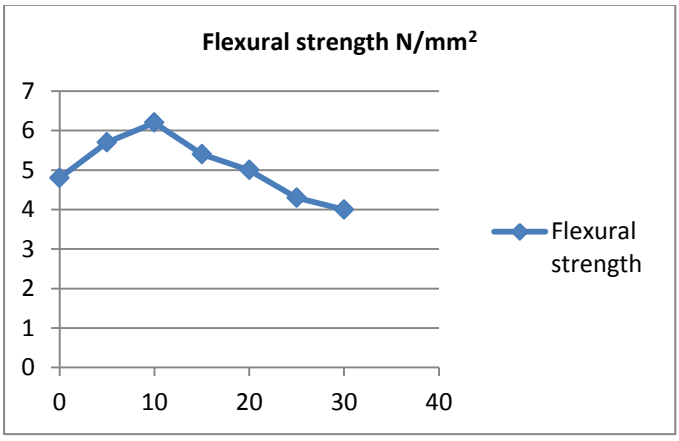

Fig 4: Flexural Strength of M35 Grade V/S % Of Glass Powder

L. Alkalinity test:

After 28 days curing the specimen are taken out from curing tank. Specimens are dried in oven at 105°C for 24 hours. The dry specimens are cooled to room temperature. Dry specimens are broken and separated the mortar from the concrete. Then the mortar is grinded into powder form. The powdered mortar is sieved in 150µ.

10 gm of mortar is taken and it is diluted in 50ml distilled water and completely stirred it. Then the pH meter immerse into the solution and pH value of the solution is noted Fig.4. The general pH value of the solution and the level of inducing corrosion in the concrete was noted and the results are shown in table VIII. Alkalinity test on Glass powder added concrete is mentioned in figure 5

Fig 5: Alkalinity test on Glass powder added concrete

TABLE VIII
THE ALKALINITY TEST VALUES FOR GLASS POWDER ADDED CONCRETE

% Replacement of Glass powder in concrete	pH Value
0	12.3
5	12.1
10	12.7
15	12.4
20	12.6
25	12.5
30	12.67

V. RESULT AND DISCUSSION

- The compressive strength test on both conventional and glass added concrete was performed on standard compression testing machine of 3000kN capacity, as per IS516-1959.cubicalspecimensofsize150mmX150mmX150mm was casted and tested for the compressive strength at the age of 28days . Each of the compressive strength test data corresponds to the mean value of the compressive strength of three cubes. At 28 days the glass powder shows a strength of 40.25N/mm2, strength at 10% cement replacement,
- The Tensile Strength test on both conventional and glass added concrete was performed on standard compression testing machine, as per IS: 516-1959prism specimens of size cylinders of diameter 150mm and height 300mm was casted, glass powder added concrete at the age of 28 days. At 28 days, in 10% replacement the strength has been increased to 10.98N/mm2 .
- The flexural strength test on both conventional and glass added concrete was performed on standard Universal testing machine,asperIS:516-1959prism specimens of size100mmX100mmX500mm was casted glass powder added concrete at the age of 28 days . At 28 days, in 10% replacement the strength has been increased to 6.2N/mm2

- The pH value observed from the alkalinity test showed that the specimen tested found to be more alkaline and hence more resistant towards corrosion.

VI. CONCLUSION

Conventional concrete shows at 28 days compressive strength as 40.25N/mm^2, split tensile strength of 10.98N/mm^2 and flexural strength of 6.2N/mm^2

1. Replacement of glass powder in cement by 10% increases the compressive strength by 13.32%, respectively.

2. Replacement of glass powder in cement by 10% increases the split tensile strength by 83..5% respectively

3. Replacement of glass powder in cement by 10% increases the flexural strength by 29.16% respectively.

4. Glass powder concrete increases the compressive, tensile and flexural strength effectively, when compared with conventional concrete

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COMPARATIVE STUDY AND ANALYSIS OF RCC & POST TENSIONED TRANSFER PLATE

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Abstract:

A comparative study and analysis is made in RCC and Post tensioned transfer plate in high-rise buildings. A number of prototype models were analyzed using elastic linear response spectrum and inelastic nonlinear time history techniques using three-dimensional finite element models. The analyzed models have different transfer floor system; conventional transfer plate and post-tensioned transfer plate. The vertical position of the transfer system with respect to the building height was investigated. Global seismic response of the buildings such as storey shear and bending moment distribution were numerically evaluated. This paper presents a case study on the conventional and post tensioned transfer plate system and comparing with various aspects in design and execution process. The result shows the economic and more flexible system in terms of transfer plate floor system. The numerical analysis revealed that the transfer girder system is a competitive alternative to the slab system in terms of reducing the seismic weights as well as the material cost with a slight change in the global seismic behaviour of the building. Transfer girder system is more flexible compared to slab system and generate lower straining actions on the structural vertical elements.

1. INTRODUCTION

Building design often involves a podium structure that houses other functional spaces such as a shopping mall or a large lift lobby which require an unobstructed spatial layout in order to give a more impressive view. While the upper structure is often used as residential units/hotel rooms using more economical shorter span design with closely spaced walls or sometimes even for providing a very congested core wall for lift shaft and other building services.

2. **ABOUT TRANSFER PLATE**

Transfer plate is a structure mostly found in high rise building in all over the world. Building design often involves a podium structure that houses other functional spaces such as a shopping mall or a large lift lobby which require an unobstructed spatial layout in order to give a more impressive view.

3. SOFTWARES USED

- AutoCAD 2015 for creating structural layout drawing for transfer level and all above levels.
- ETABS 2013 for modeling and analysis the whole structure with appropriate IS load combination system.
- ADAPT Builder for analysis both RCC and Post-tensioned transfer slab.
- ADAPT Builder for designing and calculating the materials quantity like Concrete, Rebar, Tendons and Anchorages

4. LOADING DETAILS AND ITS COMBINATION

Load Cases:-

Self-Weight (DL)

Super Imposed Load (SDL)

Live Load (LL)

Earth Quake in X Direction (EQX)

Earth Quake in Y Direction (EQY)

As per IS 1893: 2002,

Wind Load in X Direction (WL X)

Wind Load in Y Direction (WL Y)

As per IS 875: 1987

Materials assigned in model are as follows

Grade of concrete

For column and wall in all floors M 50

For beams and slab in all floors M 25

For beams and slabs in transfer floor M 50

Grade of Steel Fe 500 for all members

5. COMPUTABLE BUILDING MODEL IN EATBS AND ANALYSIS

- Import the Auto Cad file .dwg /.dfx of all podiums and above floors to ETABS software for modelling. Assign the column/beam/slab/wall sizes with appropriate IS codal provisions.
- At transfer level select slab thickness as 2 m, initial assumption for analysis.After completion of entire model with all assigned properties to members as well as all loads with the above mentioned combinations.
- Make a clear view of transfer plate level for cross verifying the arrangements of column, wall, and slab in above and below floor levels.
- It has to be ensured that the assigned properties are same for both the portion of the building in order to achieve error free analysis and design comparison.

6. EXPORTING THE ANALYSISED MODEL FROM ETABS TO ADAPT

- Exporting the Transfer plate level from ETABS in adapt format and this has to be achieved by changing the file format from .f2k to .adb file format.
- Importing the adapt format file in adapt software and this has to be achieved by selecting the .adb file through importing tool.
- Generating the fine mesh over all the transfer plate for more accurate results. In adapt meshing table select maximum allowable for mesh shape and size as 1m to 1.5m the smaller mesh give more accuracy in results than the lager mesh and it has to be ensure all the meshes at the junction of column, beams, walls are generated with zero error if any errors formed at the particular area it has to be rectify it by manually.
- Formation of strips in X&Y Direction- This is the basic requirement in order to proceed analysing and designing of any members in adapt and this strips should be in both direction in plane surface X & Y Direction. Minimum one strip is required for each bay width along in spanning Y direction.
- Assigning bottom and top reinforcement on both side of the transfer level
- Assigning tendons in X&Y Direction on one side of the transfer level- Tendons are arranged in such a way that it should have high point at support zone and low point at mid span zone
- Run analysis for the given two envelope load cases

- Run the designing process for the two envelope load cases and generate the actual requirements of reinforcement for both the structural members.

After the successful completion of the entire analysis in ETABS and now exporting the entire transfer floor alone to adapt software for next detailed analysis and designing of both conventional and post-tensioned transfer plate system.

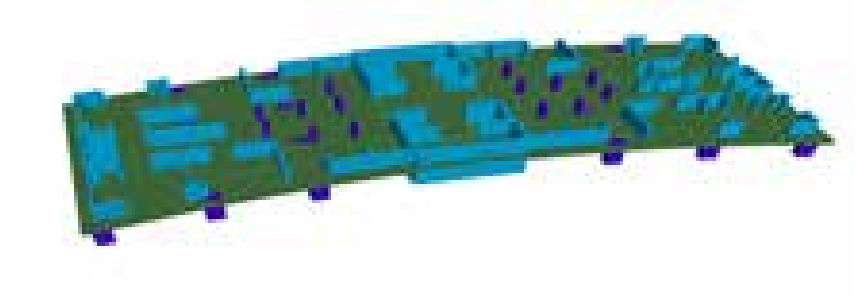

Fig1 Prismatic View of Transfer Plate in ADAPT

The above figure shows the view of transfer plate floor with all above columns, walls and slab arrangements as per the structural layout system. And it clearly shows that both the sides are having a same set of arrangements just like in ETABS model.

While exporting the transfer plate from ETABS model make sure that envelope values for flexural as well as service load cases are selected and this values may be slightly varies in adapt model.

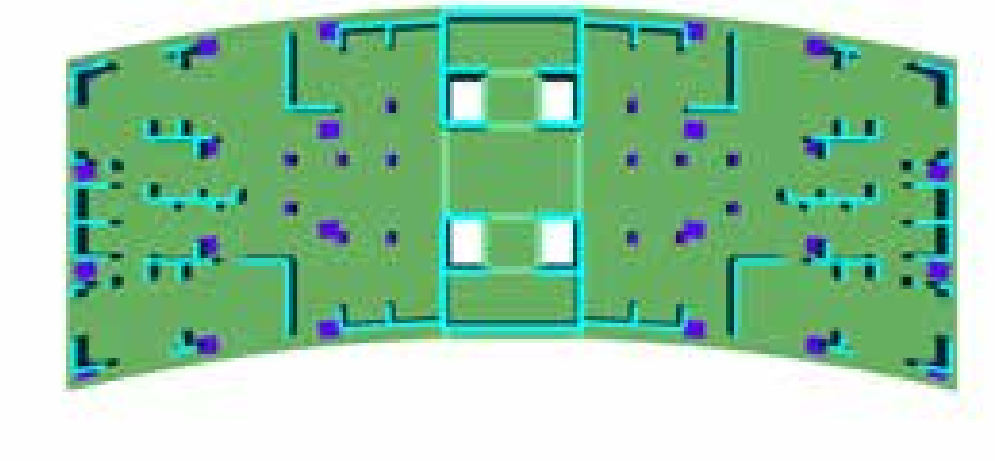

Fig 2.Top View of Transfer Pate in ADAPT

The above figure shows the top view of transfer plate floor with all above columns, walls and slab arrangements as per the structural layout system.

7. GENERATING AUTO LOAD AND LOAD COMBINATION

Generated load case for envelope values- Exporting the analyzed model from etabs by selecting the options that includes all above loading along with structural deformation due to various lateral effect. Line loads/point loads are automatically transferred in the surface of the transfer slab and these values create a base loading consideration for analysis and designing process

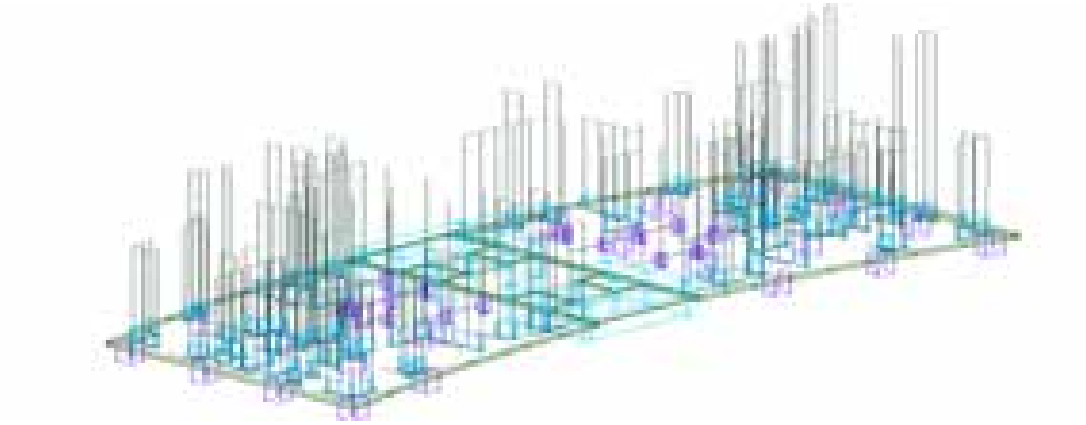

Fig 3 Generated load case for envelope values

8. GENERATE AUTO MESHING FOR TRANSFER PLATE

Auto Mesh generator-Finite Element Mesh Generation provides a concise and comprehensive guide to the application of finite element mesh generation over 2D domains, curved surfaces, and 3D space. Organised according to the geometry and dimension of the problem domains, it develops from the basic meshing algorithms to the most advanced schemes to deal with problems with specific requirements such as boundary conformity, adaptive and anisotropic elements, shape qualities, and mesh optimization.

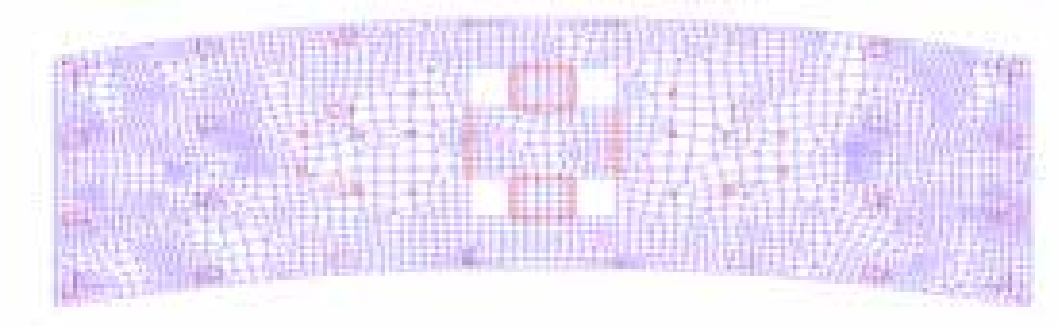

Fig 4 Auto Mesh generator limiting maximum of 1 m-1.5 m

9. DEFLECTION

Deflection Values on both side of transfer plate-The deflection of slabs and beams occurring after the attachment of non-structural elements (sum of the long-term deflection due to construction and superimposed dead loads occurring after installation of non-structural components and the immediate deflection due to live load) is limited to Span/350 or 20 mm, whichever is less. The total long term deflection of slabs and beams occurring after removal of form work is limited to span/250.

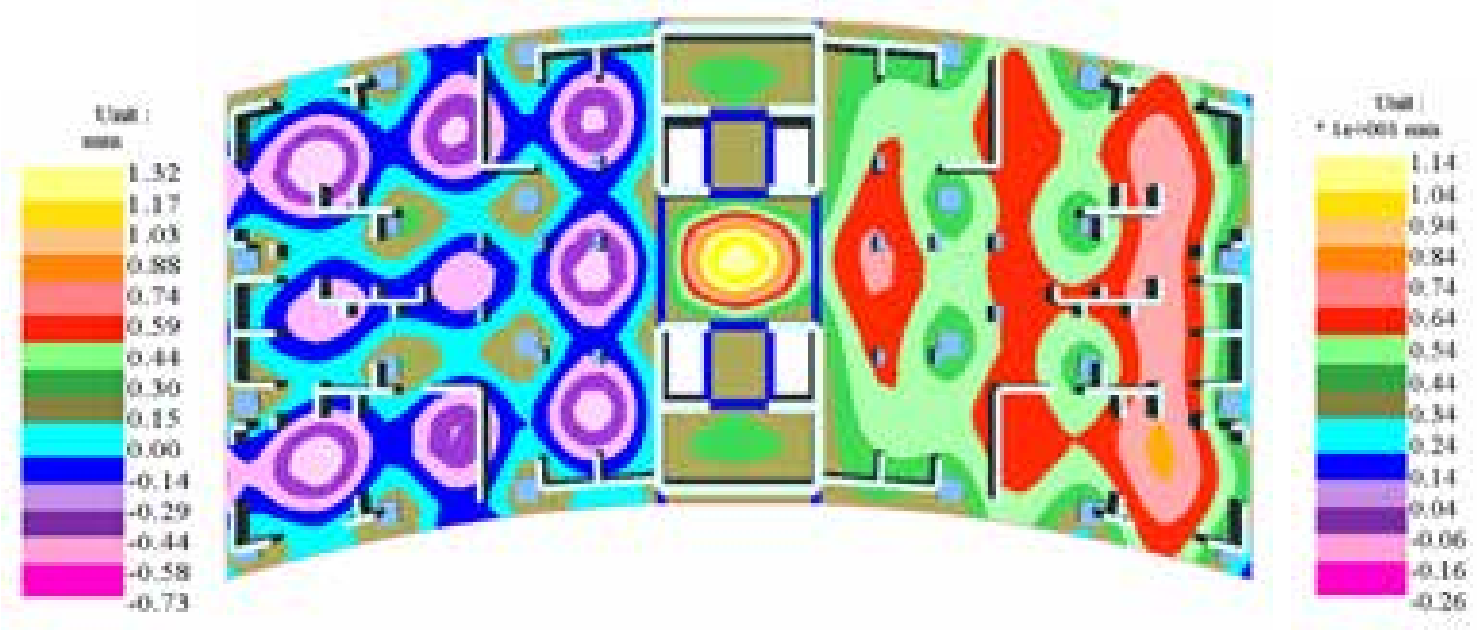

Fig3.3 Deflection values on both side of transfer plate

The above figure shows the deflection values on both side of the transfer plate under envelope service load combination.

10. CRACK WIDTH

Crack width pattern- the below figure shows the crack width pattern on both side of the transfer plate and it clearly shows the left part i.e. post tensioning transfer plate having less crack formation when compared to RCC concrete transfer plate on other side. In post-tensioning system cracks are effectively controlled by creating internal compressive force and that leads to create crack free structures. The stress-crack width relationship has been shown to be the key to an understanding of fracture propagation and mechanical behavior in tension of reinforced and post tensioned concrete materials and structures. A model is derived for the stress-crack width relationship for randomly oriented short composites which takes hybrid fiber systems and possible fiber rupture into account.

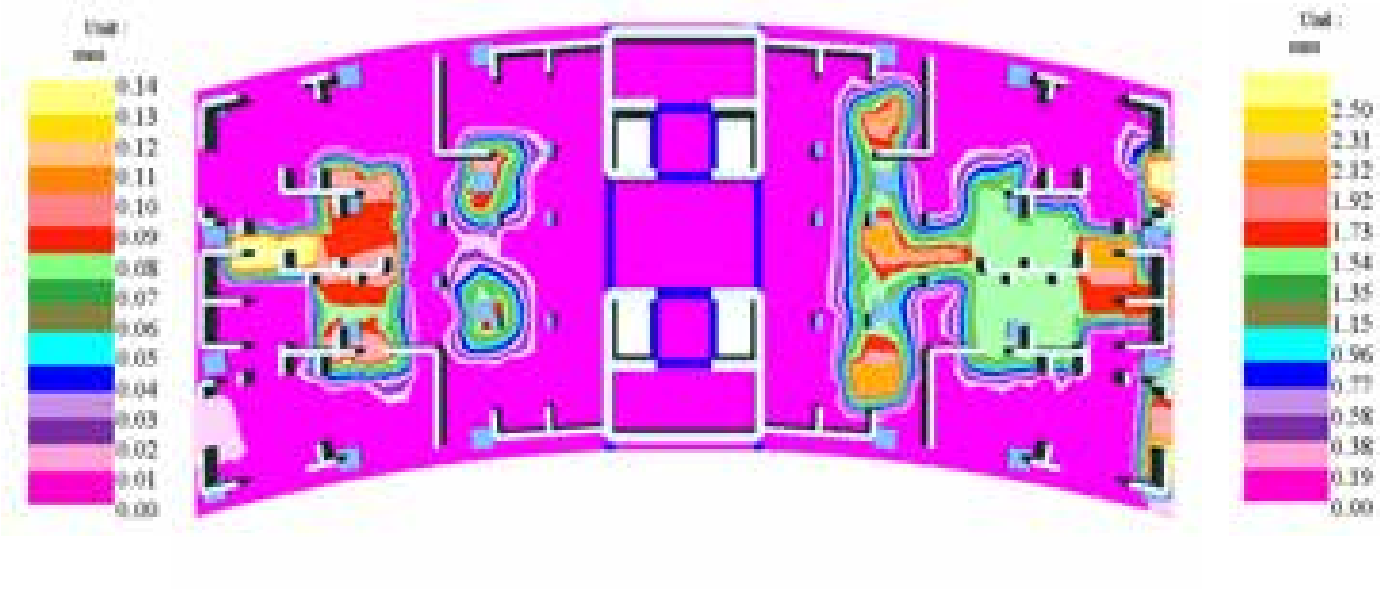

Fig 3.4 Crack width values on both side of Transfer plate

11. COST AND TIME COMSUMPTION

Due to less usage of reinforcement in post-tensioned transfer plate system it seems to be more economical. The construction activities like cutting and laying of reinforcement can also be reduced. It will reduce the overall time consumption of project.

Rebar Summary – For Post Tensioned Transfer Plate						
Reference Plane	Floor Area	Floor Volume	Weight	Rate	Rate	Cost
	m2	m3	kg	kg/m2	kg/m3	INR
Current plane	1170.77	2095.5	163208.79	139.49	77.91	5712280
Total	1170.77	2095.5	163208.79	139.49	77.91	5712280
Tendon Summary – For Post Tensioned Transfer Plate						
Reference Plane	Floor Area	Floor Volume	Weight	Rate	Rate	Cost
	m2	m3	kg	kg/m2	kg/m3	INR
Current plane	1170.77	2095.5	36057.8	30.81	17.2	2019192
Total	1170.77	2095.5	36057.8	30.81	17.2	2019192
Rebar Summary – For Conventional Transfer Plate						
Reference Plane	Floor Area	Floor Volume	Weight	Rate	Rate	Cost
	m2	m3	kg	kg/m2	kg/m3	INR
Current plane	1170.77	2095.5	395004.18	337.61	188.54	13825000
Total	1170.77	2095.5	395004.18	337.61	188.54	13825000

12.CONCLUSION

The analysis and design of the transfer plate is done and the structural stability under serviceability criteria seems to be more effective in post-tensioning system, and due to more consumption of flexural reinforcements. The post-tensioning system is recommended as it is economical. The ordinary conventional transfer plate is suitable for high rise buildings with moderate floating column loading and moments, where deflection in longer span having less values. When considering time duration and easy execution of work, the post tensioning method is more effective due to fewer requirements of reinforcement and their laying operation. Stages of casting can be achieved in post-tensioned system of transfer plate system resulting in less requirements of back propping while concerting transfer plate floor.

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Experimental Study on Stabilization of Black Cotton Soil Using Lime and Copper Slag

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***Abstract* - Expansive black cotton soil, also called shrink – swell soil, is a very common cause of foundation problems. Depending upon the moisture in the soil, shrink – swell soils will experience change in volume of upto thirty percent or more. These problematic soils can be modified to meet the design requirements using soil stabilization techniques. Utilization of industrial waste materials as a conventional stabilizers such as lime and copper slag, to increase the strength and stability of soil and to reduce the construction cost by making best use of the locally available waste materials. Copper slag is one such product obtained during the smelting and refining of copper. The test is based on the varying percentage of lime and copper slag with the clayey soil to stabilize the soil and the optimum content required is ascertained by studying the variation of unconfined compressive strength (UCS).**
Keywords: Copper slag, UCS, Lime, Stabilization.

I. INTRODUCTION

Expensive soil is a term generally applied to any soil that has a potential for shrinking or swelling under changing moisture conditions. The primary problem that arises with expansive soils is that deformations are significantly greater than elastic deformations and they cannot be predicted by classical elastic or plastic theory. Movement is usually in an uneven pattern and of such a magnitude as to cause extensive damage to the structures and pavements resting on them. Expansive soils can cause more damage to structures, particularly light buildings and pavements, than any other natural hazard, including earth quakes and floods.

Soil stabilization refers to the procedures employed with a view to altering one or more properties of soil so as to improve its engineering performance. The main objective of soil stabilization is to increase the strength or stability of the soil and to reduce its sensitivity to moisture changes. Soils can be stabilized by the addition of a small percentage of lime and Copper slag. Such stabilization processes enhance many of the engineering properties of the treated soils and produce an improved construction material.

Copper slag is an industrial by-product obtained during the matte smelting and refining of copper. It is currently being used for sand blasting, rail road ballast and also in cement and concrete industries. It can be used as fine aggregate in concrete. Also up to 15% by weight of Copper Slag was used as Portland cement replacement together with up to 1.5% of hydrated lime as an activator to pozzolanic reactions. The multiple extraction leaching tests indicate that the elements present in the slag are stable and are not leachable even through repetitive leaching under acid rain in a natural environment. Black Cotton soil when stabilized with copper slag and lime showed significant improvement in strength.

II. MATERIALS AND METHODOLOGY

A. Materials Used

Copper Slag

The physical and chemical properties of the slag as provided by the manufacturer are presented in Tables I and II respectively.

TABLE 1
PHYSICAL PROPERTIES OF COPPER SLAG (SOURCE: MANUFACTERER)

PROPERTY	TYPICAL VALUE
Colour	Black, Glassy
Grain shape	Angular, Multifaceted
Grain size	0.2 to 2.4 mm
Bulk density	1.87g/cc
Moisture content	<0.1%
pH	7

TABLE 2
CHEMICAL PROPERTIES OF COPPER SLAG (SOURCE: MANUFACTURER)

CONSITITUENT	% WEIGHT
Silica , SiO_2	26-30
Free silica	<0.5
Alumina ,Al_2O_3	1-3
Iron oxide as FeO	42-48
Calcium oxide, CaO	1-2
Magnesium oxide, MgO	0.8-1.5
Copper oxide, CuO	0.6-0.7

B. Tests Conducted

Soil and Copper Slag was mixed in different proportions and unconfined compression tests were performed at their respective Optimum Moisture Content (OMC) and Maximum Dry Density (MDD) to ascertain the optimum proportion of copper slag. The slag content was varied as 5%, 10%, 15%, 20%, 25% and 30%. To the stabilized proportion of soil and copper slag, lime was added in varying quantities (3%, 5%, 6%, 7% and 9%). Unconfined Compression tests on specimens prepared at OMC and MDD were conducted.

III. RESULT & DISCUSSION

C. Effect of copper slag on compaction characteristic of soil

With increasing percentage of copper slag, the OMC and MDD increased as compared to the values of soil alone as shown in Table: 3.

TABLE: 3

COMPARISION OF OMC AND MDD FOR VARIOUS PERCENTAGE OF COPPER SLAG

Percentage	0%	5%	10%	15%	20%	25%	30%
OMC (%)	25.20	19.00	16.20	16.85	16.00	18.60	18.04
MDD (g/cc)	1.550	1.680	1.750	1.750	1.780	1.778	1.750

With increase in copper slag content, the proportion of sand sized particles increased leading to lesser affinity towards water, and thus a reduced OMC is noticed.

D. Effect of copper slag on unconfined compressive strength of soil

From the test result it was found that unconfined compressive strength increased with the increase in percentage of copper slag. Up to 20% there is increase in strength and there after it decreases (as shown in table: 4) the increase in strength may be due to high angle of internal friction of slab.

TABLE: 4

COMPARISION OF SHEAR STRESS FOR VARIOUS PERCENTAGE OF COPPER SLAG

Percentage	0%	5%	10%	15%	20%	25%	30%
Shear Stress(N/mm^2)	0.0078	0.0139	0.0188	0.0249	0.0339	0.0295	0.0265

E. *Effect of lime on compaction characteristic of copper slag stabilized soil.*

The MDD and OMC of the stabilized mix (20% of copper slag & 80% of soil) was 1.780 g/cc & 16.00% respectively when lime is added to stabilized mix of soil and copper slag the variation of MDD & OMC as shown in table: 5

TABLE: 5

COMPARISION OF OMC AND MDD FOR VARIOUS PERCENTAGE OF LIME OF COPPER SLAG STABILIZED SOIL

Percentage	3%	5%	6%	7%	9%
OMC (%)	19.00	14.96	15.85	17.72	23
MDD (g/cc)	1.745	1.610	1.640	1.600	1.615

F.. *Effect of lime on unconfined compressive strength of copper slag stabilized soil*

The strength improvement of copper slag stabilized soil using lime as an admixture depends on the factors like curing period and its dosage, with increase in dosage the strength increases considerably as shown in table: 6

TABLE: 6

COMPARISION OF SHEAR STRENGTH FOR VARIOUS PERCENTAGE OF LIME OF COPPER SLAG STABILIZED SOIL

Percentage	3%	5%	6%	7%	9%
Shear Stress(N/mm^2)	0.0328	0.0361	0.0451	0.0375	0.0187

From the value obtained 6% lime was considered as optimum with increase in lime content beyond 6%, there is insufficient water to bring about the pozzolanic reaction to completion leading to a decrease in strength.

E. Comparison of strength gain when copper slag alone is used for stabilization and when lime is used in addition to copper slag

The unconfined compressive strength improvement of copper slag stabilized soil was 4.34 times than that of unstabilized soil. When optimum percentage 6% of lime was added to the copper slag stabilized soil the strength improvement was 5.78 times at zero days. From this it can be inferred that copper slag stabilized soil, with admixture shows better results compared to stabilization with copper slag alone.

IV. CONCLUSION

The following conclusion drawn from above study;

1. The combination of 20% copper slag and 80% soil showed 4.34 times improvement in unconfined compressive strength.
2. The chemical composition of copper slag indicates the presence of significant quantities of siliceous and silica-aluminous substances. Hence when lime added along with copper slag a considerable improvement in strength of soil is seen.
3. An optimum percentage of 6% lime was added to the 20% of copper slag stabilized soil the strength improvement was 5.78 times than the normal soil.
4. On the basis of this study, Copper slag and lime can be recommended as an effective stabilizing agent for the improvement of weak soils.

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EXPERIMENTAL STUDY ON STRENGTH OF CONCRETE BY PARTIAL REPLACEMENT OF SAND WITH BOTTOM ASH

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***Abstract*- This paper presents the experimental behavior of concrete with partial replacement of sand with bottom ash and the results are compared with the control specimen. Sand is replaced by bottom ash in various percentages and the strength is to be checked. Replacement of bottom ash up to 40% does not have any adverse effects on strength. A comparative study on strength and cost effectiveness is to be done and the effectiveness on replacement is to be analyzed. This paper presents the results of an experimental investigation on the effect of sieved coal bottom ash as a substitute for natural sand on the properties of concrete. M-20 grade concrete were casted with 10%, 20%, 30% and 40%, 50% of sieved bottom ash for the partial replacement of natural sand. Then various tests including compressive strength, split tensile strength test, flexural strength tests were performed on the sieved bottom ash concrete. The results were compared with the control concrete and the percentage variations in strength were studied at 7, 28 days.**
Key words : Bottom Ash, Compressive strength, Split Tensile strength, Cost effectiveness.

I. INTRODUCTION

Concrete is an extensively used material for most of the civil engineering projects. It is produced with cost effective material. Concrete is used to support, to enclose, to surface and to fill. Thus from the consideration of energy and resource conservation and sustainability of the environment, concrete is the most preferred material. Concrete industry is drawing upon enormous natural resources. One day these natural resources will become extinct which compels for replacement of these materials with alternate materials..Increase in demand and decrease in natural resource of fine aggregate for the production of concrete has resulted in the need of identifying a new source of fine aggregate. The possibility of utilization of thermal power plant byproduct bottom ash as replacement to fine aggregate in concrete is taken into consideration. Presently about 105 million tons fly ash is generated every year in India as a by-product of coal consumed in the thermal power plants. The thermal power plant is only the source to produce 65% of the total electricity produced in our country. Investigation on utilization of fly ash in cement mortar is carried out by many authors reported in the literature. Several million tons of coal for generating the electricity is being consumed in India out of which 40% of coal is accounted for generating of fly ash as a bye product. By the year 2010 more than 180 million tons of fly ash would be generated every year. The type of fly ash collected at the bottom of boiler furnace having lesser fineness & high carbon content is called bottom fly ash. The finest fly ash is called dry fly ash, collected from different electro static precipitators (ESP) in dry form. While the ash mixed with water, forming slurry and drained out in ponds is referred as pond fly ash. Bottom ash has coarse particle size, higher water absorption and usually no pozzolanic effect. Therefore, it is dumped in land fill sites or discharged in

pond in mass quantity and is easily available with free of cost. A previous in literature survey has indicated that, thermal power plant bottom ash would be a potential fine aggregate in concrete. The thermal power plants are the main source of power generation in India. The major obstacle in use of bottom ash in a concrete is that the chemical properties of coal bottom ash are different from place to place and are depends upon the origin of the raw material. All metro and mega cities in India are facing acute shortages of good quality of sand. Waste glass is a major component of the solid waste stream in many countries. It can be found in many forms, including container glass, flat glass such as windows, bulb glass and cathode ray tube glass. At present, although a small proportion of the post consumer glass has been recycled and reused, a significant proportion, which is about 84% of the waste glass generated in India, is sent to landfill. Glass is a 100% recyclable material with high performances and unique aesthetic properties which make it suitable for wide-spread uses. Besides, the current recycling state.

II. EXPERIMENTAL INVESTIGATIONS

A. Preparation of bottom ash

The continuous reduction of natural resources and the environmental hazards posed by the disposal of coal ash has reached alarming proportion such that the use of coal ash in concrete manufacture is a necessity than a desire. The use of coal ash in normal strength concrete is a new dimension in concrete mix design and if applied on large scale would revolutionize the construction industry, by economizing the construction cost and decreasing the ash content. This paper presents the experimental investigation carried out to study the effect of use of bottom ash as a replacement of fine aggregates. Although, fly ash is being generally used as replacement of cement, as an admixture in concrete, and in manufacturing of cement, the study on the use of bottom ash (the coarser material, which falls into furnace bottom in modern large thermal power plants and constitute about 20% of total ash content of the coal fed in the boilers) has been very limited.

Fig.1 Bottom Ash

III. INGREDIENTS

B. Cement

Portland pozzolona cement of Grade 53 Conforming to IS 1489 (Part 1) : 1991.

C. Fine aggregate (FA)

The sand used as fine aggregates was locally procured. It was first sieved through 4.75 mm IS sieve to remove any particles greater than 4.75 mm and The physical properties are reported in Table I

TABLE 1
PHYSICAL PROPERTIES OF FINE AGGREGATE

S.no	Properties	FA
1	Specificgravity	2.72
2	bulk density(Kg/m3)	1590
3	size (mm)	Below 4.75
4	Fineness modulus	2.63

D. Natural Coarse Aggregate (NCA)

Gravels used as NCA were locally obtained having average particle size of 20 mm. The aggregates were washed to remove dust and dirt and were dried to surface dry condition. The physical properties are reported in Table II.

TABLE 2-
PHYSICAL PROPERTIES OF NCA

S.no	Properties	NCA
1	Shape	angular
2	specificgravity	2.70
3	bulk density(Kg/m3)	1650
4	size (mm)	20mm
5	fineness modulus	7.4
6	water absorption	0.5
7	crushingvalue(%)	18.2
8	impact Value(%)	17.83

V. TESTING

E. Slump test

The slump is taken for every mixing of concrete with 0%, 10%, 20%, 30%, 40% & 50% replacement of bottom ash. This test is used for finding the workability of concrete. The slump value is decreased by the additions of percentage of B.A. True slump has occurred at 0.5 W/C ratios..The slump values are reported in Table V.

TABLE 3
SLUMP VALUE OF CONCRETE WITH VARIOUS PERCENTAGES OF REPLACING BOTTOM ASH

Percentage of replacement of bottom ash (%)	Slump Value
0	18
10	16
20	14
30	12
40	10
50	8

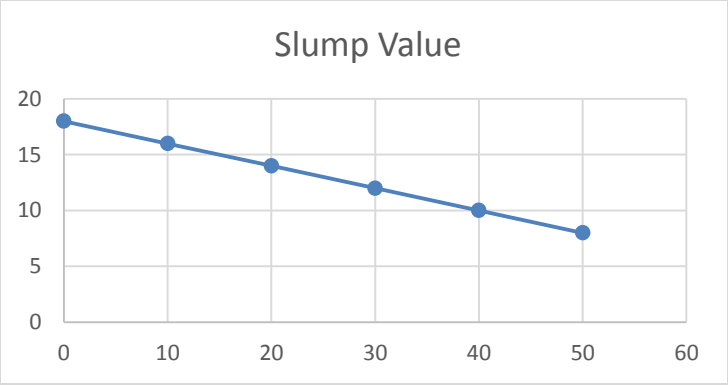


Chart.1 slump cone test

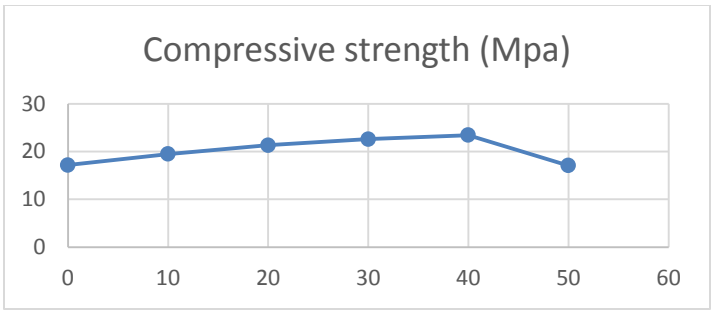
F. Compressive Strength Test for cube

Compressive strength of concrete can be defined as the measured maximum confrontation of a concrete to axial loading. The concrete specimens with 0%,10%,20%,30%,40%,50% of bottom ash. The compression test was carried out in the CTM (Compression Testing Machine) 2000KN capacity. The load is applied at a uniform rate till failure. The 7 and 28 days compression test of cement mortar cubes values are tabulated below.

Fig.2 compressive testing machine

TABLE 4
COMPRESSIVE STRENGTH (7DAYS)

Percentages replacement of bottom ash (%)	Compressive strength (Mpa)
0	17.2
10	19.5
20	21.33
30	22.6
40	23.45
50	17.1

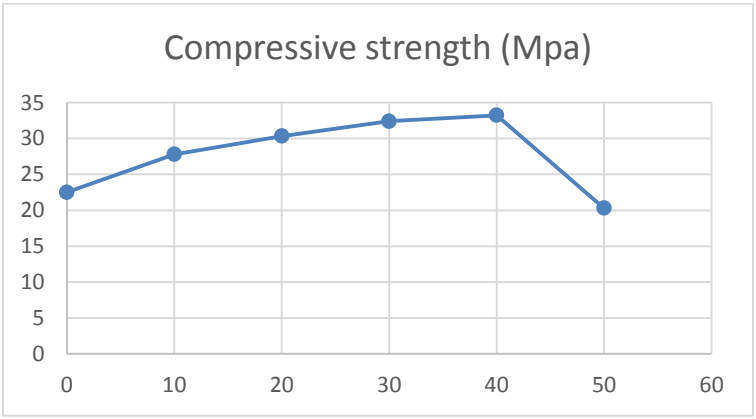


Percentage of replacement

Chart 2-Compressive strength (7days)

TABLE 5
COMPRESSIVE STRENGTH (28DAYS)

Percentages replacement of bottom ash (%)	Compressive strength (Mpa)
0	22.5
10	27.8
20	30.33
30	32.4
40	33.23
50	20.3



Percentage of replacement

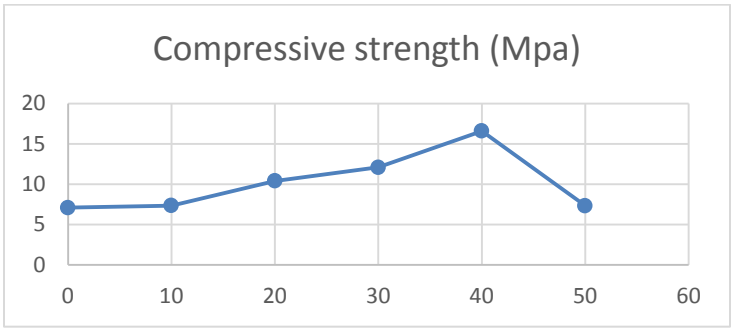
Chart 3-Compressive strength (28days)

C. Compressive Strength Test for cylinder

Compressive strength of concrete can be defined as the measured maximum confrontation of a concrete to axial loading. The concrete specimens with 0%,10%,20%,30%,40%,50% of bottom ash.The compression test was carried out in the CTM (Compression Testing Machine) 2000KN capacity. The load is applied at a uniform rate till failure. The 7 and 28 days compression test of cement mortar cubes values are tabulated below.

TABLE 6
COMPRESSIVE STRENGTH (7DAYS)

Percentages replacement of bottom ash (%)	Compressive strength (Mpa)
0	7.10
10	7.35
20	10.4
30	12.10
40	16.6
50	7.34

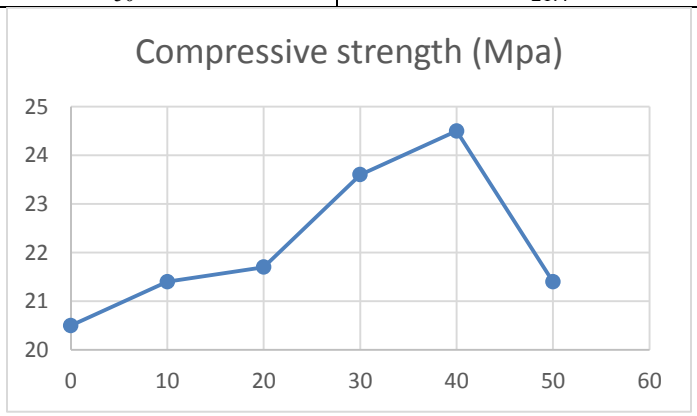


Percentage of replacement

Chart 4-Compressive strength (7days)

TABLE 7
COMPRESSIVE STRENGTH (28DAYS)

Percentages replacement of bottom ash (%)	Compressive strength (Mpa)
0	20.5
10	21.4
20	21.7
30	23.6
40	24.5
50	21.4



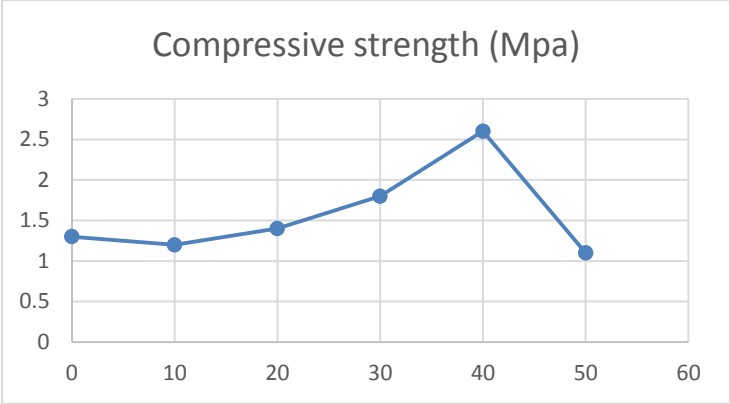
Percentage of replacement

Chart 4-Compressive strength (7days)

C. Split Tensile Strength Test for cylinder

TABLE 8
SPLIT TENSILE STRENGTH (7DAYS)

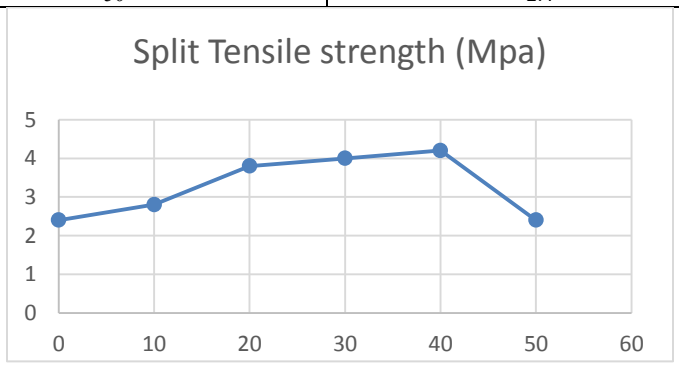
Percentages replacement of bottom ash (%)	Compressive strength (Mpa)
0	1.3
10	1.2
20	1.4
30	1.8
40	2.6
50	1.1



Percentage of replacement

TABLE 9
SPLIT TENSILE STRENGTH (28DAYS)

Percentages replacement of bottom ash (%)	Split Tensile strength (Mpa)
0	2.4
10	2.8
20	3.8
30	4.0
40	4.2
50	2.4



Percentage of replacement

Chart 5-Split Tensile strength (28days)

D. Flexural Strength Test

The determination of flexural strength is essential to estimate the load at which the concrete member may crack. It is the ability of a beam or slab to resist failure in bending.The size of the specimen is 750X150X150mm. The test were conducted on at the end of 28th day, as per IS 516 – 1959.

TABLE 10
FLEXURAL STRENGTH (7DAYS)

Percentages replacement of bottom ash (%)	Flexural strength (Mpa)
0	2.65
10	2.73
20	2.79
30	2.90
40	3.10
50	2.79

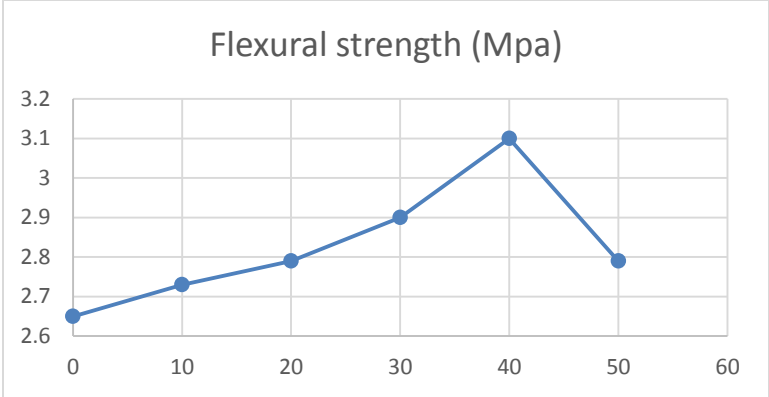


Chart 6-Flexural strength (7days)

TABLE 11
FLEXURAL STRENGTH (28DAYS)

Percentages replacement of bottom ash (%)	Flexural strength (Mpa)
0	3.96
10	4.1
20	4.21
30	4.33
40	4.45
50	2.80

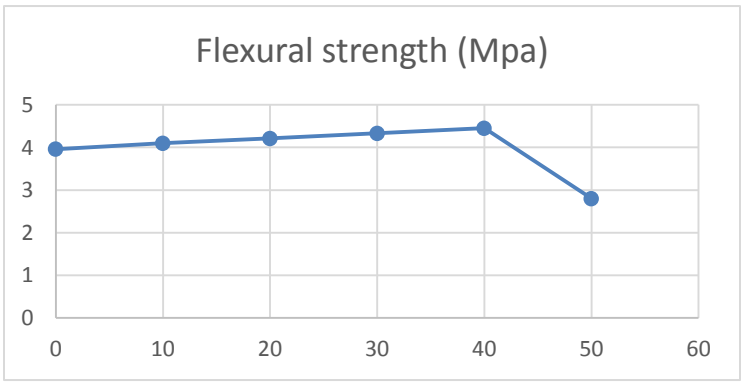


Chart 7-Flexural strength (28days)

VI. RESULTS AND DISCUSSION

E.Slump Value

This test is used for finding the workability of concrete. The slump value is decreased by the additions of percentage of B.A. True slump has occurred at 0.5 W/C ratios.

F. Compressive Strength of Cube & Cylinder

The compressive strength of concrete increase replacement of sand with bottom ash up to the percentage of 40%. The percentage of replacement of bottom ash above 40% the compressive strength of concrete is reduce suddenly.

I. Split Tensile Strength Test

The split tensile strength of concrete increase up to the replacement percentage is 40%. The percentage of replacement increase above 40% the strength decrease.

J. Flexural Strength

The flexural strength of concrete increase up to the replacement percentage is 40%. The percentage of replacement increases above 40% the strength decrease.

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mining, like Bayesian methods, Multilayer Perceptrons and Sequential Minimal Optimization(SMO), Ensemble Methods and Decision Trees are available to predict the employability of Bachelor of Engineering (BE).The Random Forest algorithm which is best suited for predicting was found to be accurate rather than Naïve Bayes and Decision Tree . The data set is developed with the traditional parameters like academic performance along with AMCAT scores. Analysis was carried out to check impact of input variables like Aptitude, Communication, Technical & Logical factors which is obtained from the AMCAT scores. Threshold cutoff point is set for the grades in order to identify under which category of job the candidate belongs. A model was developed which predicts probability of Employability of engineering graduate students in campus placement based on skill set required in IT Sector.Personality and professional skill have a significant impact on college graduate career decision making.

A HMM BASED APPROACH TO ESTIMATE DIRECTION FOR PEDESTRIAN MANAGEMENT SYSTEM

B. Vijayalakshmi, M. R. JeevagaPriya, M. Pandiselvi, S. SelliIshwarya and S. ShajithaParveen
Department of Computer Science and Engineering, Ramco Institute of Technology, Rajapalayam.

This article proposes an optimistic approach for direction estimation of a moving pedestrian as captured in a two dimensional field camera. The article is intended to estimate direction of motion of a pedestrian in a busy lane to avoid accidents. The temporal pattern of changes in the dimension of a pedestrian in each frame is unique for each direction. Hence dimension based feature is used to estimate the direction of motion.8 discrete directions of motion are considered. Hidden Markovian Model is used to classify the direction. Experiments are conducted over NITR Conscious Walk Dataset. This approach is robust towards improper segmentation, partial occlusion and constantly changing head and body orientation during walk. The proposed method can act as a standalone system or it can be combined with existing system to implement pedestrian monitoring system.

MITIGATING DOS ATTACK AGAINST ANONYMOUS USER AUTHENTICATION ALGORITHM

K. Vijayalakshmi, M. Bama, R. Priyadharshini, M. Subhasri and R. Vishnu Priya
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Wireless sensor networks (WSNs) include spatially allotted autonomous instruments that employ sensors to check environmental or physical conditions. These autonomous instruments or nodes blend with routers or gateway to make several WSN-based real-time applications. In many critical applications, an external user can directly access the real-time data from sensor node. In this context, before offering access, the legitimacy of the user is required to be verified through a secure authentication scheme. Since, in WSN-based real-time applications, the privacy of the user is greatly important, the, authentication scheme for such environment should be anonymous. Till now, impressive efforts have been made in designing lightweight anonymous authentication protocol for WSN-based real-time applications. However, most of such protocols are vulnerable to DoS attacks, which are occurred due to the loss of synchronization between the participants. Furthermore, to rebuilt synchronization between the participants, a protocol may need to compromise un-link-ability property. Therefore, it can be argued that the problem of DoS attack has not been addressed properly in the existing literatures. In this article, we present a way to deal with DoS attacks in

TWO LEVEL QR CODE USING PRIVATE MESSAGE SHARING AND DOCUMENT AUTHENTICATION

P. Vasantha, M. Sangeetha, P. Rajeswari and P. Gopikannan
Department of Computer Science and Engineering, P.S.R Rengasamy College of Engineering for Women, Sivakasi.

The quick response (QR) code was designed for storage information and for high speeds reading application. In this paper we present a new rich QR code that has two storage levels and used for document authentication. The two level QR code means private level and public level. The public level QR code is same as the standard QR code storage level and it is readable by any classical QR code applications. The private level QR code allows us not only to increase the storage capacity of the QR code but also distinguish the original document from a copy. The experimental results show a perfect restoration of private information. It also highlights the possibility of using this new rich QR code for document authentication.

A COMPARATIVE STUDY BETWEEN SUPPORT VECTOR MACHINE AND NAIVE BAYES ALGORITHMS FOR CARDIOTOCOGRAM DATA CLASSIFICATION

D. Jagannathan
Department of Computer Science, Dr. C.V Raman University, Chhatisgarh

Cardiotocography (CTG) is a simultaneous recording of Fetal Heart Rate (FHR) and Uterine Contractions (UC). It is one of the most common diagnostic techniques to evaluate maternal and fetal well being during pregnancy and before delivery. By observing the Cardiotocography trace patterns doctors can understand the state of the fetus. There are several signal processing and computer programming based techniques for interpreting a typical Cardiotocography data. Even few decades after the introduction of Cardiotocography into clinical practice, the predictive capacity of these methods remains controversial and still inaccurate. In this paper, a model based CTG data classification system using a supervised SVM and Naive Bayes is implemented which can classify the CTG data based on its training data. According to the arrived results, the performance of the supervised machine learning based classification approach provided significant performance. In this paper, we have used Accuracy, Specificity, NPV, Precision, Recall and ROC are used as the metric to evaluate the performance. It was found that, the SVM based classifier was capable of identifying Normal, Suspicious and Pathologic condition, from the nature of CTG data with very good accuracy.

SECURE DE-DUPLICATION IN HYBRID CLOUD

R. Venkatesh, L. Ramesh, M. Siva, S. Manikandan and C. Manojkumar
Department of Computer Science and Engineering, Ramco Institute of Technology, Rajapalayam.

Data de-duplication is a data compression technique for eliminating duplicate copies of repeating data (file formats) and has been widely used in cloud storage to reduce the amount of storage space and efficient access. To protect the privacy of sensitive data while supporting de-duplication, the convergent encryption technique has been used to encrypt the data before outsourcing. To maintain data security, formally address the problem of certified data de-duplication. Unlike other traditional de-duplication systems, the differential privileges of users are further considered in duplicate check besides in data. We also present several new de-duplication structures supporting authorized duplicate check in hybrid cloud architecture.

vulnerabilities, and the presence of malicious threats. Smaller areas, such as vulnerability assessment and penetration testing, are also covered because they are very significant in the security of information. While vulnerability assessment is a necessity, penetration testing is purely an option to the security engineer. This paper aims to propose methods to avoid the cyber crimes.

CAREER DENDROGRAM

R. Venkatesh, N. Rajalakshmi, V. Priyadharshini, N. Siva Sakthi and K. Logeswari
Department of Computer Science and Engineering, Ramco Institute of Technology, Rajapalayam.

A national database of actual requirement of workforce, category-wise for both Government and Industry, the type of educational or skill qualification required, nature of job, eligibility criteria, salary, career development /progression in every field / sector of employment is urgently required. Employment is the greatest challenge these days. The problem is not that we do not have employment opportunities but that we do not get exposed to all the available opportunities. This is because there is no website application that can provide both career guidance and job opportunity to individuals at the same time. So the anticipated outcome of this paper is to build a website application that makes this type of website a reality. In this paper, the proposed scheme is not only efficient in providing career guidance and exposing individuals to all the job opportunities but it also helps in increasing the career development.

RANKING BASED ON SENSITIVITY SCORE AND DATA CLASSIFICATION

J. Sabthami, K. Esakki, K. Kandha Vivek Raj, M. Mathu Kumar and P. Muthu Manickam
Department of Computer Science and Engineering, Ramco Institute of Technology, Rajapalayam.

Large amount of data are used in our day to day life. To improve the security and find the category name of the document, all documents need to be assigned with a sensitivity value that properly indicates their business value and criticality to the organization. The system proposed in this paper aims to semi-automatically measure the sensitivity levels of data assets. The categories of data in the organization and their sensitivity levels are initially determined by Subject Matter Experts (SMEs). From the set of documents of different category, the features (Unique words in the document) are extracted using pre-processing like Bag of Words (BOW) Extraction, Stop Word Removal, POS Tagging, Noun phrase identification. The useful feature from pre-processed document is selected by Term Frequency and Inverse Document Frequency (TF-IDF). The categories of the documents are identified using the classification algorithm like Naïve Bayesian Algorithm (NB). Finally, based on the classification result to the sensitivity of the assets is calculated.

PREDICTING EMPLOYABILITY OF A STUDENT IN R PROGRAMMING

V. Manjula, M. Devi Uma Sankari, A. Periya Nayaki and R. Saranya
Department of Computer Science and Engineering, Kamaraj College of Engineering and Technology, Virudhunagar.

The students employability is a major concern for the institutions offering higher education and a method for early prediction of employability of the students is always desirable to take timely action. The company invests huge time & money (budget) on training the fresh engineering graduates to make them ready for work. Various classification techniques of data

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interest, the questions posted by his/her friends will be forwarded based upon his/her interest. This enables the user get fast and appropriate response without waiting for a long time.

DOCUMENT AUTHENTICATION USING TWO LEVEL QR CODE

D. Lakshmanan, K. Lakshmi Priya, M. Sathya, B. Swathi and A. Vennila
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The Quick Response (QR) code was designed for storage information and for high speed reading applications. We present a new rich QR code, that has two storage levels and can be used for document authentication. This new rich QR code named two level QR code (2LQR), has public and private storage levels. The public level is same as the standard QR code storage level, therefore it is readable by any classical QR code application. The information encoded in QR code using q-ary code with an error correction capacity. This allows us not only to increase the storage capacity of the QR code, but also to distinguish the original document from the forged documents. The private level deals with encryption of the QR code using image encryption algorithm (Blowfish algorithm) and the generation of digital signatures to verify the contents of documents and sender's identity. The necessity of image encryption algorithm is to provide large key space and high level security for image transmissions over the internet and to provide the digital equivalent of handwritten signature to assure the evidences of origin for the document. It also highlights the possibility of using this new rich QR code for document authentication.

DATA SECURITY MECHANISM FOR CLOUD STORAGE SYSTEM

M. Chitra, V. Essakijothi, N. Maheswari, B. Suganya and V. Sunmuga Priya
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A data security protection mechanism with factor revocability for cloud storage system allows a sender to send an encrypted file to a receiver through a cloud storage server. It supports identity based encryption scheme (i.e.) sender only knows the identity of the receiver. Secret key is generated by security device issuer. Security device used here is one time password (OTP) generated by security device issuer. We append security device with the part of the secret key. Sender encrypts the file using secret key which is visible to them. Next, file is encrypted to form second level cipher text using security device which is invisible to the user. Then the second level cipher text is uploaded to cloud server. The cloud server is responsible for storing all cipher text. Receiver needs secret key and security device to decrypt the file. Security device is sent to the receiver via mail. It is impossible to decrypt the cipher text without secret key and security device. The sender sends the cipher text to the cloud where the receiver can download it at any time. Our system concentrates on revocability. Once the security device is stolen or lost, this device is revoked. Security device issuer will generate new security device and cipher text in the cloud is updated based on the new security device. The lost security device cannot be used to decrypt any cipher text. Our solution not only enhances the confidentiality of the data, but also offers the revocability of the device so that the device is revoked and the corresponding cipher text will be updated automatically without any notice of the data owner. Thus our system provides two-factor data security protection.

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of RAHCO INSTITUTE OF TECHNOLOGY has presented the paper in the International Conference on Recent Trends In Electrical, Electronics & Communication Engineering (REECE - 17) Held During 16th - 18th March 2017.

Title of the Paper : AN ONLINE MECHANISM FOR RESOURCE ALLOCATION AND PRICING IN CLOUDS

Authors : K.S. HUTHU[illegible], H. RAJESWARI, A. ROHINI, R. KEERTHANA.

Organizing secretary | Convener | Principal

From Security analysis, our scheme is secure in terms of the explanations specified in the proposed security model. As a proof of concept, we implement a prototype of our proposed authorized duplicate check scheme in all text readable format files, images and conduct test bed experiments using our system.

MULTICAST TREE CONSTRUCTION IN WIRELESS SENSOR NETWORK

M. Swarna Sudha, B. AnuSatveeha, A. MeeraParveen, K. MohanakalaiSelvi and B. MohanaPriya
Department of Computer Science and Engineering, Ramco Institute of Technology, Rajapalayam.

Wireless Sensor Network (WSN) is a network of wireless sensor nodes into which sensing, computation and communication functions are integrated. Multicasting is the way of sending data from one source to multiple selected destinations. Tree is the topology for non-redundant data transmission. We have designed multicast tree in wireless networks. Since the larger tree length clearly results in longer delay, battery of sensor nodes will drain quickly. To enable efficient multicast, we generate minimum length multicast tree in wireless sensor networks (WSNs) using steiner tree concept, where only limited knowledge of network topology is available at each node. We have designed a simple algorithm in which we call Toward Source Tree (TST) to build multicast trees in WSNs. TST algorithm is a simple and distributed scheme for constructing low-cost and energy-efficient multicast trees in the wireless sensor networks. We have designed TST algorithm with running and energy efficiency.

BILINGUAL TEXT TO SPEECH ENGINE (TAMIL AND HINDI)

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Department of Computer Science and Engineering, Ramco Institute of Technology, Rajapalayam

A bilingual text to speech engine is one which speaks the input which is given in the form of Tamil and/or Hindi Unicode character(s). This system is done using HTS, a HMM based speech synthesizer. Though there are text to speech engines available for many languages, not all the TTS engines use the phonemes extracted from the voice of the native speakers. Also for polyglot users, they need to switch between TTS engines for more than one language and also the TTS limits the language input to only one language. So, to eradicate all these difficulties, a multi-lingual TTS engine can be developed and a bilingual TTS is the first step of developing the multi-lingual TTS. Here we obtain voice from the same speaker for both the languages. Phonemes for both the languages are identified and extracted. Also, we merge the common phonemes in both the languages to reduce the number of phoneme data the system need to store. So, as a result of merging the influence of both the language in each other can be felt.

ONE POINT STUDENT VERIFICATION THROUGH MOBILE APPLICATION AND PATIENT MONITORING SYSTEM

K. Naveenkumar, G. Lakshmi Kiruthika, V. Ramya and G. S. ShivaRanchani
Department of Computer Science and Engineering, Ramco Institute of Technology, Rajapalayam

Student Details gathered from One Point Student Verification System have rich data which addresses the details about student's biometric information, SSLC details and the list of Degrees they have completed and detailed information about their previous or current degree details. To make the job of the recruiter easy the student's details are classified based on their educational qualification and sorted on basis of ranks. The large amount available jobs can be

easily identified by the student and applied. The patient monitoring system provides a facility to view all the current medical histories of a patient at any case despite of the location. The patient can view or edit their details with their recent history. This helps to trace the medical records of the patient at all time and in case of emergency for providing medical support to a patient.

REAL TIME PATH PLANNING BASED ON HYBRID VANET USING IN TRANSPORTATION SYSTEM

S. Mallika and P. Ramkumar
Department of Computer Science and Engineering, National Engineering College, Kovilpatti.

Real-time path planning can efficiently relieve traffic congestion in urban scenarios. However, designing an efficient path-planning algorithm to achieve a globally optimal vehicle traffic control still remains a challenging problem, particularly when we take drivers' individual preferences into consideration. In this paper, we first establish a hybrid intelligent transportation system (ITS), i.e., a hybrid-VANET-enhanced ITS, which utilizes both vehicular ad hoc networks (VANETs) and cellular systems of the public transportation system to enable real-time communications among vehicles, roadside units (RSUs), and a vehicle-traffic server in an efficient way. Then, we propose a real-time path-planning algorithm, which not only improves the overall spatial utilization of a road network, but reduces average vehicle travel cost for avoiding vehicles from getting stuck in congestion as well. A stochastic Lyapunov optimization technique is exploited to address the globally optimal path-planning problem. Finally, the transmission delay of the hybrid-VANET-enhanced ITS is evaluated in VISSIM to show the timeliness of the proposed communication framework. Moreover, system-level simulations conducted in Java demonstrate that the proposed path-planning algorithm outperforms the traditional distributed path planning in terms of balancing the spatial utilization and drivers' travel cost.

QUESTION AND ANSWERING SYSTEM BASED ON SOCIAL NETWORK

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In recent days, Question and Answering system is used in wide variety of applications. Some of the popular question and answering sites include stack overflow, yahoo, Quora etc. They help in finding solutions to problems faced by each and every individual. With Question and Answering System, users can post the problems they have faced and will get answers and opinions from other users. Similarly, any user in the system can answer the questions or provide them solutions from their point of view. This largely helps in knowledge dissemination to all the users. With the rapid increase in number of users and questions posted by them, getting appropriate answers in terms of quality without waiting for a long time plays a key role in the success of this system. Therefore, the objective of this paper is to improve answer quality and reducing the asker's waiting time. Social Networking provides support in reducing asker's waiting time as friends tend to provide answers quickly when compared to anonymous users. The proposed Question and Answering system based on social network uses the latent factor based recommender systems to identify the user interests for all the friends and then forward the question to the specific users. This technique also avoids the cold start problem for new users. The proposed method will help to reduce asker's waiting time because the users need not search and find the questions on the topics in which he/she has

QUEUING RECOMMENDATION BY PARALLELIZING TIME PREDICTION ALGORITHM IN BIG DATA ENVIRONMENT

G. Mahalakshmi, G. Sindhu, C. Sowmya, R. Sruthi and A. Sugapriya
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Healthcare facilities are under constant pressure to provide an improved quality of service to patients, with the available resources. Effective hospital queue management, to minimize patient wait delays and patient overcrowding, is one of the major challenges faced by hospitals. It would be convenient and preferable if the patients could receive the most efficient treatment plan and know the waiting time in prior through a mobile application that updates the information periodically. The Hospital Queue Management System has become a part and parcel of the hospital industry. Organized and systematic customer service is the need of the hour and smart organizations have been quick to realize and act. Therefore, we propose a Time Prediction Model (TPM) based on ID3 algorithm to predict the waiting time for each treatment task for a patient. We use realistic patient's data collected from various hospitals to obtain a patient treatment time model for each task. The realistic patient's data are analyzed carefully based on important parameters. We identify and calculate different waiting times for different patients based on their conditions and operations performed during treatment. The waiting time of each treatment task is predicted by TPM, and then, according to each patient's requested treatment task, a Queuing-Recommendation (QR) system is developed which recommends an efficient and convenient treatment plan for the patient

AN EFFICIENT SMALLER OBJECT RETRIEVAL APPROACH USING THREAD-OF-FEATURES

P. M. G. Jegathambal, K. Amutha Kani, R. Kavitha, S. Mahalakshmi and P. Sarojini
Department of Computer Science and Engineering, Ramco Institute of Technology, Rajapalayam

This paper represents a method for extracting the local features from images that can be used to retrieve smaller images effectively from cluttered background. An efficient object retrieval technique by hyperlinking and re-ranking is proposed. In hyperlinking, thread-of-features is used for mining smaller object. Bag of model is used to extract the bag of features of an image. Clustering is performed using k-means algorithm where similar images are grouped into one cluster. In re-ranking, initial search results are re-ranked with inverted image index. By implementing the proposed method in this paper smaller object in the cluttered background can be retrieved effectively.

CYBER SECURITY

R. Preetha and P. Mahesh
Department of Computer Science and Engineering, Ramco Institute of Technology, Rajapalayam

The greatest threats to the security, privacy, and reliability of computer networks and other related information systems in general are cybercrimes committed by cyber criminals, and most importantly hackers. After Judging the damage caused by past cyber-criminal and hacker attacks to computer networks in businesses, governments and individuals, resulting in inconvenience and loss of productivity and credibility, one cannot fail to see that there is a growing community demand to software and hardware companies to create more secure products that can be used to identify threats and vulnerabilities, to fix problems, and to deliver security solutions. Industry and governments around the globe are responding to these threats through a variety of approaches and collaborations such as ISAC, CERT, PSSO. They also provide explanation and tips on multiple subjects such as system defenses, reducing

mining, like Bayesian methods, Multilayer Perceptrons and Sequential Minimal Optimization(SMO), Ensemble Methods and Decision Trees are available to predict the employability of Bachelor of Engineering (BE).The Random Forest algorithm which is best suited for predicting was found to be accurate rather than Naïve Bayes and Decision Tree . The data set is developed with the traditional parameters like academic performance along with AMCAT scores. Analysis was carried out to check impact of input variables like Aptitude, Communication, Technical & Logical factors which is obtained from the AMCAT scores. Threshold cutoff point is set for the grades in order to identify under which category of job the candidate belongs. A model was developed which predicts probability of Employability of engineering graduate students in campus placement based on skill set required in IT Sector.Personality and professional skill have a significant impact on college graduate career decision making.

A HMM BASED APPROACH TO ESTIMATE DIRECTION FOR PEDESTRIAN MANAGEMENT SYSTEM

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Department of Computer Science and Engineering, Ramco Institute of Technology, Rajapalayam.

This article proposes an optimistic approach for direction estimation of a moving pedestrian as captured in a two dimensional field camera. The article is intended to estimate direction of motion of a pedestrian in a busy lane to avoid accidents. The temporal pattern of changes in the dimension of a pedestrian in each frame is unique for each direction. Hence dimension based feature is used to estimate the direction of motion.8 discrete directions of motion are considered. Hidden Markovian Model is used to classify the direction. Experiments are conducted over NITR Conscious Walk Dataset. This approach is robust towards improper segmentation, partial occlusion and constantly changing head and body orientation during walk. The proposed method can act as a standalone system or it can be combined with existing system to implement pedestrian monitoring system.

MITIGATING DOS ATTACK AGAINST ANONYMOUS USER AUTHENTICATION ALGORITHM

K. Vijayalakshmi, M. Bama, R. Priyadharshini, M. Subhasri and R. Vishnu Priya
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Wireless sensor networks (WSNs) include spatially allotted autonomous instruments that employ sensors to check environmental or physical conditions. These autonomous instruments or nodes blend with routers or gateway to make several WSN-based real-time applications. In many critical applications, an external user can directly access the real-time data from sensor node. In this context, before offering access, the legitimacy of the user is required to be verified through a secure authentication scheme. Since, in WSN-based real-time applications, the privacy of the user is greatly important, the, authentication scheme for such environment should be anonymous. Till now, impressive efforts have been made in designing lightweight anonymous authentication protocol for WSN-based real-time applications. However, most of such protocols are vulnerable to DoS attacks, which are occurred due to the loss of synchronization between the participants. Furthermore, to rebuilt synchronization between the participants, a protocol may need to compromise un-link-ability property. Therefore, it can be argued that the problem of DoS attack has not been addressed properly in the existing literatures. In this article, we present a way to deal with DoS attacks in

designing lightweight anonymous authentication protocol for WSN-based real-time applications without compromising any anonymity support.

DETECTION OF SENSOR NODE FAILURE BASED ON RTD TIME AND RTP IN WSN

P. Abinaya, M. Birundha, R. Gayathri, G. Harini and N. Santhiya
Department of Computer Science and Engineering, Ramco Institute of Technology, Rajapalayam

Wireless sensor networks (WSN) are mainly used to monitor physical or environmental conditions. In recent years, applications of sensor networks have been increased tremendously. The individual sensor node in a wireless sensor network is resource constrained as is they have limited processing speed, storage and bandwidth and so on. Sensor nodes are often deployed in an uncontrolled or even harsh environment and expected to last until their energy drain. Such harsh environments and limited energy in the battery-powered sensor nodes make them prone to faults. In particular, when sensor nodes actively sense and transmit to fulfill the application requirements, they deplete their energy continuously and this increases the failure of sensor nodes. The quality of service (QoS) is mainly affected by the failure of sensor nodes. In order to maintain better QoS under failure conditions, identifying and detaching such faults is essential. In the proposed method, faulty sensor node is identified by computing the Round Trip Delay time in discrete Round Trip Path.

SYSTEMATIC VEHICLE TRACE WITH RELAY CONTROL AND PULSE SURVEILLANCE

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Modern technological development in automobile industry has drastically improved people's way of living; therefore, there is a need for monitoring of vehicles to heighten its longevity. Mortality rate is also on the rise due to the lack of timely and proper medical attention.Continuous health monitoring of patients using wearable and implantable body sensor networks will increase detection of emergency conditions during health crisis. By integrating vehicle tracking and continuous wireless patient monitoring system; we can enhance safety during travel. This system is user friendly, easily installable, easily accessible and economically viable. The conventional system of tracking using battery operated radio frequency identification (RFID) is only suitable for small range. To overcome this, GPS and GSM technologies are used which will receive the location coordinates and provides real-time information which can be observed from any other remote location.The established health monitoring system is not compact and understanding the output analog signals is a tedious task. Hence, in the designed health monitoring system patient's physiological signals are acquired by the sensors attached on the patient body; if there are any abnormalities then a notification is sent and the vehicle is turned OFF using relay.

From Security analysis, our scheme is secure in terms of the explanations specified in the proposed security model. As a proof of concept, we implement a prototype of our proposed authorized duplicate check scheme in all text readable format files, images and conduct test bed experiments using our system.

MULTICAST TREE CONSTRUCTION IN WIRELESS SENSOR NETWORK

M. Swarna Sudha, B. AnuSatveeha, A. MeeraParveen, K. MohanakalaiSelvi and B. MohanaPriya
Department of Computer Science and Engineering, Ramco Institute of Technology, Rajapalayam.

Wireless Sensor Network (WSN) is a network of wireless sensor nodes into which sensing, computation and communication functions are integrated. Multicasting is the way of sending data from one source to multiple selected destinations. Tree is the topology for non-redundant data transmission. We have designed multicast tree in wireless networks. Since the larger tree length clearly results in longer delay, battery of sensor nodes will drain quickly. To enable efficient multicast, we generate minimum length multicast tree in wireless sensor networks (WSNs) using steiner tree concept, where only limited knowledge of network topology is available at each node. We have designed a simple algorithm in which we call Toward Source Tree (TST) to build multicast trees in WSNs. TST algorithm is a simple and distributed scheme for constructing low-cost and energy-efficient multicast trees in the wireless sensor networks. We have designed TST algorithm with running and energy efficiency.

BILINGUAL TEXT TO SPEECH ENGINE (TAMIL AND HINDI)

K. Naveenkumar, K. Arivarasan, M. Muppidathi Muthu and N. Udhaya Kumar
Department of Computer Science and Engineering, Ramco Institute of Technology, Rajapalayam

A bilingual text to speech engine is one which speaks the input which is given in the form of Tamil and/or Hindi Unicode character(s). This system is done using HTS, a HMM based speech synthesizer. Though there are text to speech engines available for many languages, not all the TTS engines use the phonemes extracted from the voice of the native speakers. Also for polyglot users, they need to switch between TTS engines for more than one language and also the TTS limits the language input to only one language. So, to eradicate all these difficulties, a multi-lingual TTS engine can be developed and a bilingual TTS is the first step of developing the multi-lingual TTS. Here we obtain voice from the same speaker for both the languages. Phonemes for both the languages are identified and extracted. Also, we merge the common phonemes in both the languages to reduce the number of phoneme data the system need to store. So, as a result of merging the influence of both the language in each other can be felt.

ONE POINT STUDENT VERIFICATION THROUGH MOBILE APPLICATION AND PATIENT MONITORING SYSTEM

K. Naveenkumar, G. Lakshmi Kiruthika, V. Ramya and G. S. ShivaRanchani
Department of Computer Science and Engineering, Ramco Institute of Technology, Rajapalayam

Student Details gathered from One Point Student Verification System have rich data which addresses the details about student's biometric information, SSLC details and the list of Degrees they have completed and detailed information about their previous or current degree details. To make the job of the recruiter easy the student's details are classified based on their educational qualification and sorted on basis of ranks. The large amount available jobs can be

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interest, the questions posted by his/her friends will be forwarded based upon his/her interest. This enables the user get fast and appropriate response without waiting for a long time.

DOCUMENT AUTHENTICATION USING TWO LEVEL QR CODE

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Department of Computer Science and Engineering, Ramco Institute of Technology, Rajapalayam.

The Quick Response (QR) code was designed for storage information and for high speed reading applications. We present a new rich QR code, that has two storage levels and can be used for document authentication. This new rich QR code named two level QR code (2LQR), has public and private storage levels. The public level is same as the standard QR code storage level, therefore it is readable by any classical QR code application. The information encoded in QR code using q-ary code with an error correction capacity. This allows us not only to increase the storage capacity of the QR code, but also to distinguish the original document from the forged documents. The private level deals with encryption of the QR code using image encryption algorithm (Blowfish algorithm) and the generation of digital signatures to verify the contents of documents and sender's identity. The necessity of image encryption algorithm is to provide large key space and high level security for image transmissions over the internet and to provide the digital equivalent of handwritten signature to assure the evidences of origin for the document. It also highlights the possibility of using this new rich QR code for document authentication.

DATA SECURITY MECHANISM FOR CLOUD STORAGE SYSTEM

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A data security protection mechanism with factor revocability for cloud storage system allows a sender to send an encrypted file to a receiver through a cloud storage server. It supports identity based encryption scheme (i.e.) sender only knows the identity of the receiver. Secret key is generated by security device issuer. Security device used here is one time password (OTP) generated by security device issuer. We append security device with the part of the secret key. Sender encrypts the file using secret key which is visible to them. Next, file is encrypted to form second level cipher text using security device which is invisible to the user. Then the second level cipher text is uploaded to cloud server. The cloud server is responsible for storing all cipher text. Receiver needs secret key and security device to decrypt the file. Security device is sent to the receiver via mail. It is impossible to decrypt the cipher text without secret key and security device. The sender sends the cipher text to the cloud where the receiver can download it at any time. Our system concentrates on revocability. Once the security device is stolen or lost, this device is revoked. Security device issuer will generate new security device and cipher text in the cloud is updated based on the new security device. The lost security device cannot be used to decrypt any cipher text. Our solution not only enhances the confidentiality of the data, but also offers the revocability of the device so that the device is revoked and the corresponding cipher text will be updated automatically without any notice of the data owner. Thus our system provides two-factor data security protection.

vulnerabilities, and the presence of malicious threats. Smaller areas, such as vulnerability assessment and penetration testing, are also covered because they are very significant in the security of information. While vulnerability assessment is a necessity, penetration testing is purely an option to the security engineer. This paper aims to propose methods to avoid the cyber crimes.

CAREER DENDROGRAM

R. Venkatesh, N. Rajalakshmi, V. Priyadharshini, N. Siva Sakthi and K. Logeswari
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A national database of actual requirement of workforce, category-wise for both Government and Industry, the type of educational or skill qualification required, nature of job, eligibility criteria, salary, career development /progression in every field / sector of employment is urgently required. Employment is the greatest challenge these days. The problem is not that we do not have employment opportunities but that we do not get exposed to all the available opportunities. This is because there is no website application that can provide both career guidance and job opportunity to individuals at the same time. So the anticipated outcome of this paper is to build a website application that makes this type of website a reality. In this paper, the proposed scheme is not only efficient in providing career guidance and exposing individuals to all the job opportunities but it also helps in increasing the career development.

RANKING BASED ON SENSITIVITY SCORE AND DATA CLASSIFICATION

J. Sabthami, K. Esakki, K. Kandha Vivek Raj, M. Mathu Kumar and P. Muthu Manickam
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Large amount of data are used in our day to day life. To improve the security and find the category name of the document, all documents need to be assigned with a sensitivity value that properly indicates their business value and criticality to the organization. The system proposed in this paper aims to semi-automatically measure the sensitivity levels of data assets. The categories of data in the organization and their sensitivity levels are initially determined by Subject Matter Experts (SMEs). From the set of documents of different category, the features (Unique words in the document) are extracted using pre-processing like Bag of Words (BOW) Extraction, Stop Word Removal, POS Tagging, Noun phrase identification. The useful feature from pre-processed document is selected by Term Frequency and Inverse Document Frequency (TF-IDF). The categories of the documents are identified using the classification algorithm like Naïve Bayesian Algorithm (NB). Finally, based on the classification result to the sensitivity of the assets is calculated.

PREDICTING EMPLOYABILITY OF A STUDENT IN R PROGRAMMING

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The students employability is a major concern for the institutions offering higher education and a method for early prediction of employability of the students is always desirable to take timely action. The company invests huge time & money (budget) on training the fresh engineering graduates to make them ready for work. Various classification techniques of data

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Vision-based system for counting of Moving Vehicles in different weather conditions

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***Abstract*— As Sensors are sensitive to weather conditions; video cameras could be used to record the traffic information at different weather conditions. We have sophisticated algorithms to analyze the traffic videos in real time and discover information of interest. Although some sensors could be more accurate, they could also be Intrusive and need a higher maintenance cost. We may need to embed weighing sensors in road to measure vehicle feature and classify vehicle size. In video surveillance systems, it is very complicated to extract more number of features from a video. It has been also inferred that more computations are required to calculate background model and to extract the key frames. In this paper, a novel algorithm is implemented which counts and classifies highway vehicles using regression. The algorithm proposed in this paper, starts with preprocessing the Low Quality videos by Removal of Noise using Bi-lateral filtering, followed by color image based Background mask generation using Multi-layer Background subtraction technique. A fast performing kernel is designed which then used to extract the Foreground mask using Mixture of Gaussians. Finally Contour extraction and Cascaded Regression will results the foreground moving objects in the Low quality video.**

Index Terms - Vehicle detection, Vehicle counting, Low quality video, Color image based background model, Regression analysis

I. INTRODUCTION

Currently, the most sophisticated vision-based approaches for traffic flow surveillance combine information from cameras with other technologies, such as tags installed in vehicles, laser scanners that reconstruct the 3-D shape of the vehicles, or the Global Positioning System (GPS), to estimate the direction of the casted shadows. Compared with intrusive technologies such as radar, inductive loop detectors (ILDs), or lasers, computer vision can be used to obtain richer information, such as analyzing the visual features of the vehicles (color, lights, plate number), apart from the geometry (vehicle volume). These advantages and the increasing computational power of processors have made vision-based systems an area of great interest for road operators, particularly in tolling application. As a mixture between these two groups, we have designed a robust and accurate vision-based system to obtain traffic data flow. On the one hand, it

operates in real time and works in challenging scenarios (low-cost cameras, poor illumination, and, in the presence of shadows, unknown perspective. The novelty of our approach relies on a multilayer background subtraction procedure in which the segmentation thresholds can adapt robustly to illumination changes, maintaining a high sensitivity level to new incoming foreground objects and effectively removing moving casted shadows and headlight reflections on the road and in traffic jam situations, in contrast to existing approaches that do not cover all of these functionalities at the same time [6]. A tracking module provides the required spatial and temporal coherence for the classification of vehicles, which first generates a background model of the scene followed by bilateral filtering to remove the noise. Its advantage over previous approaches, such as [3]–[5] and [7], is that it can directly apply on existing 2-D tracks to infer the dimension lost due to camera projection. The handling of severe occlusions is out of the scope of this paper, but nevertheless, our approach can be used in practice by applying it to road viewpoints, such as those achievable from cameras installed in highway gantries, with a performance significantly beyond state-of-the-art vision approaches.

We include experimental results with varying weather conditions, on sunny days with moving directional shadows, headlight reflections on the road, rainy days, and traffic jams. We obtain vehicle counting and classification results comparable with those of ILD systems, which are currently the most widely used systems for these types of traffic measurements, while keeping the main advantages of vision-based systems, i.e., not requiring the cumbersome operation or installation of equipment at the roadside or the need for additional technology such as laser scanners, tags, or GPS[9].

A new Vision-based system for detection of Moving Vehicles from Low quality videos, for multiple vehicle types is developed in this paper. This system tracks every passing vehicle for several frames, and obtains the detection and counting of every passing vehicle. This system combines with the vehicle detection and outputs vehicle counting. A color image-based adaptive background subtraction is proposed to improve the reliability of object detection. The cross-lane vehicles are taken into consideration and the repeated counting for one vehicle is avoided, which significantly improves the accuracy of vehicle counting.

II. Related Works

Owing to the complexity of the mixed traffic conditions, induction loops are not useful to collect such data. Many of these detectors are sensitive to road reflections, illumination changes. These detectors always ignore cross-lane vehicles and may repeatedly count one vehicle, which influences their accuracy of vehicle counting [10,12]

The geometric parameters of vehicles were exploited for classification, which makes the classification method universal and does not need training and learning. The features used in many existing algorithms could be robust when video quality is ideal. However, these features based on point, line, and image region could be highly unreliable with a low video quality[4,8]. Therefore, it could not be a good choice to use them for segmentation and tracking of individual vehicles and even 3-D reconstruction. Regression analysis can also be applied to count Vehicles in [16,18], which is similar to our proposed algorithm. As for vehicle detection, we compare the characteristics among different background subtraction methods, frame differential method, etc. and adopt a mean shift based background subtraction method to adapt the changeable traffic scenes[2].

Pang, Lam and Yung proposes a novel method for accurately counting the number of vehicles that are involved in multiplevehicle occlusions[1], based on the resolvability of each occluded vehicle, as seen in a monocular traffic image sequence[7,8]. A contour description model is utilized to describe the direction of the contour segments with respect to its vanishing points, from which individual contour description and vehicle count are determined. Buch, Orwell and Velastin presents a detection and classification system for vehicles and pedestrians in urban traffic scenes[11]. It performs per frame vehicle detection and classification using 3D models on calibrated cameras. Motion silhouettes (from background estimation) are extracted and compared to a projected model silhouette to identify the ground plane position and class of vehicles and pedestrians[15]. One cue used to identify target objects in a video sequence is motion. To identify motion that denotes a target object, many background subtraction methods have been proposed; each has strengths, weaknesses and applicability to different scenarios[17]. Different background subtraction methods have been proposed in the literature are described and compared: frame differencing, temporal averaging, $\Sigma - \Delta$, mixture of Gaussians and Kernel Density Estimate[13]. These methods are applied to a selection of representative test footage and the results are presented and discussed so that an informed decision can be made when choosing a background subtraction method for highway surveillance. Wren, Azarbayejani, Darrell and Pentland defines that Pfinder is a real-time system for tracking people. The system uses a multiclass statistical model of color and shape to obtain a 2D representation of head and hands in a wide range of viewing conditions[9]. Johansson, Wiklund, Forssen and Granlund presents a method that combines shadow detection and a 3D box model including shadow simulation, for estimation of size and position of vehicles[3]. The similarity measure is used in an optimization procedure to find the optimal box state. describe a tracking system that utilizes the estimated 3D boxes, including highlight detection, spatial window instead of a time based window for predicting the vehicle.

The shortcomings of the meanshift tracker, namely the selection of the bandwidth and the initialization of the tracker, are addressed with a fine estimation of the vehicle scale and kinematic model. Indeed, the projective Kalman filter[14] integrates the non-linear projection of the vehicle trajectory in its observation function resulting in an accurate localization of the vehicle in the image.

III. Design Methodology

In this paper, we present a robust vision-based system for vehicle tracking and classification devised for traffic flow surveillance. The system performs in real time, achieving good results, even in challenging situations, such as with moving casted shadows on sunny days, headlight reflections on the road, rainy days, and traffic jams, using only a single standard camera. We propose a robust adaptive multilayer segmentation strategy that detects foreground pixels corresponding to moving and stopped vehicles, even with noisy images due to compression. First, the approach adaptively thresholds a combination of luminance and chromaticity disparity maps between the learned background and the current frame. It then adds extra features derived from gradient differences to improve the segmentation of dark vehicles with casted shadows and removes headlight reflections on the road.

A. Foreground mask and edge:

All detection techniques are based on modeling the background of the image, i.e. set the background and detect which changes occur. Defining the background can be very difficult when it contains shapes, shadows, and moving objects. In defining the background it is assumed that the stationary objects could vary in color and intensity over time. Scenarios where these techniques apply tend to be very diverse. There can be highly variable sequences, such as images with very different lighting, interiors, exteriors, quality, and noise. In addition to processing in real time, systems need to be able to adapt to these changes.

B. Environment parameters for Foreground Mask and Edge

Here are the descriptions on the parameters

1. image : Input 8-bit 5-channel image.
2. mask : Input/output 8-bit single-channel mask. The mask is initialized by the function when mode is set to MORPH_CROSS. Its elements may have one of following values:
3. cross : ROI containing a segmented object. The pixels outside of the ROI are marked as obvious background. The parameter is only used when mode== MORPH_CROSS.
4. bgdModel : Temporary array for the background model. Do not modify it while you are processing the same image.
5. fgdModel : Temporary arrays for the foreground model. Do not modify it while you are processing the same image.

6. iterCount : Number of iterations the algorithm should make before returning the result. Note that the result can be refined with further calls with mode==INIT_WITH_MASK..
7. MORPH_CROSS The function initializes the state and the mask using the provided rectangle. After that it runs iterCount iterations of the algorithm.

C. Multi-layerBackground Subtraction Algorithm

Background subtraction is a major preprocessing steps in many vision based applications. In this paper, we present a new multilayer segmentation architecture to fuse different image cues, which combine bottom-up and top-down strategies to solve global/local illumination changes, and to obtain a conditional background model learning. As shown in the experiments carried out and it improves existing segmentation approaches, resulting in a step forward on the current state of the art in vehicle counting and classification using surveillance cameras.

$D_l \leftarrow Per$ xy pixel : $\left|I^y_{xy} - B^y_{xy}\right| - k_l.(\Sigma_l)xy$

$D_c \leftarrow Per$ xy pixel : $\sqrt{\left(\mathrm{I}^{c_x}_{xy} - B^{c_x}_{xy}\right)^2 + \left(\mathrm{I}^{c_y}_{xy} - B^{c_y}_{xy}\right)^2} - k_c.(\Sigma_c)xy$

Apply noise removal filtering to D_l and D_c

$t_l \,\&\, t_c \leftarrow t_{(l,c)} = \min(D_{(l,c)} + o_{(l,c)})$

if $(D_l)_{xy} > t_l$ U $(D_c)_{xy} > t_c$ (per xy pixel) **then**

  if $B^y_{xy} > I^y_{xy} \cap \left|B^y_{xy} - I^y_{xy}\right| < o_s$ **then**

    $Mask_{xy}$ = shadow

  else if $B^y_{xy} > I^y_{xy} \cap \left|B^y_{xy} - I^y_{xy}\right| \geq o_s$ **then**

    $Mask_{xy}$ = black

  else if $I^y_{xy} - B^y_{xy} > o_h \cap I^y_{xy} \leq o_w$ **then**

    $Mask_{xy}$ = highlight

  else if $I^y_{xy} > o_w$ **then**

    $Mask_{xy}$ = white

  else

    $Mask_{xy}$ = foreground

  end if

  if $Mask_{xy}$ = (shadow U black) ∩ $(D_c)_{xy} > t_c$ ∩ $(D_l)_{xy} - t_l < (D_c)_{xy} - t_c$ **then**

    $Mask_{xy}$ = foreground

  end if

else

  $Mask_{xy}$ = background

end if

$E_I, E_B \leftarrow$ Apply $Sobel_{xy}$ to I and B with t_g

Add $(E_I - E_B)$ to Mask as foreground

Crop highlight regions in Mask

Watershed (t_f): fill foreground & highlight & white blob in betweens as foreground

Reinforce Mask from shadow directions

Update B, Σ_l, Σ_c

return Mask

Figure 3.1 Algorithm for Background Subtraction

D. Contour Creation

Contours can be explained simply as a curve joining all the continuous points (along the boundary), having same color or intensity. The contours are a useful tool for shape analysis and object detection and recognition. A contour line or isoline of a function of two variables is a curve along which the function has a constant value. It is a cross-section of the three-dimensional graph of the function f(x, y) parallel to the x, y plane.

```
contours, hierarchy = cv2.findContours(fg_mask,
cv2.RETR_EXTERNAL,
cv2.CHAIN_APPROX_SIMPLE)
   log.debug("Found %d vehicle contours.",
len(contours))
   matches = []
   for (i, contour) in enumerate(contours):
      (x, y, w, h) = cv2.boundingRect(contour)
      contour_valid = (w >= MIN_CONTOUR_WIDTH)
and (h >= MIN_CONTOUR_HEIGHT)
      log.debug("Contour #%d: pos=(x=%d, y=%d)
size=(w=%d, h=%d) valid=%s", i, x, y, w, h,
contour_valid)
      if not contour_valid:
        continue
     centroid = get_centroid(x, y, w, h)
      matches.append(((x, y, w, h), centroid))
```

Figure 3.2 Algorithm for Contour Creation

E. Cascaded Regresssion Model

Compared to detection, tracking has both additional challenges and opportunities. Arguably the most important aspect in this domain is updating a tracker's models as tracking progresses, also known as incremental tracking.

The recent appearance of regression-based methods that directly infer the whole shape has revolutionized the facial land marking problem, and they have quickly become the state-of- the-art approach. The most notable exemplar is the Supervised Descent Method. Its main characteristics are the use of the cascaded regression approach, the use of the full appearance as the inference input, and the a fore mentioned aim to directly predict the full shape. In this article we argue that the key aspects of the algorithm are the use of cascaded regression and the avoidance of the constrained optimization problem that characterized most of the previous approaches. Instead, we show that, surprisingly, it is possible to achieve comparable or superior performance using only landmark-specific predictors and linearly combining them. We reason that augmenting the input with context (of which using the full appearance is the extreme) can sometimes be harmful. In fact, we found that there is a relation between the data variance and the benefits of adding context to the input.

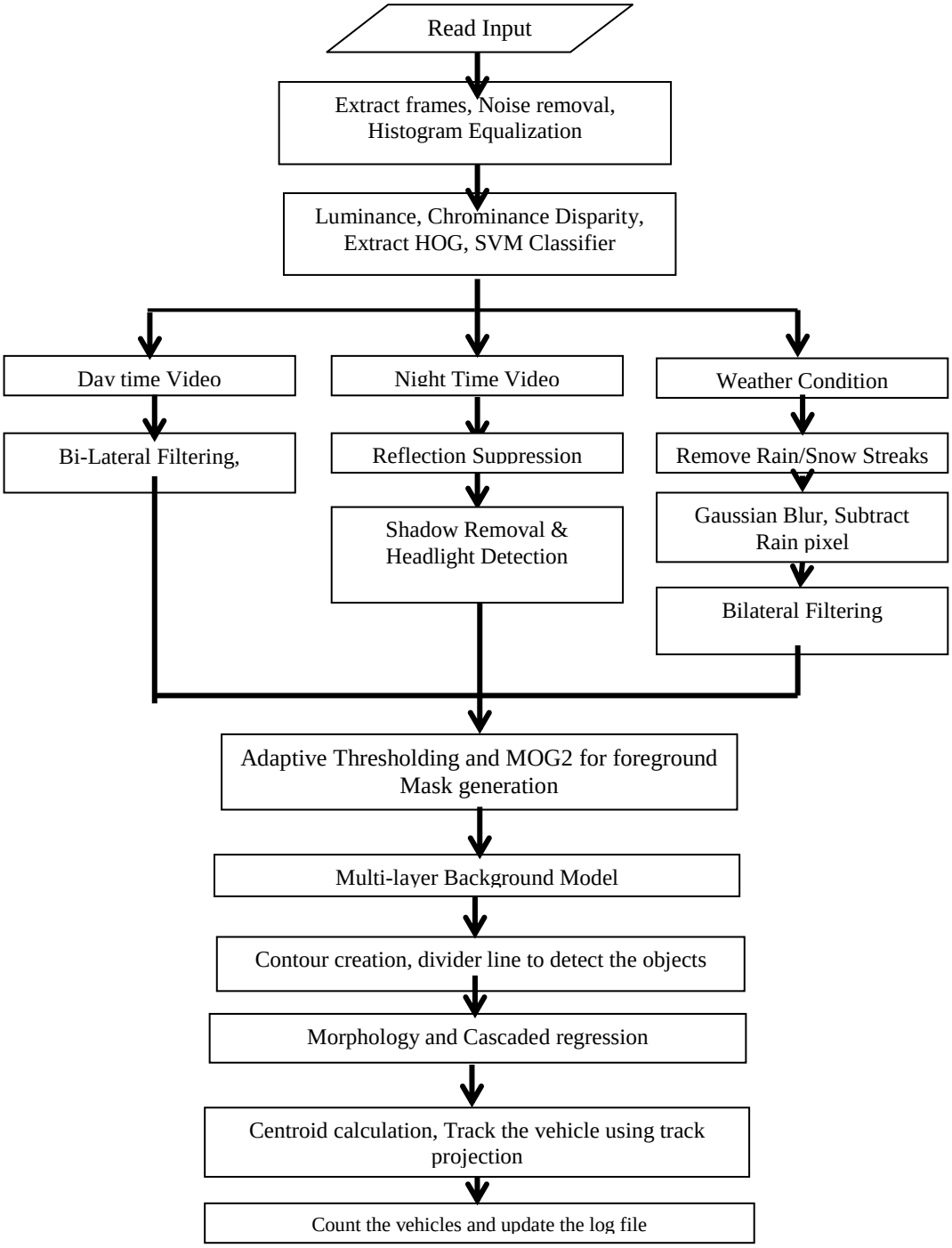

Figure 3.3 Process flow

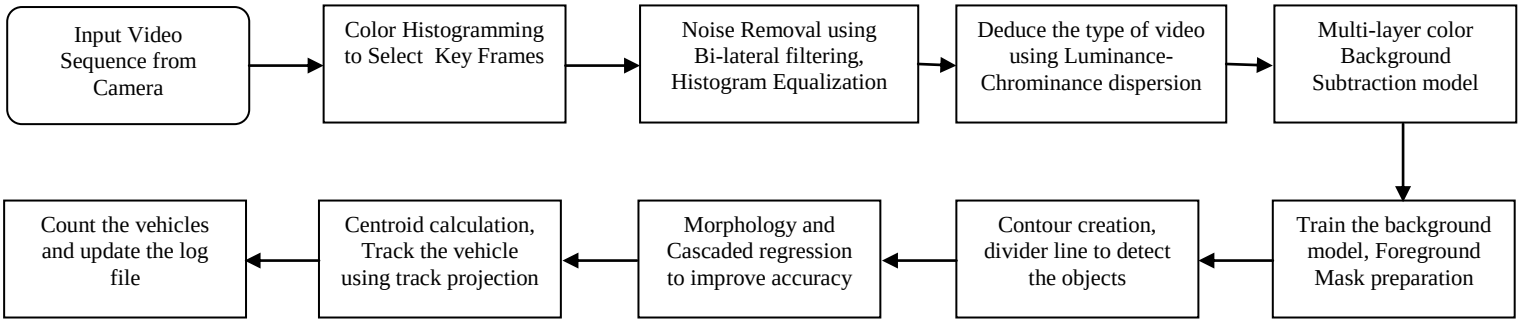

Figure 3.4 High Level Architecture of the proposed system

IV. Results and Discussions

A. Performance Measures

For testing the performance of our approach, we performed two kinds of tests: 1) a background subtraction performance to check the sensitivity of our approach to scene variations with respect to recent alternatives and 2) a counting and classification test through a set of videos with different and challenging situations for vision-based systems.

B. Performance of Background Subtraction Algorithm

We can measure the sensitivity of background subtraction methods in detecting low contrast targets against the learned background. The lower the threshold values that are needed for detecting foregrounds, the more sensitive the background subtraction approach will be, and hence the better the results. Therefore, for this test, it is not necessary to observe scenes with moving vehicles. Observing background scenes is enough as foreground pixel candidates are artificially generated.

C. Couting of Vehicles in different weather conditions

An image of each of the four videos used for this test: 1) a nightfall with diffuse ambient light in which vehicles have headlights turned on (called Nightfall); 2) a sunny day where vehicles project shadows (called Sunny); 3) a rainy day in which the sun appears and causes vehicles to project shadows (called Transition); and 4) a rainy day that includes a traffic jam in which, at times, vehicles are completely stationary in some lanes (called Jam). Each video has a duration of 5 min, and the traffic flow in all of them is significantly dense, with several passing maneuvers and vehicles in parallel.

In this test, we have compared our segmentation approach with other vision-based recent alternatives, maintaining the same tracking procedure for the following categories of traffic videos (a) Nightfall, (b) Sunny, (c) Transition, and (d) Jam videos for vehicle counting and classification.

The main difficulty in the Nightfall sequence is correctly segmenting the headlight reflections on the road with respect to the vehicle. The classification errors in light vehicles are mainly derived from this issue as the measured length in some cases includes parts of reflections. In these cases, the reflection intensity is very high, and therefore, some pixels are not classified as highlight. Therefore, the reflection is not completely cropped. In the case of MCB and MFS approaches, as they do not apply any postprocessing for removing this kind of region, they have more false positives and classification errors.

In the Sunny sequence, the main difficulty comes from the detection of dark vehicles that project shadows. In some cases, there may be some dark vehicles that do not have sufficient gradient features to identify that they are vehicles. MCB has particular problems in distinguishing these cases as it does not take into account cues other than color.

In the Transition sequence, the main challenges come from the visible slipstreams behind vehicles due to the wet road and the sudden illumination changes, but the proposed system behaves well in most cases. On the contrary, both MCB and MFS have problems with sudden illumination changes as they do not handle them explicitly, provoking more false positives.

Finally, in the Jam sequence, the most challenging of all, the proposed conditional background update allows the effect of vehicle stops on the detections to be diminished in our approach. The results of proposed system for different video types are listed in Annexure I.

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Annexure-I

Input Video	Noise Removal and Histogram Equalization	Morphological Operation using Dilation	Background Subtraction	Foreground Mask	Bilateral Filtering	Detected (processed) Frame	Type of the video and count
							DOUBLE WAY (MP4) Count=4
							HEAVY TRAFFIC IN SINGLE WAY (MP4) Count=13
							WINTER SEASON (JPG) Count=5
							HEAVY TRAFFIC IN DOUBLE WAY (MP4) Count=16
							SINGLE WAY (MP4) Count=13
							LESS TRAFFIC IN NIGHT TIME (MP4) Count=3
							SNOW RAINY DAYS (JPG) Count=2

IoT based Passenger Information System Optimized for Indian Metros

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***Abstract*— Public transport plays a crucial role in meeting a city's transportation needs. Moreover, it helps reduce traffic congestion and vehicular pollution. In India, buses are the preferred mode of transit due to their cheap fare and extensive routes. The major obstacles to their usage are: 1) overcrowding and 2) uncertainty in arrival time. Crowd estimation techniques using cameras, infrared lasers at entrances are not suitable for Indian metros. Hence, our paper proposes a solution leveraging the Internet of Things. We have simulated the handheld Electronic Ticketing Machines (ETMS) used by Tamil Nadu State Transport Corporation (TNSTC) conductors via an android application. Crowd estimation is done by maintaining a list of "live" tickets (on-board passengers) of each bus at the server side. The ETMs communicate with the server via an Application Programming Interface (API). The Global Positioning System (GPS) receiver built into the ETM is used for real time tracking of the buses thereby notifying passengers about the bus arrival time. The crowd information and location of the bus are displayed in the client side android application embedded with Google Maps. This solution empowers passengers to take better decisions by bridging the information gap between passengers and bus operators.**

Index Terms - Internet of Things, Public bus transport, crowd estimation, Smart city, android application. Electronic Ticketing Machine, Passenger Information System

I. INTRODUCTION

The urban population is steadily increasing in many cities across the world. This in turn leads to an increase in demand for quality transportation services. Public transport plays a major role in meeting cities rising demand for transport services. They have the capacity to transport large masses of people. A single bus can transport 50 people and takes less space on the road as opposed to 50 cars. Not only does it reduce traffic congestion, but it also helps to avoid polluting the environment by reducing vehicular emissions. Buses are the primary form of transportation for the majority of people in Indian cities. [8]. The buses are preferred because they are cheap and they cover more ground than the alternatives such as the metro rail. In particular for intra-city transportation, buses are more likely to reach a particular area as opposed to the alternatives like the metro which generally have stops at major locations.

Further details regarding the architecture and codes for the abstract level objects can be found in the URL: ***https://github.com/g0g0lganesh/CodeReview***

While the transportation services are adequate, a major problem is the lack of information to meet the passenger's needs in these modern times. There is also a general dissent among the public in using public transportation services. People would prefer the public transportation to be scheduled properly, on time and the frequency be increased for commuters to make good use of it

Our paper proposes a solution to provide these modern information services using an Internet of Things (IoT) based architecture which has tremendous potential to improve the information services provided to the passenger.
Such services are useful for women and senior citizens who resent the inconvenience of travelling in severely overcrowded buses. Moreover, it is good for the public transport operators as it helps attract more passengers, increases revenue & plan accordingly.

The remainder of the paper is organized as follows: In Section II, related work is discussed. An overview of the IoT based PIS system design is given in Section III. In Sections IV we outline how the PIS system was implemented. Section V discuss the results obtained and section VI presents the conclusions of our paper and future work.

II. RELATED WORK

Traditional passenger information systems (PIS) have attempted to meet this need for modern information services using a variety of methods. However, Indian cities pose some unique challenges which require unique solutions.

Automatic Passenger Counting (APC) Systems:
It is an electronic device available for installation on transit vehicles including buses and rail vehicles which accurately records boarding and alighting data [8] People counting technology has evolved as follows:

1st Generation: Infrared beam counting [9] - A widely deployed method is using infra-red beams at the entrance of the buses. It is the simplest and most inexpensive method. A pair of horizontal infrared beams are kept at both entrances of the bus. When a passenger enters the bus the beam is broken

and the passenger count is incremented by one and decremented when a passenger exits the bus. However, "foot-boarding" is prevalent in India (passengers stand on the last step of the bus). They may break the beam continuously rendering it incapable of counting boarding passengers. Also, more than one passenger may board the bus at the same time reducing accuracy.

2nd generation thermal counters have reduced accuracy in varying heat conditions and hence are not suitable for buses which move constantly leading to drop in accuracy.

3rd Generation: Video counting - Images taken from CCTV cameras are used to estimate crowd [10]. This method has the advantage of improved accuracy. Moreover, there is the added benefit of security. But, in India buses tend to get severely overcrowded as a result of a dense population. This leads to a reduction in accuracy. Also, multiple cameras are required to estimate the crowd making it expensive.

Recent trend: WiFi counting- As a recent improvement in crowd estimation the authors of this paper [ref to base paper] have proposed a solution of estimating crowd density using smart phones. This technique involves a wi-fi access point with a built in receiver mounted on the bus. The wi-fi receiver senses the probe request packets sent by the smart phones over IEEE 802.11 protocol on the bus (wi-fi). The MAC (Media Access Control) address of the phone is used to identify unique passengers on the bus. The drawback is that a sizeable portion of the passengers in Indian metros and towns don't have smart phones. In addition to that, they can't be expected to have their wi-fi activated on their phone. Furthermore, Apple iOS9 and Android 6.0 Marshmallow use aggressive MAC rotation schemes, making wi-fi counting impractical in the future. [11]

Automated Vehicle Location (AVL) systems:
Current AVL systems track the location of the bus using a GPS receiver fitted on the bus. Instead of consuming fuel we use our battery powered ETMs which are more economical and can last for 3 days before needing to be charged.

The equivalent of systems that provide these modern information services in India are missing currently. The solution that our paper proposes attempts to bridge this gap.

III. SYSTEM DESIGN

A. **Design rationale**:

Existing passenger information systems offered by Tamil Nadu State Transport Corporation (TNSTC) provide only the offline schedule of buses. Moreover, this information is available only as a web site.

In order to overcome the problems of overcrowding and uncertainty, the passenger is in need of real time location and crowd information of buses. For the information to easily reach passengers, we provide the information using a mobile application.

Existing crowd estimation techniques adopted in western countries are not suitable for Indian metros. For example, people counting using cameras is inefficient as multiple cameras are required which is expensive. Additionally buses in Indian metros tend to get severely overcrowded creating a risk of damage to cameras and a decline in accuracy. Alternative solutions like infrared beams at the entrance of the bus have poor accuracy in Indian cities due to foot-boarding passengers.

In order to overcome these shortcomings, our paper proposes the following innovations:

i) IoT based architecture with the ETMs as the Things in the network

ii) Crowd density estimation using the tickets sold by the ETM

So, crowd calculation is done using the information about tickets sold sent securely from the ETM to the server using HTTP PUT requests. The proposed solution provides improved accuracy from the previous solutions and has the advantage of not requiring any additional infrastructure.

B. Architecture diagram:

Figure 1. High level Architecture of the ETM

The ETM has 3 components namely:

Electronic Ticketing Machine – The ETM has a built in Global Positioning System (GPS) receiver. In addition to this, it is equipped with Global System for Mobile Communication (GSM) and General Packet Radio Services (GPRS) capabilities to communicate with the cloud server via an Application Programming Interface (API). The GPS is used to

track the location of the bus and GSM/GPRS is used to notify the server of tickets issued and changes in current stop.

Web Service – The web service exposes the methods needed for both the ETMs and the client-side android application. It has 6 methods namely: putCurrentStop, putLocation, putTicket, getCrowd and getLocation. The put methods are used by the ETMs whereas the get methods are used by the android application.

Android application – The client-side android application communicates with the web service via an API. The user can get the location of the bus in real time and view it graphically in Google Maps. Moreover, the user can view the amount of seats available in the bus at any moment of time.

IV. IMPLEMENTATION OF REAL-TIME PASSENGER INFORMATION SYSTEM

The real time Passenger Information system has 3 main components:

A. Electronic Ticketing Machine

The Electronic Ticketing Machine used by TNSTC is simulated using an android application.

It has the following functionality:

1. A keypad is used by the conductor to select the destinationStop that the passenger requests a ticket for. Every number on the keypad maps to a stop on the route.
2. A menu option displays the mapping of routes to numbers in the keypad for the conductor's convenience.
3. A service runs constantly in the background to fetch the GPS device co-ordinates at a periodic interval of 10 seconds. The service makes use of Google Play Services. It implements Google's onConnection callbacks namely onConnected, listens to onConnnectionFailedlistener,onConnnectionSuspended listener and onLocationChanged listener.
4. SQLite database is used to simulate the flash memory of the ETM. The database operations are done on a separate thread to avoid blocking the main thread/UI.
5. The OK button when pressed by the conductor issues a ticket by sending the ticket information to the central cloud hosted PaaS (Platform as a Service) backend API.
6. The information is sent over HTTPs protocol by means of a HTTP Post request to ensure secure transmission of data as in the HTTPs protocol the entire request is encrypted.
7. The up and down arrows are used to notify the server that the bus has arrived at the next stop.

B. Server side Web Service

Table 1: Application Programming Interface

Route	Verb	Input
/putLocation	POST	routeNo, latitude, longitude
/putTicket	POST	routeNo, currentStop, destinationStop
/putCurrentStop	POST	routeNo,currentStop
/getLocation	GET	routeNo
/getCrowd	GET	routeNo

*Electronic Ticketing Machine to Server***:**

putLocation - Sends the location fix of ETM received by built-in GPS to server every 10 seconds

putTicket - Sends the ticket information of individual passengers to server

putCurrentStop - Updates the current stop of bus on server

Server to Client side android application:

getLocation - Gets the location of the bus from server

getCrowd - Gets the number of passengers on board the bus

The bus crowd information server is used to store the ticket and location information of all of the buses.

Crowd calculation is done by maintaining a list of "live" tickets (on-board passengers).

The backend API is built using Node.js for scalability and non-blocking requests, Express framework, Body-parser object to easily parse the bodies of incoming requests. The API uses cloud hosted instance of mongoDB provided by mLab. (Database as a Service)

The *put* methods are used by the ETM to store information at the server and the *get* methods are used by the user's android application.

Input parameters are sent via the HTTP post request object which is handled by the Body-parser object and output parameters for the user's android application can be taken from the response object.

The application listens to port 5000 by default otherwise gets the port number from the heroku environment.

C. Client side android application

The client side android application is used to send a request to the server. The resultant information of the bus is received as server response.

i. Crowd

The number of passengers on board can be known by clicking on the crowd icon. The number of passengers is displayed as an editText below the icon

ii. Current Location

The current location of the bus is received & plotted on a Google Maps activity by passing the location parameters to the new Intent. This gives passengers an idea of the expected arrival time of the bus and allows them to plan accordingly.

V. SIMULATION AND RESULTS

A. Electronic Ticketing Machine

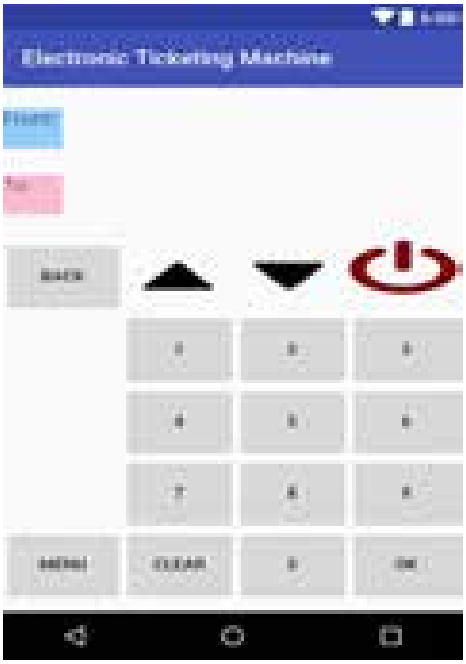

Figure -2 Home Screen of ETM

Figure-3 Stop Mapping

Figure-4 Passenger Information System

Figure-5 Real Time location of the bus plotted using google maps

VI. CONCLUSION AND FUTURE WORK

The IoT based passenger information system proposed

1) Eliminates uncertainty of bus arrival
2) Achieves accurate crowd estimation

This additional information service empowers targeted audience of female passengers, senior citizens and children to decide whether to catch the current bus which is overcrowded or wait 5 minutes for the next one which is not as crowded.
It helps empower passengers to take smart decisions by providing them with relevant real time information. In addition to this, data analytics can be performed on that data to get valuable insights about crowd patterns that can be used by the public transport operator. This can be used to plan route services accordingly to balance the passenger load.

As future work, we plan to replace HTTP protocol which is more energy draining on battery in comparison to recent IoT based protocols. Message Queue Telemetry Transport in particular follows a publish-subscribe mechanism suitable for this application and with minimum battery requirement.
The proposed solution can be used in all cities and towns that employ the required infrastructure

VII. ACKNOWLEGMENT

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in the "4th National Level Conference on Ubiquitous Technologies inElectronics" (NCUTE 17) held at Theni Kammavar Sangam College of Technology on 30th March 2017

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has participated / presented a paper entitled ENHANCEMENT OF PHOTOVOLTAIC CELL EFFICIENCY USING PELTIER TILES

in the Twelfth National Conference on "Optimization Techniques in Engineering Sciences and Technologies (OPTEST-2017)" during 17-18 March 2017, organized by the Department of Mechanical Engineering, Bannari Amman Institute of Technology, Sathyamangalam, Erode District, Tamil Nadu.

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come to help the women. The system can be initiated using Bluetooth (or) Force sensors in order to enhance the security of the person.

VEHICLE TRACKING AND THEFT CONTROL USING RASPBERRY PI

V.Palanimayil @ sivetha, V.Nithya, S.Thulasi and C.Vidhya
Department of Electronics and Communication Engineering,
Kalasalingam Institute of Technology, Krishnankoil

This paper presents a smart anti-theft system that uses GPS and GSM to prevent theft and to determine the exact location of the vehicle. The system contains Raspberry pi2, GPS module, GSM modem, infrared sensor, DC motor, relay switch, ultrasonic sensor and camera. GSM system is also installed in the vehicle for sending the information from satellites. In case of accident, this system automatically sends the message to one's relative for help. The preventive measures like speed reduction, engine ignition cut off, fuel supply cut off are also installed in the vehicle which is controlled using user or owner GSM mobile. The owner can lock or unlock his/her vehicle with the help of SMS. In order to detect the theft face, camera is provided in this system.

ENHANCED AUTOMATION USING IOT

S.Periyanayagi, V.Gobiya and M. Harini Jayalakshmi
Department of Electronics and Communication Engineering,
Ramco Institute of Technology, Rajapalayam

Smart home deals with trending technology related to IOT. An automated smart home is modeled to perform few automation activities like digital locking system, power saving system, smart gardening system, pet feeder, water level indicator and gas leakage indicator. This smart home system is made up of variety of sensors like PIR sensor, Gas sensor, Induino board, IR transmitter and receiver, Bluetooth module, time module and vibrator to control the home appliances using smart phone via IOT. The digital locking system is performed by using password and if any unauthorized persons try to open the lock an alert is sent to the user via Internet to smart phone via SMS. The power saving system enhances power utilization by avoiding wastage of power. Whenever a person enters the room, the light is turned on and as the person leaves the room, the light is automatically turned off. The smart power saver indicates the power consumption of each and every device and turns off the device that consumes more power with the permission from the user through IOT. The smart gardening system waters the plants regularly twice a day. The smart water system saves water by turning on the motor automatically when the water level in tank is less than 20% and turning off the motor when the water level is above 90%. The smart pet feeder feeds the pet at specified time with the help of a vibrator. The gas leakage detector gives an alert about the leakage to the user. Thus the smart home provides complete automation and helps user lead a sophisticated life. These kinds of home are going to be predominant in near future. This automation can also be extended to other places like office, educational institutions, hospitals and other public places. These automations are briefly explained in this paper.

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IMPACT OF WORK FUNCTION ENGINEERING IN JUNCTIONLESS MULTIGATE MOSFET

G.Lakshmi Priya, R.Kiran Rakshana, S.Kowsalya and S.Mareeswari
Department of Electronics and Communication Engineering,
Ramco Institute of Technology, Rajapalayam

The proposed mathematical model analyses the impact of work function engineering in triple material junctionless Multigate MOSFET. As the device doping material and concentration is same in the channel region and in the source and drain regions, the device has no source and drain junctions. A two dimensional mathematical model for the triple material junctionless multigate MOSFET is defined by the 2-D Poisson's equation. A new solution to the device equation is obtained by using finite-differentiation method. This finite-differentiation method has been used to decompose the 2-D Poisson's equation into two 1-D equations, which permits the modelling of the junctionless multigate MOSFET as three individual single material multigate JLFETs. The results of two 1-D models are then combined by using the appropriate boundary conditions to provide a simple solution to the complex 2-D Poisson's equation. With the results of the proposed model, we have observed that the short channel effects has been reduced and it is analyzed for different values of doping concentration (Nd), oxide thickness (Tox), and channel thickness (Tsi). Thus, the proposed Triple Material Surrounding Gate Junctionless FET (TMSG - JLFET) proves to be a promising device in minimizing the leakage current.

ARDUINO MICROCONTROLLER BASED ROBOTIC VEHICLE FOR RESCUE OPERATION

T.RamPrakash, R.Velvizhi, S.Harini Shriram and T.Mithra Preethi
Department of Electronics and Communication Engineering,
Ramco Institute of Technology, Rajapalayam.

Rescue robots are used in the search of victims and survivors. Arduino Microcontroller, a ZigBee transmitter and receiver module, DC motors, motor drivers, cameras and sensors like temperature, humidity, PIR and Gas sensors are used for designing the robotic vehicle. It is named as a rescue robot because it is designed for rescuing people in disaster areas and gives the general information about the situation of the affected areas or in mines. ZigBee protocol is used for controlling the robot and transmitting the values from sensors to Rescuers. The designed system is flexible enough so it can easily be upgraded or modified to be used in a variety of situations according to the need.

EMBEDDED BASED SYSTEM FOR REDUCTION IN DOSAGE OF PESTICIDE

S.Periyanayagi , R.Abitha Manonmani , S.Jayalakshmi and R.Sheeba Evageline
Department of Electronics and Communication Engineering, Ramco Institute of Technology, Rajapalayam

Agriculture field is facing many challenges today. An Embedded based monitoring system for addressing one of the challenges has been proposed. The monitoring system collects the data related to dosage of pesticides in the soil by measuring the pH value and Moisture content of the soil. The prompt and accurate measurement of pesticide is very important because of its advese effect on human health. The pH sensors and moisture sensors have been widely used for detecting the level of pesticides. In this system the multisensor is used to detect the pesticide level using the pH and moisture level of a soil. By measuring the pH value and

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moisture content of soil the dosage level of pesticides can be reduced. Arduino is used to interface the data collected from the sensor to the GSM which is used to transmit the pesticide value to the mobile phones and IOT is used to update that value using cloud computing. Thus the embedded based monitoring system helps to reduce dosage level in the agriculture field.

BIOMETRIC AND RFID BASED POLLING SYSTEM

B.Deepa Lakshmi, S.J.Poornima , M.Sivapriya and R.Srija
Department of Electronics and Communication Engineering,
Ramco Institute of Technology, Rajapalayam

Elections cast an notifying influence on the minds of people and forms the important feature of our country-India, in which every individual participates vigilantly and the public remains the dominant power. The world has been experimenting with diverse technologies to conduct dispute free elections, to fulfill the basic needs of the people. It should be taken into account that no elector should be excluded from their voting rights. Also, in recent times there has been a decline in the confidence of common people over Electronic Voting Machines (EVM) and it is seen that there is a noticeable reduction in the turnout rate of voters. To increase participation among all demographic groups, this design looks into the multiple dimensions, notes all security requirements and provides an inexpensive solution. In this system, Radio Frequency Identification (RFID) card is used for identification of a person before giving his vote. As an added tier of security, biometrics is used for authentication and to confirm that each voter casts their vote only once. Because biometric identifiers cannot be easily hacked or forged they are considered more reliable for person recognition than other traditional methods. Then, EVM is connected to the database of voters and candidates by means of server. This enables people to vote in the nearby polling booth by connecting the EVM to the server, thereby reducing the need to travel distances and helps to increase the turnout rate of voters.

GENERATION OF ELECTRICITY USING MICROBES

S.Periyanayagi, M. Anupriya and P.Bhuvaneswari,
Department of Electronics and Communication Engineering,
Ramco Institute of Technology, Rajapalayam

The electricity is generated from evaporation. Spores exposed to humid environment will absorb the moisture content and gets expanded. When the water is evaporated, the spores release the absorbed water and shrinks. This acts as an artificial muscle. The continuous process of expansion and shrinking of the artificial muscle is used in the generation of electricity.

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submitted to *NESR' 17* held at University College of Engineering, BIT Campus, Anna University, Tiruchirappalli, Tamil Nadu, during 24th - 25th March, 2017.

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submitted to *NESR' 17* held at University College of Engineering, BIT Campus, Anna University, Tiruchirappalli, Tamil Nadu, during 24th - 25th March, 2017.

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HYBRID SYSTEM BASED CLOSED LOOP IMPLEMENTATION OF STATCOM FOR NONLINEAR LOADS USING SVPWM

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***Abstract*: The implementation of STATCOM by solar energy source with closed loop control is used for providing instantaneous power flow on variable load condition.The harmonics are very high in normal Pulse Width Modulation (PWM) inverters hence the Space Vector Pulse Width Modulation (SVPWM) is implemented to reduce the harmonics.Space Vector Pulse Width Modulation is said to be an advanced computation intensive PWM method and possibly the best techniques for variable frequency drive applications. As for as the interaction between the three phases is considered instead of using a separate modulator for each of the three phases the complex reference voltage vector is used.Distributed STATCOM controller is used to eliminate forced oscillations, harmonics and steady state error resulting in operation of better on-off control.**

***Index Terms: SVPWM* - Space Vector Pulse Width Modulation, *STATCOM* - Static Compensator, DistributedSTATCOMcontroller.**

1. INTRODUCTION

Power generation and transmission is a complex process, requiring the working of many components of the power system in tandem to maximize the output. In most of the situations, solar panels alone are not sufficient to supply the power needs of many applications during the winter months, due to shorter daylight time and weaker solar radiation. This poses a difficulty in using renewable energy for critical applications. The proposed hybrid technology solves this problem by integrating MPPT based photovoltaic (PV) power generation with SVPWM based wind power generation. One of the major part is the reactive power in the system [1]. It is required to maintain the voltage to deliver the active power through the lines. Loads like induction motor and other inductive loads require reactive power for their operation. To improve the performance of ac power systems, we need to manage this reactive power in an efficient way and this is known as reactive power compensation[2]. There are two aspects in the problem of reactive power compensation: load compensation and voltage support. Load compensation consists of improvement in power factor, balancing of real power drawn from the supply, better voltage regulation, etc. of large fluctuating loads. Voltage support consists of reduction of voltage fluctuation at a given terminal of the transmission line.

2. SPACE VECTOR PULSE WIDTH MODULATION

It is a more sophisticated technique for generating sine wave that provides a higher voltage to the motor with lower Total Harmonic Distortion(THD). Space Vector Pulse Width Modulation (SVPWM) method is an advanced computation intensive PWM method for variable frequency drive application. In SVPWM technique, instead of using a separate modulator for each of the three phases, the complex reference voltage vector is processed as a whole [3] therefore, the interaction between the three motor phases is considered. SVPWM generates less harmonic distortion in the output voltage and current in the windings of the motor load and provides more efficient use of the DC supply voltage in comparison with sinusoidal modulation techniques through SVPWM provides a constant switching frequency so the switching frequency can be adjusted easily.A three phase system defined by Va(t), Vb(t), Vc(t) can be represented uniquely by a rotating vector

$V=Va(t) + Vb(t)\, e^{j2\pi/3} + Vc(t)\, e^{-j2\pi/3}$
where,

Va (t) = Vmsinωt ,
Vb (t) = Vmsin(ωt-2π/3) and
Vc (t) = Vmsin(ωt+2π/3).

The reference voltage is represented as a vector in this plane

$$\begin{bmatrix} \quad \\ \quad \end{bmatrix} = \begin{bmatrix} 1 & \frac{1}{2} & -\frac{1}{2} \\ 0 & \sqrt{\frac{3}{2}} & -\sqrt{\frac{3}{2}} \end{bmatrix} * \begin{bmatrix} n \\ bn \\ n \end{bmatrix}$$

where, (V , V) are forming an orthogonal two phase system as V = V + jV ,as shown in Fig1.

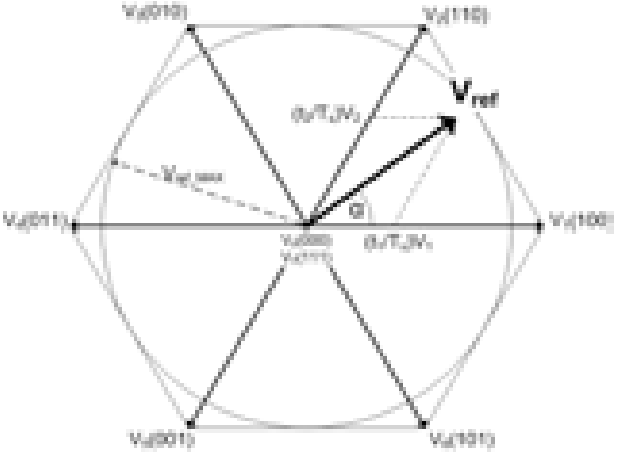

Fig 1. SVPWM Vector diagram

'0' → Negative phase voltage level and
'1' → Positive phase voltage level.

Six non-zero vectors (V1 and V6) shape the axis of hexagonal and the angle between any adjacent two non-zero vectors is 60°. Two of these states (V0 and V7) correspond to a short circuit on the output, while the other six can be considered to form stationary vectors in the - complex plane

Consider the switching states, (0,0,0) & (1,1,1)
Van = Vbn = Vcn =0;
Hence, Vd = Vq = 0 ;
Therefore, Vs= 0∠0°
Now consider the switching state (1,0,0):-
Va0 = Vdc2 , Vb0 = Vc0 = -Vdc 2
Van = Vdc&Vq=0 Therefore, Vs= Vdc∠0°
Since (0,1,1) is the complementary of (1,0,0); For (0,1,1), Vs= Vdc∠180° Similarly derive the magnitude and angle of space vector for all possible switching states.

For (0,0,0) : Vs= 0∠0° → 0
For (1,0,0) : Vs= Vdc∠0° → 1
For (1,1,0) : Vs= Vdc∠60° → 2
For (0,1,0) : Vs= Vdc∠120° → 3
For (0,1,1) : Vs= Vdc∠180° → 4
For (0,0,1) : Vs= Vdc∠240° → 5
For (1,0,1) : Vs= Vdc∠300° → 6
For (1,1,1) : Vs= 0∠0° → 7

3.BLOCK DIAGRAM

The hybrid system of wind and solar were used as a source for the proposed system. The renewable energy source has become a major energy source for modern power system. Here the STATCOM is supplied with solar and the wind is used as a main three phase source as shown in Fig2.

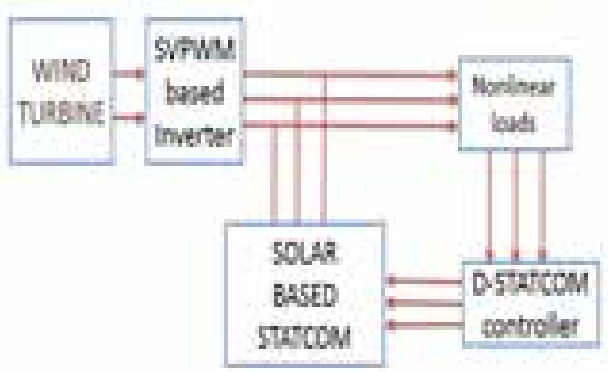

Fig 2. Block diagram for proposed system

4. SIMULATION OF PROPOSED WORK

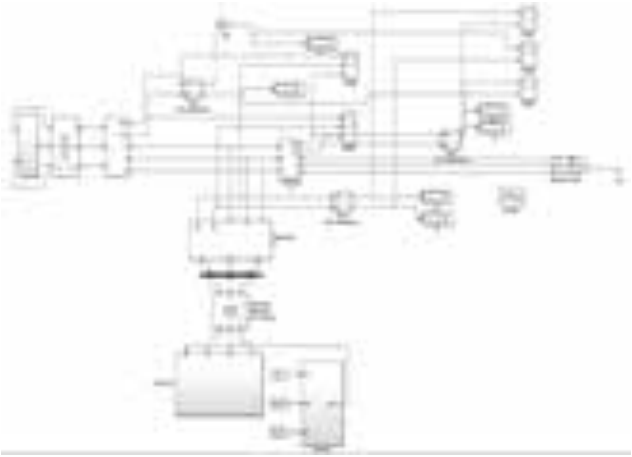

Fig 3. Simulation diagram

The simulation diagram of the proposed work is shown in Figure 3. STATCOM is a normal three phase inverter with DSTATCOM Controller. Here the load used is a normal non-linear series RL load [4].The three phase supply is supplied with wind energy convertion system where they are controlled with Space Vector Pulse Width Modulation(SVPWM) inorder to minimizes the harmonic density, since it has high switching frequency results in improved power factor (PF). SVPWM utilizes DC bus voltage more efficiently with less Total Harmonic Distortion (THD).As described earlier the STATCOM is supplied with solar PV under non-linear load condition. STATCOM proviedes the reactive power to the non-linear loads and consumption of reactive power from the main three phase source results in better reactive power control[5].The SVPWM based wind energy system is shown in Fig 4

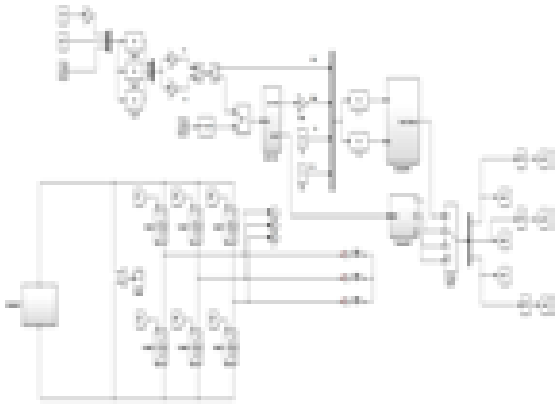

Fig 4 Simulation diagram of SVPWM based WINDpower generator system

4.1 MPPT BASED STATCOM SIMULATION DIAGRAM

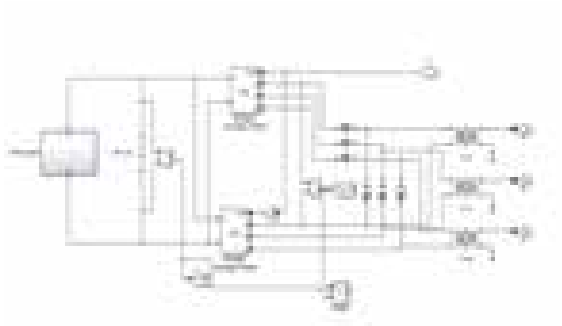

Fig 5. STATCOM simulation diagram

The simulation using the STATCOM is shown in Figure 5. Here the solar pv is designed with Maximum Power Point Tracking (MPPT) and bridge inverters are used for converting DC to AC. Two bridges are used, one for positive cycle and another one for negative cycle. An isolation transformer is used before connecting the output of STATCOM to the grid for protection purpose. A DC link capacitor is used to supply the DC power to the STATCOM [6]

4.2 DSTATCOM CONTROLLER DIAGRAM

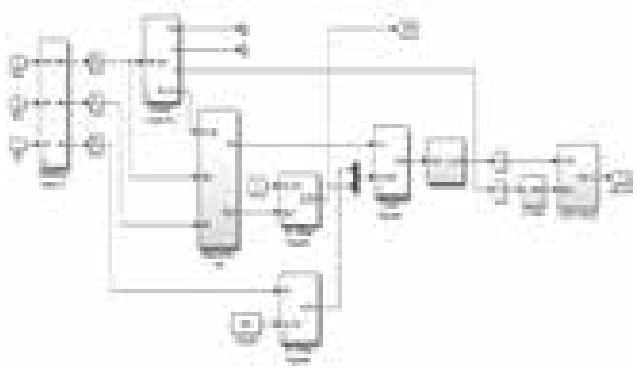

Fig 6. DSTATCOM controller simulation diagram

The controller diagram of the STATCOM is shown in Figure 6. Here the fundamental voltage and current signals (a, b, c components) are converted in to direct axis and quadrature axis component (dq) using reference frame theory. This dq component if compared with angles, which is driven from the Phase Lock Loop (PLL).PLL made of Voltage regulator, Loop filter and Voltage Control Oscilator (VCO).Then they are send to AC voltage and current regulator from this the reference voltage is generated [7]. This reference voltage is further compared with a carrier signal to create pulse for STATCOM [8].

5. RESULTS AND DISCUSSIONS

The simulation results and its output performance were discussed. The output waveforms show the results after carrying out the reactive power compensation by source, load and STATCOM. Voltage stability will be maintained at these output waveforms. Voltage stability consist of both source and load. The simulation results shows the output waveforms of voltage and current for both source and load side. Finally the reactive power compensation is done using STATCOM and the output waveforms were discussed.

Table 1. Real and reactive power values

Name	Real Power(Watts)	Reactive Power(Var)
Source Side	1200	3.5
Load Side	700	1100
STATCOM Side	460	1097

(a)Source side waveform

The source side output waveform is shown in Figure7. The waveform consist of real and reactive power of the source. Source side consumed 1200 Watts real power and 3.5 VAr reactive power. In this case, it requires less amount of reactive power.

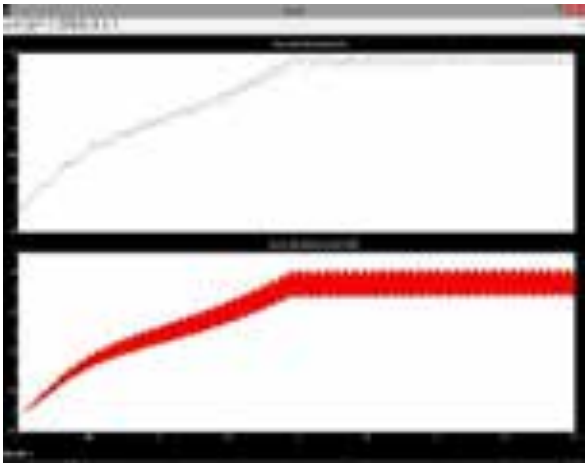

Fig 7.Output waveform for source

(b) Load side waveform

The load side output waveform is shown in Figure 8. The waveform consist of real and reactive power of the load. The load consumed 700 Watts real power and 1100 VAr reactive power. The reactive power injected to the load.

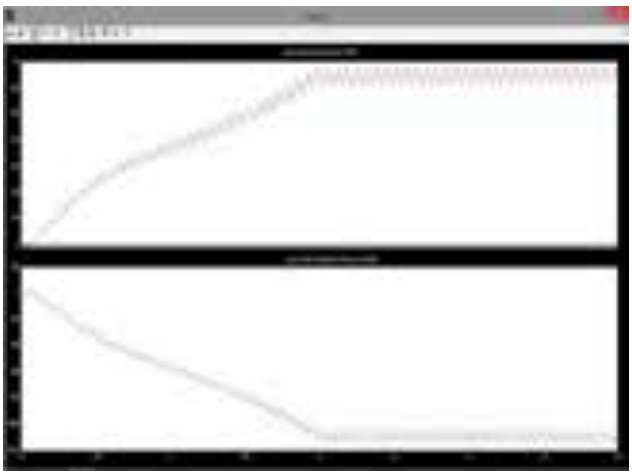

Fig 8. Output waveform for load

(c) STATCOM side waveform

The STATCOM side output waveform is shown in Figure 9. The waveform consist of real and reactive power of the STATCOM. The STATCOM consumed 1097 Watts real power and 460 VAr reactive power. In simulation, the STATCOM injects reactive power to the load, and hence does the reactive power compensation.

Fig 9. Output waveform for STATCOM

(d) Output voltage waveform

The output voltage waveform is shown in Figure 10. This waveform consist voltage waveform for source, load and STATCOM. This voltage level is maintained at stable for particular limit. Source side voltage is 440V and load side voltage is 440V. So the voltage is maintained stable.

Fig 10.output waveform for voltage

e) Output current waveform

The output current waveform is shown in Figure 11. This output waveform consist of source, load and STATCOM current. Source side current value is 5 A and load side current value is 5 A and STATCOM side current value is 1 A.

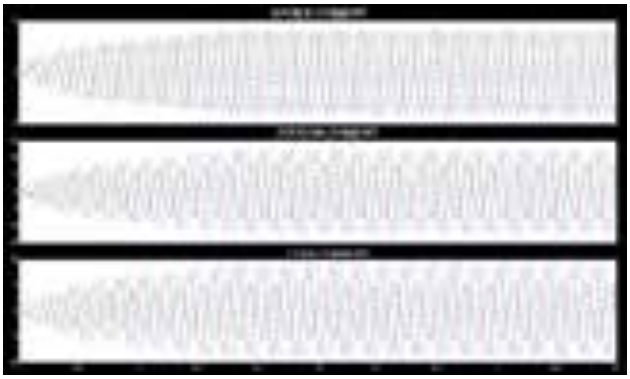

Fig 11. Current output waveform

6. CONCLUSION

This paper introduces a simulation model for DSTATCOM controller based STATCOM for reactive power compensation. The proposed model is a solution for reactive power compensation using STATCOM using hybrid source technology. The simulation model results in stablized current and voltage over particular limit and hence clearly shows that STATCOM can be successfully implemented for the reactive power compensation.The proposed system also maintains the source (Electricity Board) voltage and current in phase with each other after compensation. Thus the power factor of the utility supply is always maintained at a higher value.

7. ACKNOWLEDGMENT

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Cost Allocation for VAR providers in Utility System for Optimal Reactive Power Dispatch

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***Abstract*— The reactive power is the background power without which the active power cannot be transmitted in the power systems. Consequently, the pricing for reactive power has become imperative in the restructured power market. Determining the optimal reactive power dispatch and pricing are the challenging factors in the power market. This paper represents the cost allocation to the generator reactive power based on the opportunity cost method. The differential evolution is used for optimal reactive power dispatch. Two conflicting objective functions have been considered which are the minimization of real power loss and total voltage deviation. A detailed analysis for pricing reactive power has been performed on 62 bus Indian utility systems. By simulation, it has been shown that the optimal control variables settings reduces the loss and also economically reduces the generator reactive power cost.**

Keywords*— *Real power loss; optimal reactive power dispatch; Differential evolution; opportunity cost; reactive power pricing

I. INTRODUCTION

In a restructured power system, there are many ancillary services. Based on the Federal Energy Regulatory Commission (FERC), the reactive power that is generated from the generators is considered as one of the six supplementary services in the power system [1]. The reactive power is the backbone power without which the active power cannot be transmitted in the power system. The analysis and characteristics of reactive power are mentioned in the report submitted by FERC [1].

The Optimal Power Flow (OPF) is a potential concept for analysing, planning and operating the power system. This was first formulated by Carpentier in 1960. The optimal reactive power dispatch (ORPD) is one of the sub problems of OPF. The most dominant objective function of ORPD is the minimization of losses. When the reactive power flows in the line is high, the loss is high and thereby affect the system efficiency. So, minimization of loss is considered as one of the objective functions. Further, the reactive power and bus voltages are coupled to each other. The insufficient reactive power leads to voltage collapse which is identified as a major reason for the blackout in the states of USA, Denmark and Italy in the year 2003 [2]. So voltage profile improvement is considered as another objective function. The ORPD has been given importance in the power industry for future planning and operation.

Many researchers have analysed on pricing of the reactive power service. Gil et al. have suggested the marginal pricing approach to find the reactive power cost at each node of the network considering the cost function of power as objective. The spot pricing method has been presented by Garcia Roman [4]. These methods do not account the opportunity cost. The high volatility in the pricing leads to unstable price in the power market. The revenue gained by the reactive power seller based on this method may not recover the production cost. The modified tracing method is used to trace the generator power towards the load [5], [6]. The reactive power pricing for the generator is found based upon their contribution to the load.

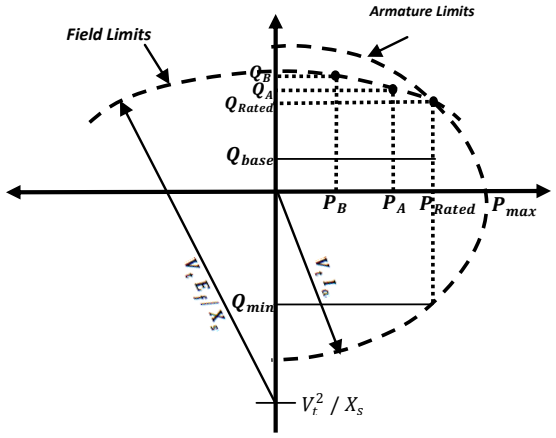
In this paper, reactive power pricing model for generator is discussed that aims to minimize the loss and the voltage deviations. The various conventional methods are available to find solution of optimization problem but finds difficult to handle the non-convexity and non differential problem. Hence one of the evolutionary computation techniques such as Differential Evolution (DE) is used to obtain solution for the reactive power dispatch problem. The DE is advantageous than other evolutionary computation techniques. The DE can find the best solution regardless of the initial trial value of simulation parameters. This technique is robust, converges faster and use less number of control parameters [7], [8], [9], [10]. The DE is used to find the optimal control variables such as bus voltage magnitude and tap settings of transformer and shunt compensation for 62 bus Indian utility systems (IUS). The generator reactive power cost allocation is found for 62 bus IUS.

In India, limited researches are carried out in the field of reactive power. Here, the ORPD and the allocation of cost for the reactive power service are carried out for different sites of Tamil Nadu state. The contributions of the paper are finding the reactive power generation with optimal control variables setting and pricing the generator reactive power in the 62 bus IUS.

II. MODEL OF SYNCHRONOUS GENERATOR

The reactive power is provided by sources such as generator, shunt capacitor, series capacitor and FACTS devices. These sources have different production cost models. One of the important reactive power sources is the generator. In the power system, most of the generators are of synchronous generator. Determining the cost model for synchronous generator is the basis for reactive power payment mechanism. The analysis of mutual relationship

between the powers of the synchronous generator [11], [12], [13], [14] is shown in Fig. 1.



Capability curve

$$C_{QGi}(Q_{Gi}) = [C_{PGi}(P_{Gi,\max}) - C_{PGi}(\sqrt{P_{Gi,\max}^2 - Q_{Gi}^2})] \times k \qquad (2)$$

$C_{QGi}(Q_{Gi}) = [C_{PGi}(P_{Gi,\max}) - C_{PGi}(\sqrt{P_{Gi,\max}^2 - Q_{Gi}^2})] \times k$ where C_{QGi} and C_{PGi} are the reactive and active power production cost of generator *i*. $P_{Gi,max}$ is the maximum real power of the generator *i*. Q_{Gi} is the reactive power of generator *i*. *k* is the expected profit rate of the real power and defined by the government agency. Here it is taken as 10%.

I. PROBLEM FORMULATION

The ORPD problem aims to find the steady performance of the power system by optimal tuning of control variables. The solution of ORPD is to optimize the objective function while satisfying various constraints. The ORPD problem is defined in the succeeding subsections.

A. Objective Function

The optimal combination of generator reactive power can be found, considering the objective as minimization of the loss. Expansion of power system sometimes leads to the wastage of energy. So minimization of loss (P_{loss}) is an important objective function , F_l which is expressed as follows [15].

$$F_l = P_{loss} = \sum_{k=1}^{nl} g_k (v_a^2 + v_b^2 - 2 v_a v_b \cos(\delta_a - \delta_b)) \qquad (3)$$

g_k is the *k*-th line conductance, v_a and v_b are the magnitude of voltage and δ_a and δ_b are the phase angles of voltage at the end buses *a* and *b* of the *k*-th line and *nl* is the number of lines

The most important security index of the power system is the bus voltage. Improving the bus voltage is possible by reducing the voltage deviation at the load bus from 1 p.u. So the minimization of total voltage deviations (T.V.D) is considered as another objective function, F_{VD} [16] which is expressed as:

In general, the generators are manufactured to generate real power and hence the investment cost is recovered from the real power sale. However, in practice the reactive power is gaining importance in the power system. So, when the generator generates the reactive power, then we can find the real power that is not produced from the capability curve. Hence the real power sale leads to loss due to the reactive power generation. This loss is called as the opportunity cost.

The real power cost functions are represented as follows.

$$C_{PGi}(P_{Gi}) = a + bP_{Gi} + cP_{Gi}^2 \qquad (1)$$

where *a, b* and c are cost coefficients, P_{Gi} is the active power generation of *i*-th generator. The cost coefficients of the generators are shown in Table VI.

$$F_{VD} = T.V.D = \sum_{j=1}^{No.ofloadbuses} |v_j - 1| \qquad (4)$$

B. Equality Constraints

The power balance equation represents the equality constraints [17] which can be expressed as shown in (5) and (6).

$$P_{Gm} - P_{Dm} = V_m \sum_{n=1}^{N_{B-1}} V_n (G_{mn} \cos\theta_{mn} + B_{mn} \sin\theta_{mn}) \qquad (5)$$

$$Q_{Gm} - Q_{Dm} = V_m \sum_{n=1}^{N_{pq}} V_n (G_{mn} \sin\theta_{mn} - B_{mn} \cos\theta_{mn}) \qquad (6)$$

where N_{pq} is the number of system load buses; N_{B-1} is the number of buses except slack bus. P_{Gm} and Q_{Gm} are the active power and reactive power generation at *m*-th bus respectively; P_{Dm} and Q_{Dm} are the active and reactive power demand at *m*-th bus respectively; $G_{mn}$and B_{mn} are the mutual conductance and susceptance of bus admittance at *m*-th row and *n*-th column; V_m and V_n are the magnitude of voltage at *m*-th and *n*-th bus; θ_{mn} is the difference in voltage angle between *m*-th bus and *n*-th bus [17].

C. Inequality Constraints

Power constraints [20] are expressed as shown in (7) and (8).

$$P_{Gslack}^{\min} \le P_{Gslack} \le P_{Gslack}^{\max} \qquad (7)$$

$$Q_{Gi}^{\min} \le Q_{Gi} \le Q_{Gi}^{\max} \qquad (8)$$

where $P_{Gslack}^{\min}$ and $P_{Gslack}^{\max}$ are operating limits of the active power at slack bus; $Q_{Gi}^{\min}$ and $Q_{Gi}^{\max}$ are

operating limits of the reactive power at *i*-th generator bus.

The line flow constraints are represented by (9).

$$P_{li}^2 + Q_{li}^2 \le S_{li,\max}^2 \tag{9}$$

$$V_{Li}^{\min} \le V_{Li} \le V_{Li}^{\max} \tag{10}$$

where P_{li}, Q_{li}, $S_{li,max}$ are the real power, reactive power and maximum thermal limit of transmission line *i*. Voltage security constraint at the load bus is given by (10). V_{Li}^{min} and V_{Li}^{max} are the operating limits of the voltage at *i*-th load bus [16].

The control variable limits are the inequality constraints [16] which are given as follows:

$$V_{Gk}^{\min} \le V_{Gk} \le V_{Gk}^{\max} \qquad k = 1...Generators \tag{11}$$

$$t_i^{\min} \le t_i \le t_i^{\max} \qquad i = 1...Transformers \tag{12}$$

$$Q_{ck}^{\min} \le Q_{ck} \le Q_{ck}^{\max} \qquad k = 1...Shunt\ Devices \tag{13}$$

where V_{Gk} is the generator bus voltage magnitude at *k*-th bus. Q_{ck} is the generation of reactive power at *k*-th shunt VAR compensation and t_i is the tap ratio of transformer. Adjusting the tap settings will make the transformer to produce a higher or lower voltage at the output terminal from the same input voltage. Both the objectives i.e. Eq. 3 and Eq. 4 achieve their minimum value by optimal tuning of control variables. The on load tap changing (OLTC) transformer maximize the voltage at the load buses by lowering tap position, this may lead to voltage instability. Thus transformer tap position is considered as one of the control variable and it is to be varied within the limits.

The optimization problem with the state variable and control variable is able to be solved by various global search techniques. In this article, the DE is used for solving the optimization problem due to its flexibility, faster convergence and simplicity.

II. DIFFERENTIAL EVOLUTION OVERVIEW

In 1995, Storn and Price introduced an evolutionary technique called DE [17]. DE algorithm can be used for ORPD problem [18]. It is a global searching technique and is characterised by its simplicity, robust and fast convergence. The steps of DE are discussed as follows:

1) Initialization: The initial step is initializing the population of candidate which is randomly chosen from its operating bounds. The Initialization can be written as,

$$x_{j,i}^{(G)} = x_j^{lower\lim it} + Random \times (x_j^{lower\lim it} - x_j^{upper\lim it}) \tag{14}$$

where *i*=1,2,... , *Np* and *j*=1,2,...,*D*. *Np* is the population size and *D* is the problem dimension. The data of power system such as generator data, bus and line data are given as an input. The DE parameters such as population size, number of iterations, problem dimension, scaling factor and crossover ratio are initialised. Every vector of population is initialised and the objective of each solution is computed and stored.

2) Mutation: The second step is the mutation process. The mutant or donor vector $V_i^{(G)}$ is generated for each target vector x_i. The mutant vector $V_i^{(G)}$ is created such that it demarcates among the various DE strategies. The mutation strategy used here is DE/rand/1. $V_i^{(G)}$ is obtained by combining random vector X_{r1} with the subtraction of two other random vector. The three vectors such as X_{r1}, X_{r2} and X_{r3}which are randomly chosen and obtained from previous step. The vectors X_{r1}, X_{r2} and X_{r3} do not overlap with current target vector x_i. The mutant vector can be found using the following equation,

$$V_i^{(G)} = x_{r1}^{(G)} + F * (x_{r2}^{(G)} - x_{r3}^{(G)}) \tag{15}$$

where *F* is the mutation scaling factor between 0 and 1.Vectors r1, r2, r3 $\in \{1, N_P\}$ and $r1 \neq r2 \neq r3 \neq i$. Where *i*=1,2,..., *Np*.

3) Crossover: The next step is the crossover which is used to increase the current population diversity. The binomial crossover is used on all the dimension variables even if the random number is chosen between 0 and 1 with less crossover constant (CR) value. The binomial crossover operation used in this paper can be expressed as,

$$U_i^{(G)} = \begin{cases} V_i^{(G)} \ if\ random_j \le CR \\ X_{j,i}^{(G)} \ otherwise \end{cases} \tag{16}$$

The DE performs this step to produce the trail vector, $U_i^{(G)}$. This trial vector is produced from the parent and mutant vector in a probabilistic concept. CR is the crossover control parameter between 0 and 1.

4) Selection: This is the last stage of DE procedure. For minimisation problem the vector which is having the lowest fitness value is selected. This existing population vector produces the population in the next iteration as,

$$X_{j,i}^{(G+1)} = \begin{cases} U_i^{(G)} \ if\ f(U_i^{(G)}) \le f(X_i^{(G)}) \\ X_{j,i}^{(G)} \ otherwise \end{cases} \tag{17}$$

Once the best solutions are reached, the stopping criteria are checked. Usually the optimization algorithm is stopped whenever the maximum iteration is reached.

III. RESULTS AND DISCUSSION

The optimal dispatch of the generator reactive power is obtained by the DE. The reactive power is priced using opportunity cost method. The ORPD with cost analysis is carried out for two different objective function in the 62 bus IUS. The one line diagram of the 62 bus IUS is referred from [19]. The first case is the base case system with the objective of transmission loss minimization (3) and finds the cost for the generator reactive power. The second case is the improvement of voltage. This can be

possible by deducing the voltage deviations at PQ bus from 1 p.u (4). The generator reactive power cost analysis for the different cases is carried out for 62 bus IUS. The system consists of 19 generator buses and 43 load buses with 89 transmission lines. The generator characteristics, load characteristics and line data are taken from [19], [20]. The base of apparent power is 100 MVA. The problem is simulated in the system having CPU with a clock speed of 2.2 GHz and 4 GB RAM. The time taken for the solution of ORPD problem is 1205.56s for case 1 and 2412.25s for case 2.

The power flow is calculated using the MATPOWER package [21]. The generator power result for the 62 bus IUS is indicated in Table I. The real power loss is 57.706 MW.

TABLE I. CONTRIBUTION OF GENERATOR POWER (WITHOUT DE)

Generator	*Real power (MW)*	*Reactive power (MVAr)*
G_1	360.71	82.92
G_2	100	-16.2
G_4	100	193.61
G_5	20	-3.19
G_8	120	53.42
G_{17}	300	59.21
G_{23}	100	157.43
G_{25}	500	57.3
G_{32}	200	5.46
G_{33}	30	11.98
G_{34}	100	114.97
G_{37}	50	26.51
G_{49}	120	-33.29
G_{50}	50	-18.05
G_{51}	125	45.43
G_{52}	55	56.66
G_{54}	55	-18.52
G_{57}	150	-31.25
G_{58}	550	54.03

The DE algorithm is applied to the 62 bus IUS with the objective as the minimization of real power losses. The DE parameters are shown in Table II. The control variable limits for the 62 bus IUS are shown in Table III.

TABLE II. SIMULATION PARAMETERS OF DE ALGORITHM

Parameter	*Value*
No. of population	65
Scaling factor	0.6
Crossover ratio	0.8
Dimension	29
Maximum number of iterations	500

TABLE III. CONTROL VARIABLES OF 62 BUS IUS

Variable	*Bus/Branch No.*	*Minimum limit*	*Maximum limit*
Generator bus voltage	Bus 1(slack),2,4,5,8,17, 23,25,32,33,34,37,49,50,51,52, 54,57,58	0.9 p.u	1.1 p.u
Transformer tap settings	Branch 1-14, 14-15, 4-14, 13-14, 12-13, 14-19, 14-18, 14-16, 48-54, 48-50,49-48	0.9 p.u	1.1 p.u
Capacitor (case 4)	Bus 11,41	4 MVAr	30 MVAr

The convergence curve is shown in Fig. 2. It can be found that the curve reduces and converges to the minimum value of 0.469×10^8 W. The optimal control variables setting for the case 1 are shown in the Fig 4. The case 1 has the minimum transmission loss of 46.9 MW compared to AC power flow solution.

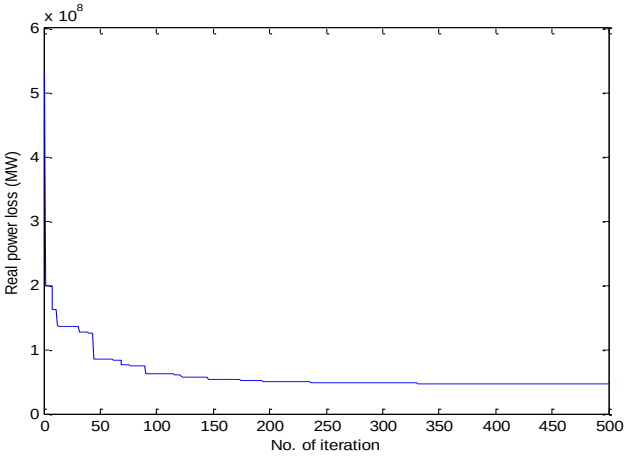


Fig. 1. Convergence curve (Case 1)

The convergence curve for case 2 is shown in Fig. 3. The value for control variables are shown in the Fig 4. The total voltage deviations in case 2 are drastically reduced and have higher transmission loss of 54.8 MW compared to case1.

Analysing the case 2, the voltage profile improvement alone as an objective function, the generator needs to supply the higher reactive power compared to the case 1. The reactive power and voltage are coupled in the system. Thus, if the voltage needs to be improved, the reactive power has to be improved.

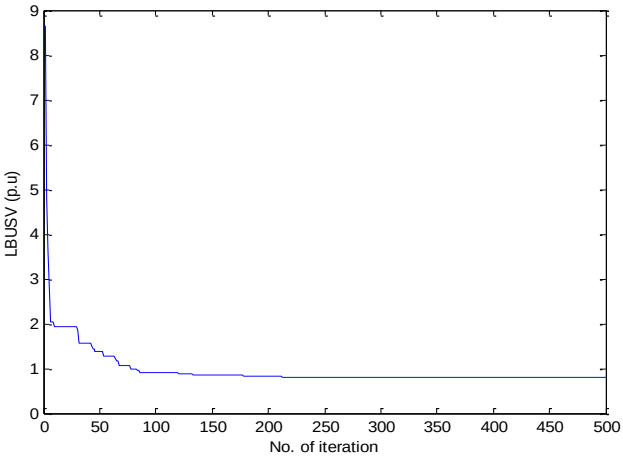


Fig. 2. Convergence curve (Case 2)

Fig. 3. Optimal settings of control variable

From Table IV, Generator G4 generates real and reactive powers of 162.98 MW and 144.64 MVAr for Case 1. But with same generator, when the objective is minimization of total voltage deviation as in case 2, the reactive power of generator G4 is increased to 153.93 MVAr at the expense of real power. Thus the real power in this case is 154.24 MW. Some generators absorb the reactive power to optimize the objective function. The absorption service of the generator also should be priced. Thus we can conclude that the reactive power is generated at the expense of active power. Thus there is need to price the generator reactive power.

Fig. 5 shows the VAr production cost of each generator for different cases. It will be found from Table V that total generator reactive power cost is high for case 2. This is because to achieve the objective of minimum voltage deviation, the reactive power needs to be increased and hence production cost is high. Case 1 has less reactive power production cost compared to case 2. This is because to achieve the minimum loss objective function, the reactive power has to be reduced and hence production cost is less.

TABLE IV. SOLUTION OF DIFFERENT CASES UNDER BASE LOAD CONDITION (USING DE)

Generators	*Case 1*		*Case 2*	
	Real power (MW)	*Reactive power (MVAr)*	*Real power (MW)*	*Reactive power (MVAr)*
G_1	369.03	28.38	352.47	112.94
G_2	100.81	10.00	100.81	10.00
G_4	162.98	144.64	154.24	153.93
G_5	17.61	10.00	20.00	51.92
G_8	123.38	45.06	104.27	79.88
G_{17}	299.57	61.33	301.85	48.91
G_{23}	149.63	111.33	134.24	129.48
G_{25}	498.66	68.00	497.68	74.84
G_{32}	199.67	12.69	194.76	-45.79
G_{33}	30.72	10.00	30.00	112.87
G_{34}	143.09	52.37	152.37	0.24
G_{37}	55.70	10.00	55.70	10.00
G_{49}	120.22	-32.48	120.00	130.00
G_{50}	53.11	-2.33	18.05	-50.00
G_{51}	129.62	29.80	107.97	77.66
G_{52}	60.19	51.11	47.67	62.95
G_{54}	57.17	10.00	57.17	10.00
G_{57}	149.36	-34.19	147.52	-41.40
G_{58}	549.91	54.89	549.36	60.19

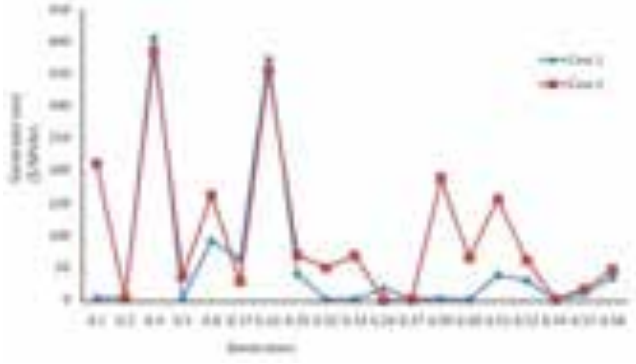


Fig. 4. Reactive power cost of generator

TABLE V. COMPARISON OF SOLUTIONS

Generator Reactive power price ($/MVAr)		
	Case 1	***Case 2***
Total Generator cost	916.2351	1906.317

TABLE VI. GENERATOR DATA

Bus No.	*Pmax (MW)*	*Pmin (MW)*	*Qmax (MVAr)*	*Qmin (MVAr)*	*a*	*b*	*c*
1.	400	50	450	0	0.007	6.8	95
2.	450	50	500	0	0.0055	4	30
3.	450	50	500	-50	0.0055	4	45
4.	100	0	150	0	0.0025	0.85	10
5.	300	50	300	-50	0.006	4.6	20
6.	450	50	500	-50	0.0055	4	90
7.	200	50	250	-50	0.0065	4.7	42
8.	500	50	600	-100	0.0075	5	46
9.	600	0	550	-100	0.0085	6	55
10.	100	0	150	0	0.002	0.5	58
11.	150	50	200	-50	0.0045	1.6	65
12.	50	0	75	0	0.0025	0.85	78
13.	300	50	300	-50	0.005	1.8	75
14.	150	0	200	-50	0.004	1.6	85
15.	500	0	550	-50	0.0065	4.7	80
16.	150	50	200	-50	0.0045	1.4	90
17.	100	0	150	0	0.0025	0.85	10
18.	300	50	400	-50	0.0045	1.6	25
19.	600	100	600	-100	0.008	5.5	90

III. CONCLUSION

In this paper, the DE is used to obtain the solution for the ORPD problem subject to various constraints in the power system. Adapting this method improves the possibility of good decision making in the reactive power production cost. The generator reactive power is obtained for the 62 bus IUS by optimally tuning the control variables. The generator reactive power cost is analysed for 62 bus Indian utility system. This analysis has been performed using different objective functions by applying them in two diverse cases. In the second case, it was found that in order to improve the voltage; the reactive power service has to be improved with the increase in generator reactive power cost. This is the compromise pricing method between seller and buyer. Depending upon the importance of objective function, the pricing value of reactive power varies but the method adopted to price the

reactive power is same for two cases. It is a simple method which can recover the production cost of power.

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parameters to achieve a secured communication. In an information-theoretic sense, the secrecy capacity of the wireless transmission is the difference between the channel capacity of the main link and that of the wiretap link. However, in industrial environments, the presence of machinery obstacles, metallic frictions and engine vibrations makes the wireless fading fluctuate drastically, resulting in the degradation of the signal quality. As a consequence, a weight based priority scheduling scheme is proposed to protect the legitimate wireless transmission against the fading and loss of data, where a sensor with the highest priority is scheduled to transmit its sensed information to the sink.

A NOVEL APPROACH FOR SECURED AUTHENTICATION IN AUTOMATED TELLER MACHINE WITH DEPLOYMENT OF MULTIMODAL BIOMETRICS WITH THREE TIER SECURITY SYSTEM

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ABSTRACT

For the increasing demand of security system, biometrics has become very popular now. A multimodal biometrics is an integration of multiple modalities such as fingerprints, iris, ear, DNA and face for verifying and identifying a person. In proposed system three level security is provided for user authentication. First stage of this approach is using ATM card which has unique PIN number. Now one time password is generated and sent to user mobile number. The second stage is using integrated biometric features iris, and finger print called multimodal biometrics for identification and verification of the person who uses ATM card. Meanwhile the user receives OTP and enters it in ATM machine. Now system validates entered OTP and if OTP is correct then comparison is performed between the input image and all the images already stored in the database and it gives a ranked list of matches. Finally the system could verify whether the user is a genuine user or an imposter. So this kind of multimodal biometrics will provide a highly secured and authenticated access to ATM.

EFFECTS OF PUMPED STORAGE SYSTEM ON GENERATION CAPACITY EXPANSION PLANNING

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Abstract

To satisfy the increasing energy demand, it is essential to add additional power generation. Renewable Energy Sources (RES) such as wind and solar are promoted in a large scale, to overcome the problems of pollution, depleting energy sources, global warming and safety of pollution, depleting energy sources, global warming and safety caused by the use of conventional plants. In this work, Wien Automatic System Planning (WASP-IV) package is used to find the most optimal Generation Expansion Planning (GEP). In addition to conventional plants, the wind, solar and pumped storage system energy sources are considered as the expansion candidates. The analysis has been done for a state Tamil Nadu, India for the 30 years of period from 2015 to 2044. The Expected Energy Not Served (EENS) and minimizing the emission were the two objectives considered. In this paper, an effort is made to study economic, environmental influences and Flexibility Index (FI) of the Tamil Nadu power system for varying RES penetration level with and without Pumped Storage System (PSS). The reliability index ENS is sensitive to RES penetration level. The impact of RES penetration were demonstrated.

Keywords: Energy Not Served,Renewable Energy Sources, Flexibility index, Pumped Storage System.

A DATA MINING APPROACH TO PREDICT INDIAN AIRLINE DATA USING COMPOSITE ANALYSIS

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ABSTRACT:

On an average day in the India, thousands of commercial flights make their way through more than 5,000,000 square miles of Indian airspace. People rely on these flights for business and pleasure needs. Flying can be a very frustrating experience. Data mining past flight data can help consumers make informed decisions about many aspects of flying and also to find how time is made up for in the air during late flights and how airport size relates to efficiency? According to the Bureau of Transportation Statistics, commercial flights are delayed right approximately 17 % of the time. Every

Generator Reactive Power Pricing for Practical Utility System Using Power Flow Tracing Method

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***Abstract*—The shift from regulated to restructured power system results in an increased competition among the electricity market. In restructured power system, the separation of transmission services from generation and distribution makes it necessary to find the contribution of power from individual generator to individual load. The power flow tracing method is used to obtain the generator power output to a particular load. The reactive power has to be maintained in order to sustain the voltage level throughout the system for reliable and secure operation. Hence the reactive power cost allocation has become imperative in the power system. In this paper, the tracing method is integrated with the optimal reactive power dispatch problem to trace the generator minimal reactive power for sustaining the real power transaction and enhancing the system security by meeting the demand. The Differential Evolution is used for optimal reactive power dispatch. The cost allocation to the generators for the reactive power service based on the opportunity cost method is obtained for 62 Bus Indian Utility Systems.**

Keywords—Power flow tracing method; opportunity cost; capability curve; reactive power pricing; ancillary services

I. INTRODUCTION

The power industry in the world is currently moving towards restructuring for providing economical choice and quality service to the consumers. The separation of transmission services from generation and distribution necessitates finding the generator power contribution towards the load. The real power does the useful work while the reactive power supports the voltage and maintains the security and reliability of the power system. System security can be obtained by utilizing diverse services available in the market. So, proper strategies must be provided in the power system market. The importance of reactive power and its framework for calculation exercises the competition among power producer and brings technological innovation in power quality [1]. The voltage is managed by maintaining the reactive power. Hence the reactive power service is considered as one of the important supplementary services and thus pricing of this service is gaining importance in power market. Based on the Federal Energy Regulatory Commission (FERC) Order No.888, the generator is considered as an important ancillary service provider [2].

The procurement of the reactive power and cost allocation for this service is carried out by system operator. In a power market, meeting the reactive power requirement of the load is not a generator's responsibility, but it is a service of the generator. Hence the optimal reactive power dispatch (ORPD) along with the power flow tracing method is introduced to determine the optimal reactive power contribution of the generator. This method can assess a minimal dispatch of generator's reactive power that will be required to move the real power and hence pricing the generator's optimal reactive power using opportunity cost method. In India, only a limited number of research studies have been carried out on reactive power pricing [2]. Thus a reactive power price modeling is applied for a 62 Bus Indian Utility System (IUS).

The basic concept of restructured power system is to make the generator to gain profit for energy production and also meet the demand of the load reliably. John W. Lamont [3] has analyzed the various costs associated with the generation and transmission sources. Garcia Roman et al. have suggested the spot pricing of reactive power at the bus. The revenue gained by the reactive power seller based on spot pricing does not recover the production cost [4]. Javad Saebi et al. have used zonal pricing method to contracted generator for providing the reactive power [5]. Mala De et al. have calculated the generator reactive power price using cost functions and a power flow tracing method [6]. They have not considered the opportunity cost of the generator. Further they have allocated the cost for line charging capacitance which is not advisable because this will improve the cost for consumer. The method allows the system operator to optimally procure the reactive power from the available source to meet the demand reliably [7]. Kadir et al. have solved the ORPD problem using Differential search algorithm considering different objective function [8]. The biogeography based optimization algorithm is used to find the solution for ORPD problem of IEEE 30 bus system [9]. Ramesh et al. have obtained the solution for the multi-objective problem for IEEE 300 bus system using differential evolution [10]. From the literature, it can be understood that the reactive power maintenance is an important ancillary service. This paper is organized as follows. The section II deals with reactive power tracing, section III details the problem formulation and solution methodology, section IV examined the results of reactive power cost of 62 bus Indian utility system and section V concludes the paper.

II. Reactive Power Pricing

The power flow tracing method is a powerful tool to trace the reactive power flow by considering the modification in the line. This is because the reactive power flow in a few transmission lines has bidirectional flow. The transmission line is represented by equivalent π-model as shown in Fig. 1. The Q_i and Q_o are the incoming and outgoing reactive power at the branch *ab*. The shunt admittance produces the reactive power which is given by the expression (1).

$$Q_{C,ab} = (V_a^2 + V_b^2) \times B_{sh/2,ab} \tag{1}$$

where V_a and V_b are voltage at the bus *a* and *b* and B_{sh} is the line charging admittance for the branch *ab*.

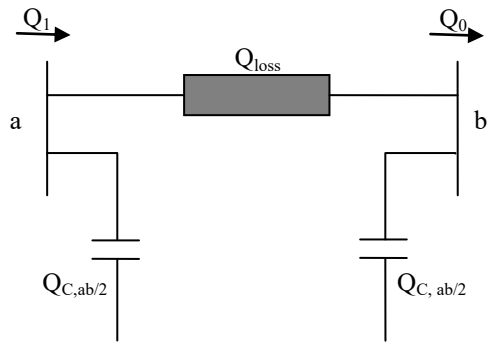

Fig. 1. π-model representation of Transmission line [6]

The reactive power loss in the line *ab* is calculated using (2).

$$Q_{loss(L)} = \mathrm{Im}\frac{(V_a - V_b)^2}{Z_{ab}} \tag{2}$$

where Z_{ab} is the branch impedance between the bus *a* and *b*. If we remove the losses, $Q_{loss(L)}$ and reactive power injection, Q_C then we can overcome the problem of bidirectional reactive power flows in the line. This can be made possible by moving the reactive power by line reactance and capacitance as load and generation to the terminal buses. This results in the lossless network. The modified reactive power flows in the line *ab* are calculated as shown in (3) & (4).

$$Q_{i,new} = Q_i + \frac{Q_{c,ab}}{2} - \frac{Q_{loss(L)}}{2} \tag{3}$$

$$Q_{o,new} = Q_o - \frac{Q_{c,ab}}{2} + \frac{Q_{loss(L)}}{2} \tag{4}$$

III. Problem formulation and solution methodology

The ORPD problem is framed and generator reactive contribution to the load are found using the power flow tracing method. The individual generator reactive power towards individual load are priced using the concept of opportunity cost. These are explained as follows.

A. Optimal reactive power dispatch problem

In this paper, the ORPD problem is formulated subject to equality and inequality constraint.

1) Objective function

The minimization of real power loss (P_{loss}) is considered as an important objective function [10] which is expressed as:

$$F_{loss} = \sum_{k=1}^{nl} g_k (V_a^2 + V_b^2 - 2V_a V_b \cos(\delta_a - \delta_b)) \tag{5}$$

where g_k is the conductance of *k - th* line, V_a and V_b are the voltage magnitude at buses *a* and *b* of *k - th* line, *nl* is the number of lines and δ_a and δ_b are the phase angles of voltage at buses a and b of the *k - th* line.

2) Equality constraints

The power balance equation represents the equality constraints [8] and it states that power system generation should meet the demand and losses.

3) Inequality constraints

The inequality constraints of power generation [5] are expressed in (6) & (7).

$$P_{GSlack}^{\min} \le P_{GSlack} \le P_{GSlack}^{\max} \tag{6}$$

$$Q_{Gi}^{\min} \le Q_{Gi} \le Q_{Gi}^{\max} \tag{7}$$

The Bus voltage constraints are expressed in (8).

$$V_{Li}^{\min} \le |V_{Li}| \le V_{Li}^{\max} \tag{8}$$

where $P_{GSlack}^{\min}$ and $P_{GSlack}^{\max}$ are the bounding limits of the active power generation at slack bus; $Q_{Gi}^{\min}$ and $Q_{Gi}^{\max}$ are the bounding limits of the reactive power at *i-th* bus; $V_{Li}^{\min}$ and $V_{Li}^{\max}$ are bounding limits of the voltage at *i-th* load bus respectively.

The Line flow constraints are represented by (9).

$$P_{Li}^2 + Q_{Li}^2 \le S_{Li,\max}^2 \tag{9}$$

where P_{Li}, Q_{Li}, $S_{Li,max}$ are the real power, reactive power and maximum thermal limits of the transmission line *i*. The control variable limits are the inequality constraints which are given as follows:

$$V_{gk}^{\min} \le V_{gk} \le V_{gk}^{\max} \cdots k = 1,\ldots, No.of\ PV\ Buses \quad (10)$$

$$t_i^{\min} \le t_i \le t_i^{\max} \cdots i = 1,\ldots, No.of\ transformers \quad (11)$$

$$Q_{gk}^{\min} \le Q_{gk} \le Q_{gk}^{\max} \cdots k = 1,\ldots, No.of\ Shunt\ devices \quad (12)$$

where V_{gk} is the generator bus voltage magnitude at *k-th* bus. Q_{gk} is the reactive power at *k-th* shunt compensation and t_i is the tap ratio of transformer. Adjusting the tap settings will make the transformer to produce a higher or lower voltage at the output terminal from the same input voltage. The objective function (5) achieves their minimum value by optimal tuning of control variables. The on load tap changing (OLTC) transformer maximize the voltage profile at the load buses by lowering tap position, this may lead to voltage instability due to inadequate reactive power. Thus transformer tap position is considered as one of the control variable and it is to be varied within the limits. The optimization problem with the state variable and control variable is able to be solved by various global search techniques. Here, DE is used for solving the optimization problem due to its flexibility, faster convergence and simplicity.

B. Power flow tracing method

The power flow tracing is a topological method. It is based on network power flow and proportionality sharing principle. The power at the nodes can be calculated by Kirchoffs current law. This method has the assumption that the system is lossless as proposed by J. Bialek [11]. The *k-th* generator contribution to the *m-th* load can be expressed as:

$$Q_{Lm} = \frac{Q_{Lm}}{Q_m} Q_m = \frac{Q_{Lm}}{Q_m} \sum_{k=1}^{n} \left[A_u^{-1}\right]_{mk} Q_{Gk} \quad (13)$$

where *m*=1,2,3,...,no of buses, Q_{Gk} is the reactive power at *k-th* bus. Q_{Lm} is the reactive power demand at *m-th* bus. Q_m is the reactive power at *m-th* bus A_u is the upstream distribution matrix. The elements of A_u can be found as:

$$\left[A_u\right]_{mk} = \begin{cases} for\ m = k \\ \frac{1}{0}\ C_{mk} = -|Q_{mk}|/Q_k\ for\ l \in \alpha_i \\ otherwise \end{cases} \quad (14)$$

where C_{mk} is the contribution factor. The steps to solve these equations are given by Bialek [12]. Once the generator contribution to the load is found, then the price should be allocated to the generator using opportunity cost which is well explained in the following section.

C. Reactive power cost allocation

Generally the relation between the real and reactive power is expressed as:

$$S^2 = P^2 + Q^2 \quad (15)$$

The cost of the real power is given by Cost (P_m) which is expressed as:

$$Cost(P_m) = a_p P_{Gi}^2 + b_p P_{Gi} + c_p; \$/hr \quad (16)$$

The relationship between the real and reactive power is obtained from the capability curve [12]. From the knowledge of generator capability curve, when a generator is producing the reactive power, the real power that is not produced can be obtained. Thus, there is loss in the profit of the real power sale due to the production of reactive power which is known as opportunity cost of reactive power production [12].

The opportunity cost can be found using (17).

$$C_{QGi}(Q_{Gi}) = \left\lfloor C_{PGi}\left(\sqrt{P_{PGi}^2 + Q_{QGi}^2}\right) - C_{PGi}(P_{PGi}) \right\rfloor \quad (17)$$

where P_{PGi} and Q_{QGi} are the real and reactive power dispatch of the i- *th* generators, C_{PGi} and C_{QGi} are the real and reactive power production cost equation of i-*th* generator. $S_{PGi} = \sqrt{P_{PGi}^2 + Q_{QGi}^2}$ is the apparent power of i-*th* generator. In this paper, the Differential Evolution (DE) is used to solve the ORPD problem and a brief description about this algorithm is given in the section IV-D.

D. Implementation of DE to reactive power cost allocation problem- Procedural steps

The procedural steps of DE for solving the ORPD and reactive power cost allocation problem are summarized as follows:

Step 1. Read the Input data such as generator, bus and line data of the 62 bus Indian utility system.

Step 2. Initialize the DE parameters such as population size (N_p), population dimension(D), mutation factor (F), crossover probability (CR), maximum iteration or generations, the number of constraint variables and constraint limits.

Step 3. Let the iteration G=0 and initialize the population within the feasible bounds.

Step 4. Find the fitness function of each individuals and check the constraints.

Step 5. Make the iteration G=1

Step 6. Perform mutation, crossover and selection operators to introduce new individuals.

Step 7. Obtain the fitness value of new population and check the constraints.

Step 8. Update the best fitness value by comparing solution of the present and the previous iterations.

Step 9. Verify the termination criterion and solution. If the stopping criteria and solutions are not reached, then go to step 5 for repeating the process to search the best solutions. Once the best solutions and the stopping criteria are obtained, then go to the next step.

Step 10. The output shows the generator minimal reactive power dispatch model. The individual generator reactive power contribution are found and priced.

IV. RESULTS AND DISCUSSIONS

The reactive power pricing method is analyzed in detail by considering the 62 bus IUS. The system consists of 19 generators, 89 transmission lines and 43 load buses with a load demand of 3028 MW and 1320 MVAr. The data is on 100 MVA base apparent powers. The one line diagram, generator, load and line data are referred from [13]. The simulation results are carried out using MATLAB environment. It was found that the total real power loss is 57.71 MW.

The objective of the introduced method is to determine the generator minimal reactive power and the consumed reactive power by the individual load. The DE is used to obtain the solution for the 62 bus IUS. The objective of ORPD problem is the minimization of real power losses as shown in (5). The generator voltages, tap settings of transformer and reactive power of shunt devices are considered as control variables. The operating range of generator voltage and transformer tap position are 0.9 p.u to 1.1 p.u. The parameters of DE algorithm such as number of population, scaling factor, crossover ratio and dimension are taken as 65, 0.6, 0.8 and 29 respectively. The maximum number of iterations are taken as 1000. The convergence curve is shown in Fig. 2. The curve converges and reaches the minimum value of 51MW.

The optimal control variables are shown in Fig. 3. The ORPD solution has the minimum transmission loss of 51.2 MVAr compared to AC power flow solution. Bus voltage is the indicative of system security. Improving voltage profile at generators is nothing but minimization of voltage deviation at load bus from 1 p.u. Total voltage deviation is sum of minimization of voltage profile at all load bus from 1 p.u. The total voltage deviation of the system using DE is 1.37 which is higher than the total voltage deviation of the AC power flow without using DE whose value is 0.9511 p.u. This is due to the minimization of the real power losses. Since the objective is minimization of the real power losses, the reactive power has to be reduced. Since the reactive power and voltage are closely coupled and the generator voltage is also reduced, the total voltage deviation at the load bus is higher. Thus in order to maintain the voltage throughout the system, the reactive power has to be maintained even the objective is the minimization of real power loss.

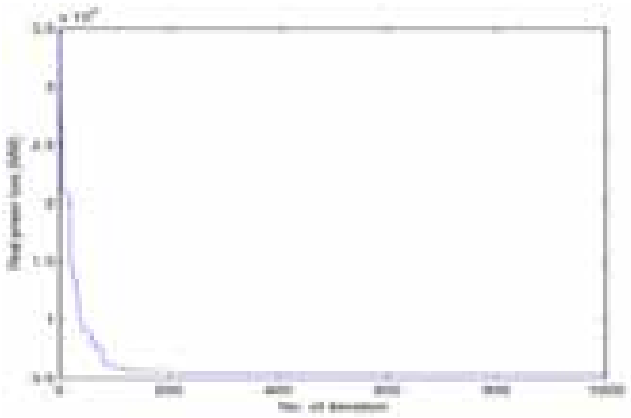

Fig. 2. Convergence curve

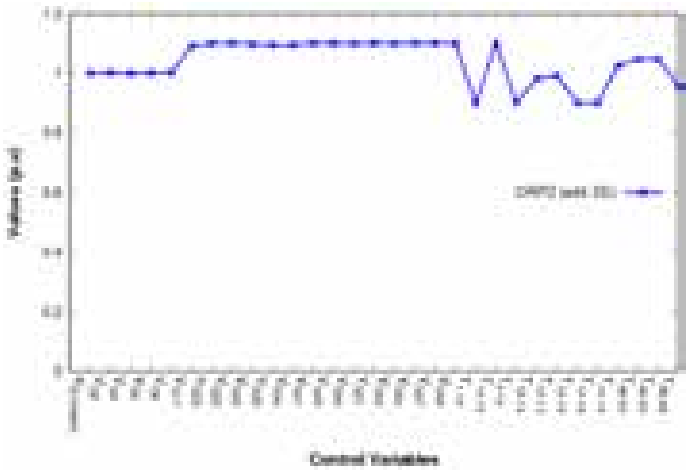

Fig. 3. Control variable values of 62 bus IUS

The optimal values of generator real power and reactive power are shown in Table I. From the result, we have analyzed that the generator loss is reduced compared to the AC power flow in order to achieve the objective of the ORPD problem. By using (17), the generator reactive power production cost is found and it is shown in the last column of Table I. The generator 4 delivers more reactive power of 142.01 MVAr and hence costs 321.44 $/MVAr. The total cost of the generator reactive power are 975.7 $/MVAr.

TABLE I. RESULTS OF ORPD OF 62 BUS IUS

Generator	Real Power (MW)	Reactive Power (MVAr)	Cost ($/MVAr)
G_1	369.8734	13.4584	2.932343
G_2	100.8089	10	2.529095
G_4	165.2806	142.0111	321.4375
G_5	17.61182	10	2.49484
G_8	115.8604	61.8876	94.24813
G_{17}	296.9503	72.9819	64.64275
G_{23}	140.334	122.8437	315.0936
G_{25}	500.0533	56.8333	40.32177
G_{32}	199.945	-7.1987	1.217762
G_{33}	30.71678	10	0.993395

Generator	Real Power (MW)	Reactive Power (MVAr)	Cost ($/MVAr)
G_{34}	147.4976	38.2434	14.38513
G_{37}	55.44504	11.3414	1.297426
G_{49}	123.8273	-13.2296	2.143597
G_{50}	52.73495	-6.6953	0.856625
G_{51}	127.0081	39.4693	38.28573
G_{52}	65.6917	43.8173	27.22139
G_{54}	57.16634	10	0.987843
G_{57}	149.8093	-32.1516	10.10984
G_{58}	550.2382	51.5479	34.50866
Total cost of generators reactive power			975.7074
P_{loss}			51.2 MW

Table II shows the contribution of power from individual generator to individual load. Most of the generators are operating in the over excitation region to meet the load. Also it can be found that the generator 1 generates reactive power and reactive cost of 2.93 $/MVAr is distributed among the load from load 10 to load 15 depending on the contribution factor of reactive power from generator to load. load No.15 consumes reactive power from generator 1 at a cost of 1.095 $/MVAr. The generator reactive power production cost is divided among the consumers based on the contribution of the reactive power at the bus. The generator No. 49, 52 and 57 are not contributing any reactive power to the load. The reactive power generated at this bus is used only to meet the line loss. Hence, the load responsible for producing the higher reactive power loss in the line is identified and the line loss costs are charged for those load. The cost to be collected from the load for consuming the reactive power is shown in Table III. The calculated cost is in $/MVAr. Table III shows the generators reactive power cost towards the load for the 62 bus Indian utility system.

From Table II and Table III, the reactive power consumption of the individual load was determined and the generators total opportunity cost is found to be 974$/MVAr to meet the demand. The generator reactive power reaching the load is 496.5 MVAr. The generator and line admittance produce reactive power of 823.5 MVAr at different buses to meet the demand. The line charging effects are not priced separately. Thus the cost collected for meeting the reactive power demand of load is exactly equal to the generator reactive power opportunity cost. This paper has introduced a fair and simple pricing method to recover the generator reactive power cost based upon the power flow tracing method.

V. CONCLUSION

In this work, the allocation of the reactive power to the load and pricing scheme based on the power flow tracing method is presented for the 62 bus Indian utility system. The generator reactive power contribution to the individual load is priced. The tedious problem of the bidirectional power flow in a meshed network is solved by the modifying the transmission line model. Then, by using the concept of lost opportunity cost, the reactive power cost of the individual generators was found. The total revenue offered to the reactive power source is recovered from the load. So the proposed method can be considered for fair pricing of reactive power.

TABLE II. CONTRIBUTION OF REACTIVE POWER FROM EACH GENERATOR TO EACH LOAD

Gen (MVAr) / Load Buses	1	2	4	5	8	17	23	25	32	33	34	37	50	51	54	58
8	0	0	0	3.454	71.83	0	0	0	0	0	0	0	0	0	0	0
10	0.033	0	0.181	0.021	0	0.561	0.064	0.076	0	0	0	0	0	0	0	0.048
11	0.581	0.002	3.148	0.357	0	9.758	1.121	1.313	0	0	0	0	0	0.005	0.001	0.827
12	0.83	0.003	4.496	0.51	0	13.934	1.601	1.876	0	0	0	0	0	0.007	0.001	1.18
13	0.816	0.002	4.421	0.501	0	13.705	0.015	0.018	0	0	0	0	0	0	0	0.011
14	1.605	0.005	8.698	0.986	0	0.462	0.03	0.035	0	0	0	0	0	0	0	0.022
15	2.303	0.007	38.192	4.278	0	0.041	0.005	0.006	0	0	0	0	0	0	0	0.003
20	0	0	0	0	0	0	20.166	23.627	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	15.914	18.646	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	43.722	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	16.013	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0.034	22.13	1.577	0.376	0.008	0	0	0.004
34	0	0	0	0	0	0	0	0	0.839	0.019	38.469	9.16	0.195	0.001	0	0.086
36	0	0	0	0	0	0	0	0	0.036	0.001	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0.15	0.003	3.763	1.636	0.035	0	0	0.015
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.036
42	0	0	0	0	0	0	0	0	0	0	0	0	0	0.001	0	0.197
43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.001
44	0	0	0	0	0	0	0	0	0	0	0	0	0	0.007	0.001	1.206
53	0	0	0	0	0	0	0	0	0	0	0	0	1.085	46.606	6.209	0
55	0	0	0	0	0	0	0	0	0	0	0	0	0.308	13.214	1.761	0
62	0	0	0	0	0	0	0	14.853	0	0	0	0	0	0.003	0	0.495
Total	6.168	0.019	59.136	10.107	71.83	38.461	38.916	120.185	1.059	22.153	43.809	11.172	1.631	59.844	7.973	4.131

TABLE III. COST ALLOCATED ($/MVAR) TO GENERATORS FOR REACTIVE POWER SERVICE

Gen (MVAr) / Load Buses	1	2	4	5	8	17	23	25	32	33	34	37	50	51	54	58
8	0	0	0	0.852	94.25	0	0	0	0	0	0	0	0	0	0	0
10	0.015	0	0.983	0.005	0	0.942	0.518	0.0254	0	0	0	0	0	0	0	0.401
11	0.276	0.266	17.111	0.088	0	16.399	9.075	0.44	0	0	0	0	0	0.0032	0.00012	6.907
12	0.394	0.399	24.438	0.125	0	23.418	12.961	0.629	0	0	0	0	0	0.0044	0.000124	9.855
13	0.387	0.266	24.03	0.123	0	23.033	0.121	0.006	0	0	0	0	0	0	0	0.0919
14	0.763	0.665	47.278	0.243	0	0.776	0.242	0.011	0	0	0	0	0	0	0	0.184
15	1.094	0.931	207.596	1.056	0	0.0689	0.04	0.002	0	0	0	0	0	0	0	0.0251
20	0	0	0	0	0	0	163.26	7.926	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	128.84	6.255	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	14.668	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	5.372	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0.039	0.992	0.517	0.043	0.0042	0	0	0.033
34	0	0	0	0	0	0	0	0	0.964	0.0008	12.629	1.064	0.102	0.00064	0	0.718
36	0	0	0	0	0	0	0	0	0.041	0.000045	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0.172	0.00013	1.235	0.19	0.0189	0	0	0.125
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.301
42	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0006	0	1.645
43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0084
44	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0045	0.0001	10.072
53	0	0	0	0	0	0	0	0	0	0	0	0	0.57	29.812	0.769	0
55	0	0	0	0	0	0	0	0	0	0	0	0	0.162	8.453	0.218	0
62	0	0	0	0	0	0	0	4.983	0	0	0	0	0	0.0019	0	4.134
Total	2.932	2.529	321.44	2.495	94.25	64.64	315.058	40.321	1.217	0.9933	14.383	1.297	0.857	38.28	0.987	34.5

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Novel Optimization of Friction Stir Welding Process Parameters on Aluminum Alloy 6061-T6

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ABSTRACT: The aim of this study is to investigate optimization process parameters for friction stir welding (FSW) for an optimal parameter combination to have better hardness and tensile strength using COPRAS decision model. The friction stir welding parameters considered are tool rotational speed (r.p.m), welding speed (mm/min), dwell time (min) and tool tilt angle (degree). Taguchi L9 orthogonal array design of experiments is used to perform the functions. Multi criteria decision model using COPRAS (COmplex PRoportional ASsessment) is proposed to solve the problem. Analysis of variance (ANOVA) is used to determine the percentage of contribution of the given process parameters. Finally confirmation test is carried out to verify the outcome.

KEYWORDS: Friction stir welding, Taguchi method, COPRAS decision model, Process parameters and ANOVA.

1 INTRODUCTION

Aluminum alloy contain a number of advantages, such as weldability, machinability, low strength, good corrosion resistance, good formability and low weight [1]. Friction stir welding (FSW) is a solid-state welding process in which the heat for welding is produced by direct conversion of mechanical energy to thermal energy at the interface of the work piece with the tool without the application of electrical energy or heat from other sources of the work pieces. Various process parameters such as tool speed, tool material, feed etc., influence the mechanical and micro structural prosperities of the weld. Different kinds of optimization methods are also reported in literature.

2 LITERATURE REVIEW

The parametric investigations of friction stir welding on AA6061 using Taguchi technique to test the mechanical properties tensile strength of the welds. The tool rotational speed, welding speed and tool pin profile act as main parameters. As the result found from the study revealed that welding speed plays virtual role for the variation of tensile strength [1]. Jayaraman et al [2] have analysed the parameters of FSW of cast aluminium alloy A319. The primary process parameters (tool rotational speed, welding speed and axial force) which contribute to heat input and subsequently influence tensile strength variation in FSW aluminium alloy joints were selected for this study. Using ANOVA and signal noise ratio to find the optimum welding condition and tensile strength. A non linear regression model developed to correlate tensile strength has been found to be useful in predicting tensile strength. Rajkumar et al [3] studied the effect of tool design and welding parameters of dissimilar aluminium alloy AA5052-AA6061 joint by friction stir welding. To examine mechanical properties hardness test, tensile strength of the welds were measured. The tool rotational speed, welding speed was considered as the main parameters. The influence on mechanical properties was analyzed.

Rodriguez et al [4] evaluated the mechanical properties of dissimilar metals (AA6061 to AA7075) joint obtained by FSW. To inspect mechanical properties hardness test, tensile strength of the weld was calculated. The tool rotational speed, welding speed, cylindrical threaded tool

were considered main parameters. The fracture surface inspection shows poor material intermixing produced at low tool rotational speed was the causes for the low mechanical strength and failure through the stir zone. On other hand failure is observed in heat affected zone at high rotational speeds due to material softening as established by the micro hardness measurements. The COPRAS method is a common application MCDM which assigns the best alternative between a group of alternatives by determining solution with the ratio to the best solution and ratio with the best-worst solution [5]. Overall quality and performance of a supervisor has been computed by applying COPRAS method [6]. The success of this method (COPRAS) is simplicity. However only limited number of successful application of COPRAS method have been literature review in various field of decision making like design, construction etc., [7]. COPRAS was used by several researchers to optimize blind s to reduce the road accidents, to optimize the road design and to select the quality control manager [8] [9] [10]. In this work, a Taguchi L_9 orthogonal array with four parameters tool rotational speed (r.p.m), welding speed (mm/min), dwell time (min) and tilt angle (degree) with three levels was used to optimize the friction stir welding conditions, in order to achieve greater hardness and tensile strength. Further COPRAS decision model was implemented to find the better parameter setup because of its multi objective nature.

3 EXPERIMENTAL WORK

3.1 MATERIALS

In this study aluminum alloy (AA) 6061-T6 having dimension of 125 x 125 x 6mm square plate was used to join the butt edges of the specimen with single pass weld. The non-consumable tool used in this process is high strength steel (HSS) having shoulder diameter of 25mm, pin length 5.8mm and pin diameter 10mm. The American society for testing materials (ASTM E8) regulations was followed for conducting the test specimen. The smooth tensile specimens were prepared then evaluate the ultimate tensile strength.

3.2 TAGUCHI METHOD

From the literature review the parameters which influence the weld quality and mechanical properties are tool rotational speed (r.p.m), welding speed (mm/min), dwell time (min) and tilt angle (degree) and their level which are tabulated in table 1.

Table 1. Parameters and Their Levels

Symbol	Factors	Unit	Level 1	Level 2	Level 3
N	Tool rotational speed (N)	r.p.m	450	560	710
S	Welding speed (W)	mm/min	20	40	63`
D	Dwell time (D)	min	1.5	2	2.5
T	Tilt angle (T)	Degree	0	1	2

Table 2. Taguchi L9 Orthogonal Array and the Parameter Setup

Ex no	Parameters (Level)				Parameters			
	1	2	3	4	N	S	D	T
1	1	1	1	1	450	20	1.5	0
2	1	2	2	2	450	40	2	1
3	1	3	3	3	450	63	2.5	2
4	2	1	2	3	560	20	2	2
5	2	2	3	1	560	40	2.5	0
6	2	3	1	2	560	63	1.5	1
7	3	1	3	1	710	20	2.5	1
8	3	2	1	2	710	40	1.5	2
9	3	3	2	1	710	63	2	0

In actual method the selection of optimum level of process parameters is difficult one, in which one parameter is varied at a time and other parameter are kept constant. So it was having large number of experiments and more time consuming. To eliminate this difficulty design of experiment based Taguchi method can be hugely reduce the total number of experiments. In this work Taguchi L_9 OA used to performing the experiments is given in table number 4. Taguchi method uses a statistical tool to measure the performance called signal to noise ratio (S/N ratio). The S/N ratio used in this work is given in equation (1) [Larger the better (Maximize the response)].

$$\frac{S}{N} = -10\log_{10}[\sum(1/y_i^2)/n] \quad (1)$$

n – Number of experiments; y_i – Value of parameter for i^{th} experiment

3.3 COPRAS METHOD

The COPRAS method was introduced by Zavadskas in the year 1996. The detailed step by step procedure of COPRAS method is given below [8]:

- Construct the decision matrix (X)

The FSW was performed on the specimens using the combination of parameters obtained from L9 orthogonal array. The tensile strength and hardness of the welded specimens were tested. The test results were presented in the form of matrix as shown in equation 2.

$$[X] = \begin{bmatrix} x_{11} & x_{12} \cdots\cdots & x_{1m} \\ x_{12} & x_{22} \ldots\ldots & x_{2m} \\ \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots \\ x_{n1} & x_{n2} & x_{nm} \end{bmatrix} \quad (2)$$

Where, n = Number of alternatives; m = Number of attributes

- Formation of Normalized Decision Matrix $\overline{X}$

The decision matrix was normalized using equation (3) to get the normalized decision matrix.

$$\bar{X} = \begin{bmatrix} \bar{x}_{11} & \bar{x}_{12} \cdots\cdots & \bar{x}_{1m} \\ \bar{x}_{12} & \bar{x}_{22} \ldots\ldots & \bar{x}_{2m} \\ \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots \\ \bar{x}_{n1} & \bar{x}_{n2} & \bar{x}_{nm} \end{bmatrix} \quad (3)$$

Where, $\overline{X_{IJ}} = \frac{x_{ij}}{\sum_{i=1}^{n} x_{ij}}$; I = 1, 2, 3.....n; J = 1, 2, 3.....m

- Determination of the weight of the (Wj)

In this paper, equal weights are assumed to find the weights of the output responses.

- Determination of weighted normalized matrix

$$\hat{\boldsymbol{X}} = \hat{\boldsymbol{X}} = \boldsymbol{x_{ij}\, X\, W_j} \quad (4)$$

- Calculating the sums P_J (larger value preferable) and R_J (smaller value preferable) of criterion values

$$\boldsymbol{P_j} = \sum_{i=1}^{k} \hat{\boldsymbol{X}}_{\boldsymbol{ij}} \quad (5)$$

$$R_j = \sum_{i=1}^{k} \hat{X}_{ij} \quad (6)$$

Where,

K = Number of attributes which is to be maximized; C Determination of relative weights of each alternatives (Q_j)

- Calculating COPRAS grade

$$Q_j = P_j + \frac{\sum_{i=1}^{n} R_j}{R_j \sum_{i=1}^{n} \frac{1}{R_j}} \quad (7)$$

3.4 ANOVA

ANOVA is used to investigate which parameter significantly affect the performance characteristic [1]. This is accomplished by separating the total variability of the COPRAS decision model, which is measured by the sum of the squared deviations from the total mean of COPRAS decision model, into contributions by each machining parameter and the error. First, the total sum of squared deviations SST from the total mean of COPRAS decision model was calculated (equation 8).

$$SS_T = \sum_{i=1}^{n} \left(\mathrm{Y_L} - \overline{\mathrm{Y_{Li}}}\right)^2 \quad (8)$$

Where, n – Number of experiments; Y_L – Mean of grey relational grade for L^{th} experiment

The total sum of the squared deviations SST is split into two categories one is the sum of the squared deviations SSM due to each machining parameter and the sum of the squared error SSe. The percentage of contribution by each of the machining parameter in the total sum of the squared deviations SST can be evaluate the importance of the machining parameter change of the performance characteristic. SSe is the sum of squared error without or with pooled factor, which is the sum of squared corresponding to the insignificant factors. Mean square of a factor MSM or MSe is found by dividing its sum of squares with its degrees of freedom. Finally percentage of contribution of each of the design parameters is given by the following equations.

Percentage of Contribution = $\frac{SS_M}{SS_T}$ (9)

In addition, the fisher's F test can also be used to determine which machining parameters have a significant effect on the performance characteristic.

4 RESULTS AND DISCUSSION

The experiments (FSW) were conducted based on the L9 orthogonal array setup. After that the tensile specimen was cut from the welded material using EDM process. For all the nine specimens, the tensile strength and hardness were determined and tabulated in Table 3. Next S/N ratio for tensile strength was determined using equation 2, since the higher value is preferable in tensile strength. For hardness, equation 3 was used to find S/N ratio since the lower the hardness number reflects the higher the hardness value. Then the S/N ratio values were normalized and shown in Table 3. These weights were multiplied with the corresponding output response to get the weighted normalized matrix (Table 3).

Table 3. Experimental results

Ex no	Experimental Values		S/N Ratio		Normalized Value		Weighted Normalized Matrix	
	Hardness	Tensile strength	Hardness	Tensile strength	Hardness	Tensile strength	Hardness	Tensile strength
1	43.66	212.67	32.7196	46.5541	0.1081	0.1115	0.05576	0.05409
2	48	217.16	33.6102	46.7356	0.1111	0.1119	0.05597	0.05556
3	46.66	198.18	33.3711	45.9412	0.1103	0.1100	0.05502	0.05516
4	47.66	207.07	33.5597	46.3223	0.1109	0.1109	0.05548	0.05547
5	49.33	200.52	33.8621	46.0432	0.1119	0.1102	0.05514	0.05597
6	51.66	230.35	34.2382	47.2478	0.1131	0.1131	0.05659	0.05660
7	44	207.06	32.8187	46.3219	0.1084	0.1109	0.05548	0.05425
8	48	219.20	33.5979	46.8168	0.1110	0.1121	0.05607	0.05554
9	55.33	188.36	34.6999	45.4998	0.1147	0.1089	0.05449	0.05736

Finally the maximizing index P_J, minimizing index R_J and COPRAS grade Q_j were determined using equation 7 to 9. These values are given in Table 4. From the grade, the higher value is selected as the best. A COPRAS model is near to one and not exceed one is taken as best process response. In this study the main effects of each parameter were calculated (Table 5 and Fig 1).

The highest mean value of each parameter is considered as optimum parameter.

Table 4 COPRAS Computations

Ex. No	Maximizing Index (P_j)	Minimizing Index (R_j)	COPRAS Grade (Q_j)	
1	0.082	0.029	0.1121	1.0000
2	0.082	0.030	0.1116	0.9955
3	0.080	0.030	0.1104	0.9848
4	0.081	0.030	0.1109	0.9893
5	0.081	0.030	0.1102	0.9831
6	0.083	0.030	0.1119	0.9982
7	0.081	0.029	0.1116	0.9955
8	0.082	0.030	0.1118	0.9973
9	0.080	0.031	0.1085	0.9679

Table 5. Main Effects Based on COPRAS Decision Model

Parameter	Level 1	Level 2	Level 3	Max-min
Tool rotational speed (N)	0.99357	0.99037	0.98683	0.00674
Welding speed (W)	0.99503	0.99180	0.98393	0.01110
Dwell time (D)	0.99857	0.98437	0.98782	0.01420
Tilt angle (T)	0.983593	0.996631	0.990541	0.01304

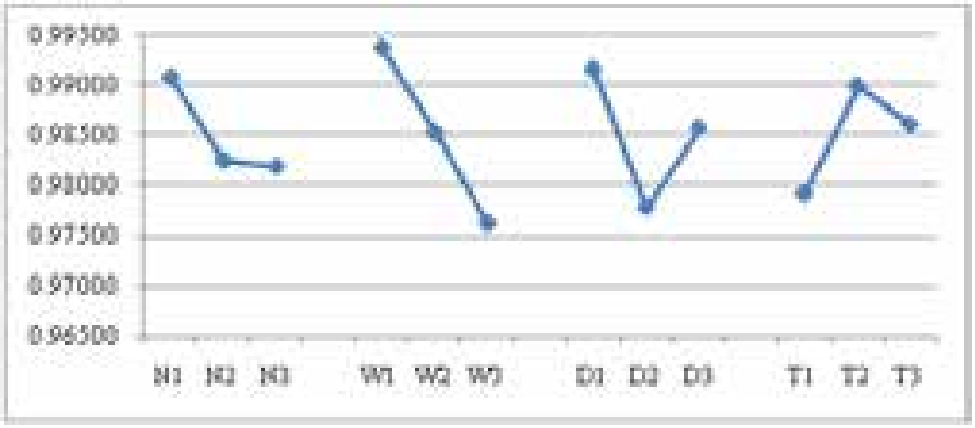

Fig. 1 Main Effect

Table 6. ANOVA Table

Parameter	Degree of Freedom	Sum of Square	Mean Square	F	%of Contribution
N	2	3.908×10^{-6}	1.954×10^{-6}	1.954×10^{-6}	19.17
W	2	1.032×10^{-5}	5.160×10^{-6}	5.160×10^{-6}	50.63
D	2	4.48×10^{-6}	2.240×10^{-6}	2.240×10^{-6}	21.98
T	2	1.673×10^{-6}	8.37×10^{-7}	8.37×10^{-7}	8.20
Total	8	2.038×10^{-5}			

The final step is verifying the improvement in hardness and tensile strength by conducting experiments using optimal parameter conditions. The confirmation experiment was conducted using the optimum setting of parameters. The tool rotational speed, welding speed and dwell time were set as level 1 and tilt angle set as level 2 and the hardness and tensile strength of friction stir welded AA6061-T6 was found to be 43.33 and 228.42 MPa.

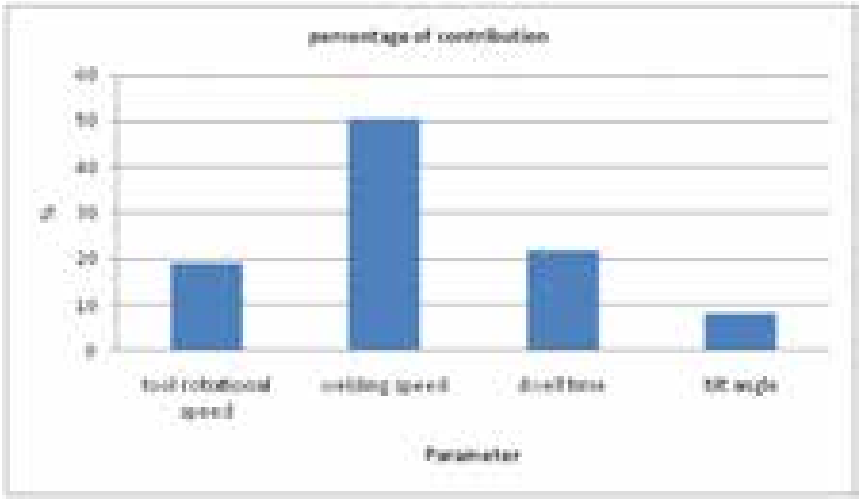

Fig 2. Percentage of Contribution

Then ANOVA is used to investigate which parameter significantly affects the performance characteristic. The ANOVA calculations were shown in Table 6. From the Table 6 and Fig. 2, it was understood that the welding speed is the most influencing factor followed by dwell time, tool rotational speed and tilt angle.

5 CONCLUSION

Friction stir welding experimental results conducted for AA6061-T6. The hardness and tensile strength values are collected under different welding conditions for various combinations of welding parameters. The following conclusions were drawn.

- Taguchi based COPRAS decision model is a very useful tool to solve the multi objective function to predict the hardness and tensile strength in friction stir welding of AA6061-T6
- The percentage of contribution of FSW process parameters was evaluated for hardness and tensile strength.
- Based on the ANOVA results welding speed (50.63%) is the most significant parameter compared to tool rotational speed (19.17%), dwell time (21.98%) and tilt angle (8.20%).
- The optimum level of friction stir welding parameter are found as 1112, which represents tool rotational speed at 450 (r.p.m), welding speed at 20 (mm/min), dwell time at 1.5 (min) and tool tilt angle at 1 (degree)

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DESIGN FMEA OF ADIABATIC DEHUMIDIFICATION SYSTEM FOR DRYING HERBAL LEAVES

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***Abstract*— The failure mode effective analysis of the adiabatic dehumidification for drying herbal leaves is done. The system studied contains the FMEA for each and every part of the system such as dehumidifier, vacuum pump, vacuum chamber, control valves and their subassembly. These results are established to find the future modification required for the system.**

Keywords—failure mode effect analysis; Adiabatic Dehumidification Drying;Herbal Leaves

I. INTRODUCTION

India is a country well rich in herbals and origin of Ayurveda, Siddah. Most of the Ayurvedic industries across India are facing problems in drying herbal leaves to extract powder to produce medicines. The high temperature drying process degrades the quality of the products [2]. High power consumption of drying process leads to high cost of drying consequently increases the price of the product. Nutrients degradation, color loses and high power consumption is major problems which are encountered by most of the herbal industries. Thus designing of adiabatic dehumidification system for drying herbal leaves didn't affect the nutrient contents and color [3].

Most of the "Ayurvedic Industries" across India are facing problems in drying herbal leaves to extract powder to produce medicines as it requires a long time to dry without affecting its herbal characteristics. Evolution of science and technology has identified some techniques such as Sun drying, Freeze drying, Microwave drying, Infrared drying, Lyophilization to dry the leaves quickly by using thermal energy in different forms. But use of thermal energy drastically deteriorates the herbal quality of leaves[5]. For overcoming the limitations of microwave drying, vacuum drying method implemented with microwave drying process. The diffusivity of water in microwave assisted vacuum drying is higher than hot drying [1].The requirement of all "Ayurvedic Industries" is to remove water content from the leaves without utilizing the heat energy or better at temperature lower than the atmospheric temperature. This could be met by adiabatic dehumidification followed by adiabatic dehydration at vacuum. This technique is literally expected to be the most effective in removing the moisture from the leaves provided in no way it will affect the herbal characteristics of the leaves and rate of moisture removed will also be high[4].

FMEA (Failure Mode and Effect Analysis) is a well-established tool devoted for the aforementioned purpose used for risk and reliability analysis of systems in a wide range of industries, including automotive, construction, aerospace, nuclear, and electro-technical, etc. It is an inductive approach to support risk assessment studies and the principle of FMEA is to identify potential hazards along with the focused system and to prioritize the required corrective actions or strategies. In this case FMEA is applied to an adiabatic dehumidification system for drying herbal leaves and the failure modes contributing a risky hazardous situation or a disturbance to normal operation are considered and identified. The failures are ranked on the basis of importance established by the RPN number. Thus the suitable technique is suggested based on the FMEA results.

II. ADIABATIC DEHUMIDIFICATION SYSTEM FOR DRYING HERBAL LEAVES

Adiabatic dehumidification system has involved in two drying techniques such as vacuum drying and dehumidified air drying. These drying processes dry the leaves in room temperature itself. It saves the nutrients in the leaves [3]. Processes such as Sun drying, Microwave drying [2], Infra-red drying[6] had been following high temperature operation. Vacuum drying process uses low pressure for dry the leaves. Under low pressure, the corresponding saturation temperature of the moisture (water) decreases [4]. Due to decrease of saturation temperature, moisture content evaporated at atmospheric temperature itself. Under low pressure, moisture content in the leaves pull out from the leaves and it came into the surface of the leaves. The leaves to be dried, is placed in the tray which has been placed in the vacuum chamber. Low pressure (0.2 – 0.5 bar) maintained inside the vacuum chamber by vacuum pump. 1.8 CFM vacuum pump has used for creating low pressure. Dehumidifier gives low relative humidity air. This dehumidified air capable of absorbing moisture content (water). Thus dehumidified air collected in the reservoir.

Relative humidity maintained between 40% RH or below. After creating low pressure inside the vacuum chamber, collected dehumidified air passes through leaves. Gate valve had employed for flow control of dehumidified air from the reservoir. Low pressure and dehumidified air remove the water content of the leaves.

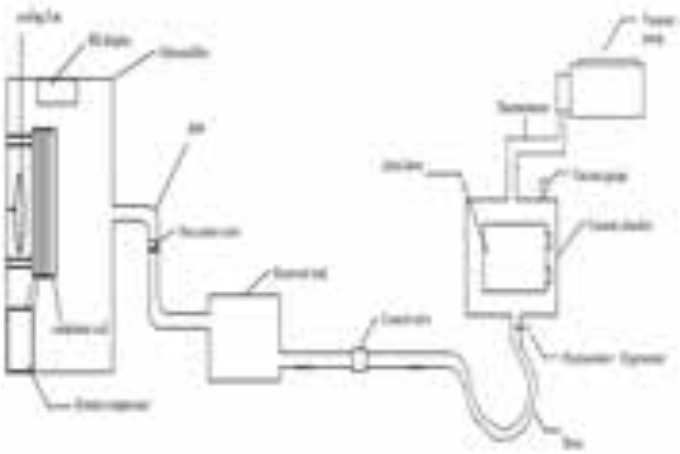


Fig1 Schematic diagram of Adiabatic Dehumidification system

S.No	Parts	Specification	Material
1	Vacuum chamber	[illegible]	Mild steel
2	Vacuum chamber door	[illegible]	Plexi sheet
3	Joints	Ø1 inch	Galvanized iron
4	Control valve	Ø1 inch	plastic
5	Union	Ø1 inch	Galvanized iron
6	Reservoir tank	[illegible]	Plexi sheet
7	Rotary vane compressor	Lubrication, piston type	-
8	Condenser coil	Ø 7mm	copper
9	Cooling fan	[illegible]	-
10	Vacuum pump	[illegible]	-

Table1Specifications for the adiabatic Dehumidification system

III. FMEA

Failure mode effective analysis (FMEA) is a methodology designed in which the components fail to perform its intended functions. FMEA promoted development in the life cycle of a product. FMEA terms such as failure modes, effects of failure, severity, causes of failure, occurrence, process controls, delectability, risk priority number, and recommended actions. FMEA is an effective method for ensuring better reliability of a product. This technique is used to denote causes of failure and prevent them from happening. FMEA tool assess risks, evaluates the severity, occurrence and detection of risks to prioritize according to how serious the consequences are, how frequently they occur and how easily they can be detected. Failures are defects that harm the customer. Effects are the consequences of those failures. FMEA is an important tool for sustainable designing of components. FMEA attempts to detect the potential failure modes. Design FMEA is used to identify and rectify potential failure modes. Safety and reliability are to be considered in designing and the manufacturing the product. Design FMEA reduces development time and cost of manufacturing process by eliminating many potential modes prior to operations of the process and by specifying the appropriate tests to prove the designed product. FMEA allows engineers to Keep a record of all thoughts and actions taken to ensure a safe and reliable product. FMEA is to compare the design characteristics with the planned structure for meeting the customers' requirements.

Risk Priority Number (RPN) denotes occurrence, detection difficulty and modifications in design respective to the failure modes. RPN to prioritize the modes of failure based on the rankings of severity, detection and occurrence. This method provides rankings from 1 to 10 with respect to their severity(S), detection (D), occurrence (O). Failure modes having high RPN number are considered to be more critical and most priority is given for carrying out the control actions [7].

IV. FMEA SCALE

A. Severity(S)

Severity is the seriousness of the effect of the potential failure mode. The complexity of the component is described only by the severity. FMEA plays a vital role is decreasing the severity of failures. Severity should be rated on 1-to-10 scale, with a 1 being none and a 10 being the most severe.

Effect	Severity of effect on product	Rank
Hazardous – without warning	Operation is Unsafe without warning	10
Hazardous – with warning	Operation is Unsafe with warning	9
Very high	Customer very dissatisfied. System inoperable	8
High	Customer dissatisfied. Product performance severely affected but function able and safe	7
Moderate	Customer experiences discomfort, but operable and safe	6
Low	Customer experiences some dissatisfaction. Moderate effect on product or system	5
Very low	Customer experiences minor nuisance. Minor effect on product or system performance	4
Minor	Slight effect on product or system performance	3
Very minor	Very slight effect on product or system performance	2

None	No effect	1

Table 2.severity(S)

B. Detection (D)

The method by which a failure is detected. This is important for maintainability control and it is especially important for multiple failure scenarios. It should be clear that how the failure mode or cause can be discovered by an operator.

Detection	Criteria	Rank
Almost certain	Controls will almost certainly detect	1
Very high	Very high probability of detection	2
High	Likely to be detected/ High probability of detection	3
Moderately high	Design controls are moderately effective	4
Medium	Design controls have an even chance of working	5
Low	Design controls may miss the problem	6
Slight	Design controls are likely to miss the problem	7
Very Slight	Design controls have a poor chance of detection	8
Remote	unreliable design/poor chance for detection	9
Almost impossible	No known techniques available	10

Table 3.Detection (D)

C. Occurrence (O)

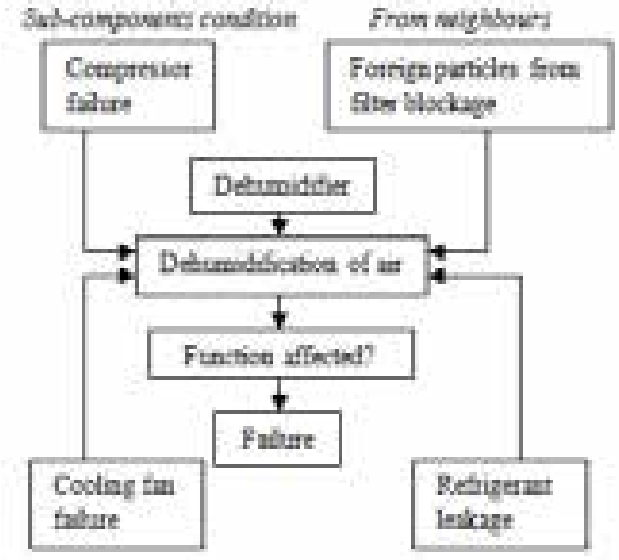
FMEAs, the occurrence ranking considers the likelihood of occurrence during the design life of the product. The probability of occurrence is an estimate of how often a hazard event occurs

Occurrence	Criteria	Rank
Almost never	Failures unlikely	1
Remote	Rare number of failures likely	2
Very slight	Very few failures likely	3
Slight	Few failures likely	4
Low	Occasional number of failures likely	5
Medium	Medium number of failures likely	6
Moderately high	Moderately high number of failures likely	7
High	High number of failure likely	8
Very high	Very high number of failures likely	9
Almost certain	Failures almost certain	10

Table 4.Occurence (O)

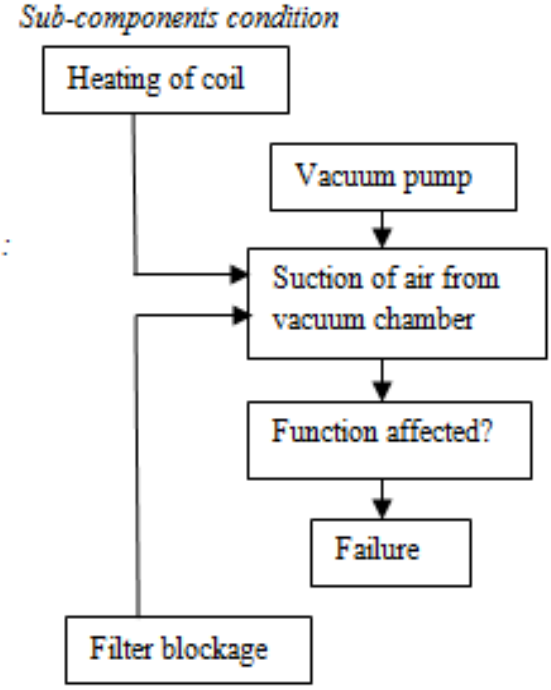
V. FMEA DATA FLOW FOR THE COMPONENTS

A. Dehumidifier:



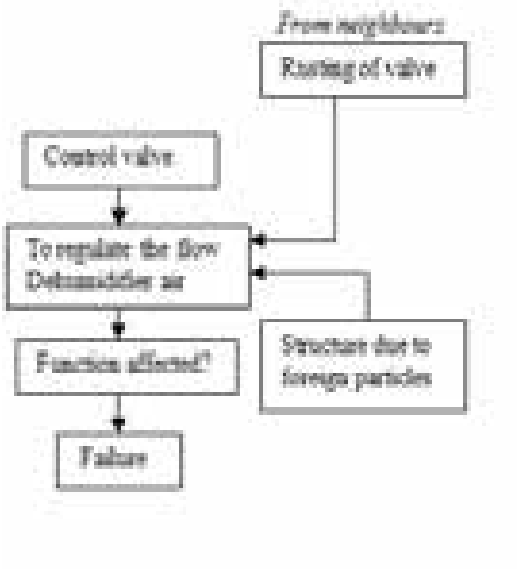
Flow chart1. Dehumidifier

B. Vacuum pump:



Flow chart2. Vacuum pump

C. Control valve



Flow chart3.control valve

VI. FMEA APPLIED TO ADIABATIC DEHUMIDIFICATION SYSTEM FOR DRYING HERBAL LEAVES

The process in the adiabatic dehumidification system for drying herbal leaves was categorized based on two major functions (dehumidification, vacuum pulse creation). The analysis has been constrained to system components/equipment and process for which the FMEA was performed, involving dehumidifier and vacuum drying process. The analysis revealed 24 failure modes with its root causes enlisted in Table

The Failure Modes (FM) which are more possible to occur provided with higher ranking and other failure modes are ranked according to their RPN value. A single failure mode may be the result of a sequence of other sub events each of which has an different frequency of occurrence. Typically this sub event would prevent other sub-events with higher risk-ratings from materializing. The failure modes which are related to safety and which has the capacity to stop the process provided with higher severity rating. The severity ranking for the failure modes which have the tendency to stop the process for less than an hours are ranked according to their approximate repair time. Simple problems like rusting, etc. are quite easy to detect. So these failure modes categorized into low detection rating. Similarly complex problems like heating, plexi sheet bending has higher severity rating and other failure modes were ranked according to the criticality of their RPN value. The RPN scores allow for the overall identification of the prioritization of technical improvement efforts for the system.

VII. RESULT AND DISCUSSIONS:

The FMEA analysis shows the failure modes that are categorized into 6 major areas as follows;

- Dehumidifier- FM1-FM3[3 failure modes]
- Vacuum pump- FM4-FM5[2 failure modes]
- Reservoir – FM6 [1faliure mode]
- Material properties – FM7 – FM8 [2 failure modes]
- Control valve – FM9 [1 failure mode]
- Vacuum chamber – FM10 [1 failure mode]

A final useful analysis from the FEMA is the identification of the different failure modes and its root causes in the safety and operational perspective. The main purpose of the FMEA application was to quantify the risk analysis by determining the RPN values for each potential failure mode. The proposed method in the table reduces the RPN value in the considerable amount.

The results indicated that the vacuum pump causes major interpretation to the operation of the system by contributing failure mode having highest RPN value. Failures were commonly reasoned as using the obsolete technologies. The RPN value is decreased by using reasonable changes in the design.

The plexi sheet bending failure mode (FM7) having highest RPN value (i.e.RPN#160) this value is reduced by using high thickness plexi sheet by introducing this technique RPN value reduced to #8. After that heating failure mode (FM4) having the RPN value (i.e. RPN#126). This value is decreased by introducing self-lubrication pump next blockage failure mode (FM5) having RPN value (i.e.RPN #120) this value is reduced by introducing filter.

Blockage failure mode (FM9) in the having RPN value (i.e. RPN #112) is controlled by suing pressure control regulator. Inadequate oil lubrication failure mode (FM2) having RPN value (i.e. RPN#100) is reduced by introducing oil pump to the dehumidifier. The pressure accumulation failure mode (FM6) in the reservoir having RPN value (i.e. RPN#42) is reduced by attaching dehumidifier into the reservoir. The leakage of the refrigerant failure mode (FM 1) in the dehumidifier having RPN Value of #40.This value is reduced by using gas welding to seal the gap. The pressure drop decreases is the failure mode (FM8) for increasing the drop G.I. pipe is used in the assembly line.

The Blockage in the condenser coil failure mode (FM 3) having the RPN value of #16 this is reduced by filling the refrigerant in the clean environment this needs utmost care by the operator. Finally Rusting of tray in the vacuum chamber failure mode(FM 10)having the RPN value of # 4 is reduced by using chromium coated plate for the tray to carry the leaves.

Based on the results of FMEA analysis, technical improvement actions for different stages of processes were suggested.

The failure modes are ranked based upon the RPN value assigned to the failure mode and the lists are tabulated (6)

Components	FM	Interior parts	Potential Failure mode	Potential Effect	SEV	Potential causes	OCC	Current process control	DET	RPN	Actions Recommended	Action Taken	SEV	OCC	DET	Future RPN
Dehumidification	1	Refrigerant	Leakage	RH value increases which lead to improper drying of leaves	5	Improper Welding	2	Seal the leakage using Mseal in the container	4	40	Efficient gas Welding	Use gas welding	2	1	3	6
	2	Compressor	Inadequate oil lubricant		4	Improper maintenance	5	Proper maintenance	5	100	Oil pump introduction	Oil pump introduction	2	1	2	4
	3	Condenser coil	Blockage		4	Introduction of foreign particles in refrigerant	2	Careful filling of refrigerant	2	16	Filling in cleaned environment	Filling in cleaned environment	3	1	2	6
Vacuum Pump	4	Reciprocating piston	Heating	Vacuum pump may get failure which leads to loss of vacuum	6	Low quality and long duration of operations	7	Use Intermediate operations	3	126	Self-lubricating pump	Self-lubricating pump	4	2	3	24
	5	Suction valve	Blockage		5	Dust inclusions	6	Frequent maintenance	4	120	Filter	Filter	2	2	4	16
Reservoir	6	Tank	Pressure accumulation	Busting of reservoir tank	7	Due to continuous inflow of air	2	Non-return valve	3	42	Attach dehumidifier into the reservoir	Attach dehumidifier into the reservoir	3	1	3	9
Material Properties	7	Plexi sheet	Plexi sheet bending	Crack in the plexi which leads to vacuum loss	8	Low thickness plexi	10	To maintain low vacuum	2	160	High thickness plexi and mild steel plate	High thickness plexi and Mild steel plate	2	2	2	8
	8	Plastic pipe	Pressure drop decreases	Need more time for creating vacuum	2	Plastic pipe which have low coefficient of friction	3		4	24	Use of G.I Pipe	Use of G.I Pipe	1	2	4	8
Control valve	9	Guiding passage	Blockage	Insufficient flow of dehumidify air	4	Back pressure formation	4	Bypass system	7	112	Introducing pressure control regulator	Introducing pressure control regulator	2	2	2	8
Vacuum chamber	10	Tray	Rusting	Life decreases	2	Moisture content in the leaves during drying	2	Adequate replacement	1	4	Use chromium coated plate	Use chromium coated plate	1	1	1	1

Table 5. FMEA of Adiabatic Dehumidification system for drying herbal leaves

Rank	FM	Failure Mode	Causes	RPN
1	4	Heating	Low quality and long duration of operations	24
2	7	Plexi sheet bending	Low thickness plexi	18
3	5	Blockage (Suction valve)	Dust inclusions	16
4	6	Pressure accumulation	Due to continuous inflow of air	9
5	8	Pressure drop decreases	Plastic pipe which have low coefficient of friction	8
6	9	Blockage (control valve)	Back pressure formation	8
7	1	Leakage	Improper Welding	6
8	3	Blockage (Condenser coil)	Introduction of foreign particles in refrigerant	6
9	2	Inadequate oil lubricant	Improper maintenance	4
10	10	Rusting	Moisture contents leads to corrosion	4

Table 6.Ranking of Failure mode

VIII. CONCLUTION

FMEA approach, widely used for risk analysis, has been successfully applied to the Adiabatic Dehumidification system for drying herbal leaves. The study suggest that the technical improvement for the system to overcome the process problem. The result from this study might help the manufacturers of the system.

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OPTIMAL SELECTION OF PROCESS PARAMETERS IN CNC FACE MILLING OF AL 7075 – T6 ALUMINIUM ALLOY USING A TAGUCHI TECHNIQUE

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The objective of this paper is to use taguchi method for minimizing the surface roughness and maximizing the material removal rate simultaneously, in CNC face milling of Al 7075 T6 aluminium alloy using HSS M2 with coolant on and off condition. The input parameters taken into consideration are speed, feed and depth of cut. In Taguchi method, L_9 orthogonal array with 3 factors and 3 levels are chosen and S/N ratios are calculated. The S/N ratios of roughness and material removal rate are analyzed for optimal values of parameters can be get from this method. With application of ANOVA , the feed and depth of cut are identified as the most significant parameters contributing higher percentage than speed. Further the process interprets the most optimal selection of parameters to improve quality of the material.

DESIGN AND DEVELOPMENT OF ADIABATIC EHUMIDIFICATION SYSTEM FOR DRYING OF HERBAL LEAVES

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Most of the "Ayurvedic Industries" across India are facing problems in drying herbal leaves to extract powder to produce medicines as it requires a long time to dry without affecting its herbal characteristics. Evolution of science and technology has identified some techniques such as Sun drying, Freeze drying, Microwave drying, Infrared drying, Lyophilization to dry the leaves quickly by using thermal energy in different forms. But use of thermal energy drastically deteriorates the herbal quality of leaves. The requirement of all "Ayurvedic Industries" is to remove water content from the leaves without utilizing the heat energy or better at temperature lower than the atmospheric temperature. This could be met by adiabatic dehumidification followed by adiabatic dehydration at vacuum. This technique is literally expected to be the most effective in removing the moisture from the leaves provided in no way it will affect the herbal characteristics of the leaves and rate of moisture removed will also be high. Theoretical mass transfer calculations, Experimental mass transfer, Failure mode effect analysis (FMEA) has been done and to be presented in the project presentation.

PERFORMANCE ENHANCEMENT OF SINGLE BASIN SINGLE SLOPE SOLAR STILL BY IMPROVING THE EVAPORATION RATE

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Solar desalination is one of the methods for converting the salt water into fresh water. it involves two main processes – evaporation and condensation. in this work, single basin single slope solar still is used. to overcome the low productivity of solar still, the evaporation rate is improved in this work. evaporation rate is improved by the agitation of the basin water. also by using the energy absorbing material, the evaporation rate is improved. iodine salt is preferred as an energy absorbing material instead of most common materials like charcoal, jute cloths. this experimentation is carried out by enhancing the evaporation rate and

compared with the conventional solar still. the overall objective of this experiment is to increase the productivity in a cost – effective manner. in this work, 590 ppm content of water is converted to 290 ppm and the experimental result shows that the modified still enhanced the distillate productivity by 26% as compared to the conventional still.

INVESTIGATION OF MECHANICAL PROPERTIES OF AL6063 BY EQUAL CHANNEL ANGULAR EXTRUSION DIE

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Aluminium 6063 was subjected to equal channel angular extrusion (ecae) to improve the mechanical properties of al6063. an equal channel angular extrusion die has been designed with channel intersecting angle (ϕ) of 120° and fillet radius (ψ) of 30°.the mechanical properties of al6063 before and after ecae process were investigated to examine the effect of ecae die channel intersection angle(ϕ) on al6063.equal channel angular extrusion is an effective processing technique to produce material with increased mechanical properties without changing the cross sectional area of the billet. this technique is used to refine the microstructure of different materials. the ecae die channel displacement has more influence on the homogeneity of effective strain, increasing the channel angle results in more homogeneous effective strain on the sample cross section. strain distribution depends on outer and inner radii of the die. Decreasing the channel angle results in higher magnitude of effective strain impose on the sample and a higher pressing force. the grain size produced by equal channel angular extrusion are typically in micrometer range and this lead to high strength.

MULTI-OBJECTIVE OPTIMIZATION OF TURNING OF AL7075 USING GREY RELATIONAL ANALYSIS

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Intelligent modelling and optimization techniques are required for solving the complex problems. problems can be solved by identifying the most significant factor. roughness plays a major role in determining how the object interacts with the environment. rough surface wear quickly and have high friction coefficient than the smooth surfaces. this paper represents the machining parameters which affects the surface roughness and material removal rate of al7075 with tungsten carbide tool under dry and wet conditions using grey relational analysis. multi-objective optimization is done to decide the suitability of cutting speed, feed, and depth of cut. suitable machining parameters for turning of al7075 are suggested at the end of the investigation based on gra results and confirmed using anova results.

PERFORMANCE ENHANCEMENT OF SOLAR STILL WITH IN-BUILT CONDENSER

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Water is the primary requirement of life in our universe. though water covers about three-quarters of the earth's surface, only 3% of water is available in potable form. the demand for fresh - water have increased rapidly due to population growth and rapid industrialization. solar still is one of the best solution to solve fresh water scarcity without the use of electrical energy. in this method the saline water is evaporated using thermal energy (solar) and the resulting vapor is collected and condensed as final product (fresh water). major problem associated with conventional solar still is least productivity. objective of this work is to overcome this problem by increasing rate of condensation. modified still with in – built condenser is fabricated to increase the condensation area. both conventional and the modified solar still were fabricated with same basin area and the performance will be compared.

DESIGN, FABRICATION AND EXPERIMENTATION OF THE PORTABLE, SOLAR ENERGY POWERED DRYING APPARATUS FOR RED CHILLIES

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Red chilli is a very important ingredient of most of the food recipes of south india. It is cultivated extensively in most part of the southern states. The main difficulty faced by the farmers cultivating red chilli is in drying the harvested red chilli. farmers are suffering a lot for drying because the natural drying takes 20 to 25 days. in our project work we have tried to reduce the drying time by using solar energy. further the drying apparatus is made portable so that it can be carried to the field where red chilli is cultivated. The apparatus is mostly based on the design of parabolic trough cooker. the receiver of the equipment is made rotatable to ensure all the red chilli loaded in the receiver is heated uniformly. the main advantage of the experimental set up is it uses only solar energy. the experimental set up is fabricated in such a way that the parabolic trough angle can be changed manually in order to receive maximum heat energy from the sun. The theoretical heat transfer rate to the receiver is calculated by thermal analysis and it’s compared with the actual heat transfer rate. the actual heat transfer rate is calculated by monitor the receiver temperature.

EXPERIMENTAL ANALYSIS OF ELECTROLESS NICKEL PHOSPHOROUS COATINGS

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Electroless nickel plating is a process for depositing a nickel alloy from aqueous solutions onto a substrate without the use of electric current. electroless nickel plating is a chemical process which reduces nickel ions in solution to nickel metal by chemical reduction. in this present study electroless nip and nip-sic coatings had been deposited on a mild steel substrate and eddy current testing are made to find the amount of coating materials. in which the time of deposition rate is varied accordingly and thickness of coating is identified. it is clearly identified that the variation in time of electroless process varies the amount of deposition in the specimen.

MIXED-MODE SOLAR DRYER FOR DRYING GINGER

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Solar drying is the process of removing the moisture content with the help of solar radiation. mixed mode forced convection solar crop dryer is designed and used for drying ginger and other crops in an enclosed structure is presented. designing dimensions with1x0.5 m collector area and 0.5x0.5 m chamber area for drying is fabricated. the entire setup is fabricated using plywood and covered using aluminium foil sheet. a thin sheet metal of 1x0.5 m is used to cover the tray, filled with heat storage material. heat storage materials are used to improve the efficiency of the dryer. rice husk is used as sensible heat storage and paraffin wax as latent heat storage material. the air inlet and outlet area of the chamber is reduced so that the air stay period in both collector tray and drying chamber is increased. increase in stay period in collector area improves the heat transfer rate to inlet air. increasing the stay period in drying chamber enhances the mass transfer from the ginger to hot air leading to greater efficiency.

DESIGN AND FABRICATION OF 6 CYLINDER PNEUMATICALLY OPERATED CLAMPING DEVICE FOR CABIN CONTROL VALVE IN A VMC

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Cabin control valves (ccv) is used to actuate the hydraulic cylinders in the dippers and trucks to unload the goods carried by them, e.g.to dump the sand carried by a dipper, a hydraulic cylinder is used and, this hydraulic cylinder is actuated using a cabin control valve that is operated using pneumatic system. the manufacturer is facing a problem in improving their production rate while manufacturing cabin control valve in the vertical machine center, objective of this work is to overcome this problem by increasing production rate of cabin control valve. at present the raw material is fixed using manual clamping in the vertical machine center, the time taken for clamping the ccv in the vmc is very high and therefore the production is very less, and because of this the delivery time is more, in order to improve the production, a pneumatically operated clamping device with six cylinder is designed in the vmc to accommodate the ccv, this device helps in clamping the cabin control valve that is to be machined in a vertical machining center.

INVESTIGATION OF STRAIN MEASUREMENT ON GFRP SMART STRUCTURE BY USING EXPERIMENTAL AND SIMULATION TOOLS

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In modern days the steel leads to high weight, corrosion rate, tensile strength and compressive strength in the application of aerospace, ships, transportation. in order to rectify that problem, we have chosen the composite material. . we have chosen glass fiber as reinforcement, polyester matrix to increase the strength and corrosion resistant. the newly developed composite material is characterized to identify the mechanical properties like tensile strength, yield strength, and shear strength. the main purpose of this paper is to measure the strain rate on composite material under static loading condition as cantilever beam arrangement with quasi static loading condition. the results were compared with the lab view® simulation tool. the test specimen is fabricated using hand lay-up method for strain measurement. we have fabricated the strain measuring setup by using load cell setup.

EXPERIMENTAL EVALUATION OF MATERIAL CHARACTERIZATION ON GLASS FIBER/EPOXY COMPOSITE MATERIAL

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In this paper, a generic experimental investigation procedure was developed on mechanical characterization and testing of glass fabric/epoxy material under uniaxial tensile loading condition. the problem faced with the current alloys were cost and weight is high and it has less corrosive resistance. Their weight to strength ratio is low. In order to eradicate that problem, composite should be replaced for that application mainly due to low density, low cost, renewable, biodegradability and also have the comparable higher mechanical strength. to understand the material characteristics composite should be fabricated as per astm standards using hand layup method. It should be tested in the UTM (Universal Testing Machine) mechanical properties are found. the unidirectional elastic properties such as elastic modulus, shear modulus, poisson's ratio, and strength parameter like ultimate tensile strength, shear strength values were calculated from the experimental data and compared with the other metallic and polymer materials. the results shows the considerable improvement in the mechanical strength.

EXPERIMENTAL INVESTIGATION ON PERFORMANCE OF SHOCK TOWERS IN SCALE MODEL VEHICLES

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Scale model vehicles (1/8 scale) are becoming a popular attraction among people all over the world and since it demands takers with highly commanding technical knowledge in the automobile field it is becoming popular among technical institutes. so people resort to buying unassembled kits and modifying them. however these kits contain components that are mostly fabricated using hobby grade materials like plastic and aluminium (al 6061 t6). the above mentioned materials are cheap and easily available yet the performance of parts are not satisfactory. for our study we have selected 'shock towers' which is an important structural component in scale model vehicles. the shock towers hold the shock absorbers, suspension system and wheel linkages. flexing of shock towers affects the performance of these components and also affects handling and stability to a great extent. also there are several cases where these shock towers failed under high speed impact and fatigue due to structural vibrations. here we have investigated the performance of shock towers using several materials (aluminium 7075, nylon 6 6, graphite fiber). we have compared the performance of shock tower for different material selection using finite element analysis software (ansys r16.2).

INVESTIGATION OF MANGANESE PHOSPHATE COATING ON BEARING STEEL

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The bearing is a mechanical element that constraints relative motion to only the desired motion, and reduces friction between moving parts. It has several applications from prototypes to industry machines that also includes automobiles, moreover bearings undergo several failure modes such as flaking of surface, corrosion, wear, deformation, contamination,

fatigue, etc. the project relates the above mode of failure and inferred to overcome the corrosion of bearing material through coating of surface. the coating of earing material is classified into three types. blackening, zinc phosphating, manganese phosphating. from the concept of coating, it was inferred that manganese phosphate coating was best suitable to overcome the corrosion through literatures. manganese phosphating was coated to bearing material sae52100 (equivalent standards = en 31 steel). upon coating the material the time period of corrosion to occur was increased. the coating was done through chemical immersion process. test was done on the basis of american standard – astm b117. the coated material also exhibits higher hardness than uncoated material. hence the process of manganese phosphating on the bearing material surface was influencing the corrosion resistance and hardness which consequently increases the life time and durability of the bearings used in marine, aeronautics and other industrial applications.

REDUCTION OF CARBON MONOXIDE EMISSION IN SPARK IGNITION ENGINES BY STEAM INJECTION METHOD

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Now a days pollution is the major environmental problem. pollution is created due to the various emissions of harmful gases from different sources like automobiles and chimneys of industries. one of the major harmful gases in the emission is carbon-monoxide. recently in delhi the state government decided to ban the vehicles that were aged more than five years because of toxic emission. the carbon monoxide is denser and it makes particulate matter emission from the vehicle to settle down in the atmosphere region for a month. here a new idea is proposed to reduce the co emission from the automobiles. in this idea, steam is injected in the region of emitted gases. for that purpose a small water tank is attached around the exhaust pipe and the steam is produced by the extracted heat from the exhaust pipe. then the steam is injected inside the exhaust pipe and mixed with the exhaust gases. and the final exhaust gas is tested. the results of the test before and after the steam injection are analyzed.

ASSEMBLY LINE AUTOMATION OF CABIN CONTROL VALVE

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The cabin control valve body has four connectors which are one touch fittings used to connect the pneumatic hoses to the valve. To assemble the connectors, we have positioned them by use of pneumatic grippers. We feed the connectors to the gripper by a slide feed system. The slide feed system will bring the connectors to horizontal orientation. The connectors will be picked by the gripper in horizontal orientation. To fasten the connector, it must be oriented vertically. So, the gripper will be rotated 90 degrees. Based on the location of the threaded region the connector will be rotated 180 degree or kept as such if threaded region is in correct position. The connector will be fastened by use of electric motors once they are positioned by the gripper. All the system will be automated and synchronised be use of Programmable Logic Controller(PLC).

ENHANCEMENT OF HEAT TRANSFER RATE IN DOUBLE PIPE HEAT EXCHANGER BY SHOT BLASTING THE INNER TUBE

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Heat transfer rate in heat exchangers are being researched till date with various methods. in this paper, a double pipe heat exchanger has been designed and fabricated with a 1 m long copper pipe as inner pipe and 1 m long stainless steel pipe as outer pipe. the experimental analysis is conducted by passing hot water in the inner tube and the cold water in the annulus. the experiment is performed with counter flow configuration under different mass flow rates. the process of shot blasting is used to increase the roughness of the outer surface of the inner pipe, thereby increasing the rate of heat transfer. experiment were performed with the designed heat exchanger with and without the shot blasted inner tube. so, this paper has studied the performance of double pipe without taking into account the pressure drop with and without the shot blasted inner tube.

MODELLING AND ANALYSIS OF MASTER LEAF SPRING FOR A LIGHT COMMERCIAL VEHICLE WITH CONVENTIONAL STEEL AND ALUMINIUM REINFORCED WITH BORON CARBIDE AND FLY ASH

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A leaf spring is a type of spring, which is commonly used for suspension system in automobiles. For light commercial vehicle, a leaf spring can be made from several leaves stacked on top of each other in several layers, often with progressively shorter leaves. Leaf springs are long and narrow plates attached to the frame of a trailer that rest above or below the trailer's axle. Here, in our proposed project We have considered only the master leaf and reduced the weight of leaf spring by replacing conventional steel material by Aluminum Reinforced Boron carbide with addition of fly ash. The newly proposed material is produced using stir casting method. Its parameters were evaluated experimentally, according to ASTM standards. We have selected Leaf spring of Tata ace as our base model. The leaf spring is designed using modelling software and FEA is done to find stress and deflection. Values are also compared both experimentally and numerically for steel. From this, it is found that the newly proposed material is more economical and has less weight when compared to conventional material.

INVESTIGATION OF MECHANICAL AND TRIBOLOGICAL PROPERTIES ON ALUMINUM METAL MATRIX

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In the present paper, the mechanical (density and hardness) and tribological properties (wear and friction) of aluminium matrix composite reinforced with silicon nitride and magnesium processed by powder metallurgy technique. the metal matrix composite is processed by aluminium 6063 alloy as base metal and mixed with silicon nitride and magnesium as reinforcement. the two different volume fraction of silicon nitride used as a reinforcement materials. the theoretical density was calculated from rule of mixture method. the experimental densities were calculated by archimedes principle. the hardness test conducted

by rockwell hardness tester with 1.58 mm ball diameter and 100 kgf load condition. the dry sliding wear test were conducted using pin-on disc type apparatus at two linear sliding speed such as 1 m/s, 2 m/s at same load condition for a sliding distance of 2000m. the hardness test concluded that the increase in hardness with increase in volume fraction of the reinforcement. wear resistance increases with increase in volume fraction of silicon nitride whereas coefficient of friction is higher for wear and friction study.

ENHANCING ROOM TEMPERATURE MECHANICAL AND TRIBOLOGICAL PROPERTIES OF HYBRID ALUMINIUM METAL MATRIX COMPOSITE BY POWDER METALLURGY METHOD

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In this experimental study, aluminum (al)-based silicon nitride and copper nitrate particle reinforced hybrid composite materials were manufactured by powder metallurgy technique. the tribological and mechanical properties of these composite materials were investigated under dry sliding conditions. the results of the tests revealed that the silicon nitride and copper nitrate -reinforced hybrid composites exhibited a lower wear loss compared to the unreinforced alloy and al–silicon nitride composites. it was found that with an increase in the copper nitrate content, the wear resistance increased monotonically with hardness. the hybridisation of the two reinforcements also improved the wear resistance of the composites, especially under high sliding speeds. additionally, the wear loss of the hybrid composites decreased with increasing applied load and sliding distance, and a low friction coefficient and low wear loss were achieved at high sliding speeds. the composite with 12 wt. %silicon nitride and 4 wt.% copper nitrate showed the greatest improvement in tribological performance. on the complete study, these results indicate that the hybrid aluminium composites can be considered as an outstanding material where high strength and wear-resistant components are of major importance, predominantly in the aerospace and automotive engineering sectors.

DESIGN AND FABRICATION OF STEERING CYCLE FOR PARAPLEGICS

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Traditional manual wheelchairs require considerable use and control of both arms for operation, thus adaptations are required for individuals with asymmetrical use of their arms. Building upon previous projects, the goal of this project was to create an accessory, to be installed on a standard wheelchair, which would allow full control of the wheelchair with only onearm/hand while addressing areas lacking in commercial products and previous designs, such as manufacture ability, attendant control, user comfort and ergonomics. After preliminary testing and analysis of three one-arm propulsion designs, the project team developed a design for a removable, lever-operated accessory which could be adapted to fit a range of the most popular standard wheelchair models. The propulsion system, connected to the main lever by a coupler link, consists of a crank assembly in which the desired direction of motion is chosen by moving a shifter to engage one of the two gears press-fit around clutches, each of which allows motion in only one direction, either forward or reverse. By including a neutral pawl position in which neither clutch is engaged, this design allows an attendant to propel and control the chair.

STUDY ON MICROSTRUCTURE AND MECHANICAL PROPERTIES OF HYBRID METAL MATRIX COMPOSITE

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In the present paper, the Mechanical (Density and Hardness) and Tribological properties (Wear and Friction) of Aluminium matrix composite reinforced with Silicon nitride and Magnesium processed by Stir casting technique. The metal matrix composite is processed by Aluminium 6063 alloy as base metal and mixed with Silicon Nitride and Magnesium as reinforcement. The two different volume fraction of silicon nitride used as a reinforcement materials. The theoretical density was calculated from rule of mixture method. The experimental densities were calculated by Archimedes principle. The hardness test conducted by Rockwell hardness tester with 1.58 mm ball diameter and 100 kgf load condition. The dry sliding wear test were conducted using pin-on disc type apparatus at two linear sliding speed such as 1 m/s, 2 m/s at same load condition for a sliding distance of 2000m. The hardness test concluded that the increase in hardness with increase in volume fraction of the reinforcement. Wear resistance increases with increase in volume fraction of silicon nitride whereas coefficient of friction is higher for wear and friction study.

COMPRESSION MOLDING MACHINE FOR FABRICATION OF COMPOSITE MATERIAL UNDER THERMAL CURING METHOD

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Compression moulding is a well-known fabrication technique to develop the wide variety of composite products. It is a closed moulding process with high pressure application. In this method, a two matched metal moulds are used to fabricate composite product. In compression molder; base plate is stationary while upper plate is movable. Reinforcement and matrix are placed in the metallic mould and the whole assembly is kept in between the compression molder. Heat and pressure is applied as per the requirement of composite for a definite period of time. The material placed in between the moulding plates flows due to application of pressure and heat acquires the shape of the mould cavity with high dimensional accuracy which depends upon mould design. Curing of composite may be carried in the moulding setup itself. After curing, mould is opened and composite plate is removed for further processing. In this principle, a compression moulding machine is a kind of press which is oriented vertically with two moulding halves, dead load mechanism is used for pressure application in compression moulding. The controlling parameters can be varying the curing time and finishing of the composite plate. If applied pressure is not sufficient, it will lead to poor interfacial adhesion of fiber and matrix. If the pressure is too high, it may cause fiber breakage, expulsion of enough resin from the composite system. If temperature is too high, properties of fibers and matrix may get changed. If temperature is lower than the desired, fibers may not get properly wetted due to high viscosity of polymers especially for thermoplastics.

FABRICATION OF LOW-COST ROBOTIC ARM WITH FIVE DEGREES OF FREEDOM

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Robotic arm is a automated working hand used to perform various operations in industries. The main aim of our project is to design and develop robot arm in an affordable cost. The robot arm is designed with five degrees of freedom. It is designed to perform simple tasks such as light material handling and pick and place of objects. The arm is designed to carry the weight up to 0.5kg. The robotic arm is further integrated into a mobile platform that serves as an assistant for industrial workforce. The arm is equipped with several servomotors which links between arms and perform arm movements. We have also included "IR SENSOR" to detect objects to pick .The servo motor includes encoder so there is no need of external controller. To control the robot we use "ARDUINO" microcontroller board to perform initiate motion and communicate proper angles to microcontrollers that drives the servomotors with the capability of modifying position, speed and acceleration.

MULTI PURPOSE MULTI SPIDLE MACHINE

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The essence of manufacturing process is the conversion of raw material to finished product. Production process is an important factor in manufacturing industry which determines quality and quantity of production. Productivity can be improved by reducing total machining time and by combining the operation. In case of mass production where variety of jobs are less and quantity to be produced is large, it is very essential to produce the job at a faster rate. This is not possible if we carry out the production by using general purpose machines. Thus to improve the production rate the multipurpose machines are needed. This paper deals with design and fabrication of such type of multispindle machine especially for rectangular work pieces.

DESIGN AND DEVELOPMENT OF PNEUMATIC ARTICULATED ROBOT FOR PALLETIZING OPERATIONS

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Pick and Place Robot can pick the objects on the conveyor belt based on Optical sensor and Metal detecting sensor and placing it in a specific location. The robot uses a picking arm which uses a pneumatic cylinder to pick the particular object from the conveyor belt and place it according to the metal and non-metal conveyor. The end effector can be considered the most important component of the robot, which deals with various sources like manufacturing products, horticulture products, etc. The designed adaptive gripper can perform easier and faster picking and placing operation for multiple shapes and size objects. Pick and place robotic automation speeds up the process of picking parts up and places them in new locations, increasing production rates. With many end-of-arm-tooling options available, pick and place robots can be customized to fit specific production requirements. Moving large, small, heavy, or hard-to-handle products can be an easy task to automate in the factory line. Consistency is also a benefit of using a pick and place system. The robots can be easily programmed and tooled to provide multiple applications if required.

MACHINING STUDIES OF ALUMINIUM IN CNC LATHE MACHINE USING TAGUCHI METHOD

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The objective of this study is to utilize Taguchi methods to optimize the surface roughness and MRR for turning operations and the effects of CNC machining processes of aluminum samples. There are three important machining parameters namely, cutting speed, feed rate and depth of cut, which has been considered during the machining of aluminum. This study examines the effects of machining parameters on surface roughness and MRR during the machining on CNC Lathe. An orthogonal array has been selected and constructed to find the optimal levels and to analyze the effect of turning parameters. The signal-to-noise [S/N] ratio has been calculated to construct the analysis of variance [ANOVA] table to study the performance characteristics in dry turning operations. ANOVA has shown that depth of cut has significant role in producing higher MRR. Similarly, Feed has significant role in producing lower surface roughness. The optimal results have been verified through conformation experiments with minimum numbers of trails. The optimal machining parameters of surface roughness has been found as cutting speed 600 RPM, feed rate 0.25mm/rev and depth of cut 0.65mm on the basis of analysis using ANOVA.

FINITE ELEMENT MODELLING OF SMART PIEZOELECTRIC SENSORS/ACTUATORS

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Piezoelectric material plays an essential role in the field of micro level energy harvesting, structural health monitoring and vibration control. This paper emphasis on the finite element simulation of actuation and sensing of smart piezoelectric materials. PZT which is termed as the piezo zirconate titanate is a kind of smart materials which deals with various applications in smart environment. A finite element approach is presented by using the ansys® mechanical apdl 17.2 fea software. The present finite element study delivers a virtual simulation of piezoelectric sensors and actuators using ansys® environment which is pre-requisite for the implementation of smart piezoelectric structures.

MODAL FREQUENCY ANALYSIS OF NOSE LANDING GEAR FOR A TRAINER AIRCRAFT

N Selva Karthi and A.Vasanthanathan
Department of Mechanical Engineering, Mepco Schlenk Engineering College, Sivakasi,

Landing gear is an important one in aircraft structure which is used for safe landing and take-off. It should able to withstand the load acting while the aircraft landed. The present work is focused on nose landing gear of a basic trainer aircraft. The model of nose landing gear is done by using catia[tm] and the modal analysis is performed by using msc patran and msc nastran. msc patran is pre-processor and msc nastran is a solver. The present work is to analyses the modal frequency modes and to compare with the same model with modified model.

MRR AND SURFACE ROUGHNESS IN MACHINING OF ALUMINUM BASED COMPOSITE BY WEDM

M.Lakshmanan, J.Selwin Rajadurai and S.Rajakarunakaran
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This study highlights the behavior of Aluminium reinforced with silicon carbide particles when machined by Wire Electric Discharge Machining Process (WEDM). The problem faced while machining metal matrix composites by conventional machining is severe tool damage. To reduce the tool damage, Electrical discharge machining is employed for machining MMC in the place of conventional machining. In this study, machining is carried-out in WEDM by varying the machining parameters such as applied current, pulse on time and pulse off time, while other parameters such as voltage, dielectric flushing pressure, wire tension etc. are maintained constant. Based on the machining study, the following are the observed results i) increase in the material removal rate and reduction in surface roughness for increasing reinforcement percentage in the composite and ii) applied current and pulse on time increases the material removal rate where as pulse off time has less effect on it. This paper also highlights the feasibility of the different control strategies of obtaining the optimal machining conditions using various optimization techniques.

DESIGN AND FABRICATION OF FOLDABLE TELESCOPIC CRUTCH

B.Safiudeen, S.Raghu balan, R.Sankar ram, R.Sriabiram and S.Rajakarunakaran
Department of Mechanical Engineerings, Ramco Institute of Technology, Rajapalayam.

Crutches carry physiological and psychological benefits especially when they're compared to the wheelchair. Traditional crutches yield a large number of problems to the user. Engineers found that forearm crutches are suitable for the majority as it has minimum disadvantages compared to the other crutches. They still make loud noises when the user walk which could make him/her feels uncomfortable. To reduce the noise and to provide stability and balance by transferring the weight of one's lower body to the upper body and can be foldable for transportation purpose a crutch is proposed and designed. A telescopic combined crutch and walking stick, having a upper tube and a lower tube which slides inside the upper tube compressing the spring on it. The locking of the two tubes are achieved by using snap buttons provided at the top end of the lower tube and the hole for the latching is provided at the top end and the bottom end of the upper tube. The handle for grip is provided at distance from the top end of the upper tube. And the handcuff is attached to another rod with height adjustable feature; this rod is coupled to the upper tube with pivot clamping so that the rod can be folded. While in use, when the snap button is pressed the lower extends or comes out from the upper tube because of the tension in the spring and gets locked at the lower end hole of upper tube. A rubber shock absorber is provided at the end of the lower tube for preventing the slipping and dampens the shock of walking.

MECHANICAL BEHAVIOUR OF COMPOSITE BIKE CRANK UNDER STATIC LOADING CONDITION USING FINITE ELEMENT SIMULATION –ANSYS WORKBENCH®

J.Jerold John Britto, A.Vasanthanathan and S.Rajakarunakaran
Department of Mechanical Engineering, Ramco Institute of Technology, Rajapalayam

In this paper, a crank mounted on a bicycle is modeled and simulated for getting structural response of a bike crank and of bolted flange subjected loading. The bicycle crank is

subjected to a variable force with respect to time. In this analysis, the variation of the forces with time is neglected and it is mainly focused on the response of the crank under static force condition. The governing equation is derived for the static loading condition and suitable boundary conditions were selected for crank configuration. The theoretical results were compared with Numerical solution using Finite Element Simulation tool ANSYS WORKBENCH®. The different composite materials were selected for analysis and the output parameters like deformation, normal stresses, bending stresses and shear stresses were calculated and compared with different materials. Based on the output results, suitable material is selected for crank with the properties of lesser weight with high stiffness to weight ratio. The Finite Element Simulation tool gives ample guidance for selecting the appropriate material for application.

ANGLE TILTING VICE

G.V.Ram Shankar, S.Manikandan, B.Raghuram, E.Udhaya Kumar and M.Ashok Kumar
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In the modern days, humans like to do all the works within a certain time with fast and effectively. At the same time, the job should fulfill the requirement. In the existing system, the radial drilling machine can be used to drill the fixed job with higher efficiency. But it cannot tilt the job at particular angle. The drawbacks of earlier system are overcome in the existing system. These drawbacks are overcome by proposed system. Design and fabrication of the tilting machine vice can be operated by using mechanical linkage such as bevel gears and shaft. This vise may include other features such as a small anvil on the back of its body. And with the help of nut and screw arrangement, we can achieve the required angle. Most engineers' vices have swivel base. Some engineers vices marketed as 'Home Owner Grade' are not made of steel or cast iron but of pot metal. Vices have two parallel jaws, one fixed and other movable threaded in and out by a screw and lever. It's key feature that the main body of the vice can be adjusted to a 90 degree angle, while the base remains stationary on the machine's table. This tilt allows the user to place the work piece in the most convenient position for task including drilling, reaming, or milling. The proposed machine vice will be very useful to these generation and future generation of peoples.

REVERSE SHIFT IN BIKES FOR PHYSICALLY CHALLENGED

R.Venkatesh,G.Manikandaraja, V.Ramesh Narayanan, A.Mohamed Noorul Habeeth, S.Muthu Raj and V.Marieswaran
Department of Mechanical Engineering, AAA College of Engineering & Technology

The main motive of this paper is to induce a reverse shift in bikes designed for physically challenged. This is being done to overcome the problem of pulling the bike back by those people when it gets stuck somewhere. The Conventional bikes only have forward motion whereas this project design involves the placement of a gear for the reverse shift also. This design involves the placement of a gear in the engine which enables the reverse acceleration of the bike. The gear which is fitted in the engine along with the help of differential makes the reverse acceleration possible thereby making the bike to move backwards. This provision can be used by the rider through the usage of switch or a gear rod placed somewhere in the anterior part of the bike. Thus by switching, the rider could alter the direction of the motion of his bike. The reverse acceleration will be too limited such that it enables the reverse motion in very slow pace which also caters to the safety of the rider. This design has the advantage of both being cost effective and also serves the purpose of reverse motion of the bike.

DESIGN AND FABRICATION OF GRASS CUTTER USING SCOTCH YOKE MECHANISM

P.Sudhakar, J.Selva Ganesh and R.Meby selvaraj
Department of Mechanical Engineering, AAA College of Engineering & Technology, Sivakasi

A grass cutter is a machine that uses sliding blades to cut a lawn at an even length. Even more sophisticated devices are there in every field. Grass cutter is a very useful device which is very simple in construction. It is used to maintain and upkeep lawns in gardens, schools, college's etc. We have made some changes in the existing machine to make its application easier at reduced cost. Unskilled operation can be done easily and the lawn can be made into fine and uniform surface. In our project grass cutter is used to cut the different grasses for the different application and we are using scotch yoke mechanism for this project to cut the grass in linear motion.

MECHANICAL PROPERTIES OF HYBRID COMPOSITE WITH VARYING CARBON REINFORCEMENT

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Department of Mechanical Engineering, P.S.R.Engineering College, Sivakasi

The role of natural and manmade reinforced hybrid composite materials are growing in a faster rate in the field of engineering and technology. Due to its considerable properties they are less expensive and also more suitable for noise attenuation. In the present study the carbon particles (carbon/Epoxy/polyester) reinforced polymer hybrid composites to fabricate and evaluate the mechanical properties such as tensile strength, flexural strength and impact strength. The composite plates are prepared by varying carbon weight percentage. We use carbon particles as a size of 75μm. Carbon/Epoxy/ polyester composite of 2 various combination . The carbon content is varied upto 2 weight percent of the matrix. The proportion of Carbon/Epoxy 30:70. However, the sample with 40:60, and the carbon/polyester combination as likewise the same proportion. Finally we have come to conclusion that the Mechanical properties vary from each and every combinations. The work has to still be continued to find some other possibilities for increased properties.

DYNAMIC BALANCING OF CRANKSHAFT USING OPTIMIZATION TECHNIQUE

K.Thiagarajan, R.Vendharasan, S.Saravanaraj and M.Ramar
Department of Mechanical Engineering, P.S.R. Engineering College, Sivakasi

The main objective of this study is to optimize the cycle time in dynamic balancing. In this study dynamic balancing was conducted on several crankshafts of six stroke engines. The analysis was done on different machines in the crankshaft manufacturing. The time variation and imbalances were investigated. Results from particular machines were verified with the previous one. Results achieved from aforementioned analysis were used in optimization of cycle time in dynamic balancing of crankshaft. The optimization process included some calibrations and balance weight designing, resulting in efficient process time reduction and increase in productivity.

DESIGN AND FABRICATION OF SEMI-AUTOMATED MULTIPURPOSE HYDRAULIC MACHINE

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Ramco Institute of Technology, Rajapalayam.

Hydraulic operated equipment's are used in different fields. Nowadays machines are getting automated. The aim of our project is to design and fabricate semi-automated multipurpose hydraulic machine. In this project we are converting the conventional hydraulic jack into automated hydraulic jack by using slider crank mechanism with the help of a wiper motor. Purpose of the project is to fabricate a lifting and also bending machine for bending processes like sheet metal bending. Sheet metal bending process plays a major role in the metal manufacturing industries. In order to remove bends and also to create bending in sheet metal, this machine will be very useful. The machine works by the principle of slider-crank mechanism. In fluid power, hydraulics is used for the generation, control, and transmission of power by the use of pressurized liquids. Hydraulic bending machine is portable, flexible and less expensive, hence it is better to replace conventional machines by hydraulic machines in industries. The vehicles can be lifted from the floor without any impact force. The fabrication part has been considered to be simple and economical, such that this can be accommodated as one of the essential tools on automobile garages.

ANOTHER DECOMPOSITION OF CONTINUITY

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In this paper we introduce M-closed set, $\alpha Cglc^{**}$- set, M-continuity and $\alpha Cglc^{**}$-continuity. Using this new continuity we obtain another decomposition of continuity in topological spaces.

ON EDGE COVERING CHAIN OF A GRAPH

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In the study of domination in graphs, relationships between the concepts of maximal independent sets, minimal dominating sets and maximal irredundant sets are used to establish what is known as domination chain of parameters.

$$ir(G) \le \gamma(G) \le i(G) \le \beta_0(G) \le \Gamma(G) \le IR(G)$$

In this paper,starting from the concept of edge cover, six graph theoretic parameters are introduced which obey a chain of inequalities,called as edge covering chain of the graph G.

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Finite Element Modeling and Simulation of Condition Monitoring on Composite Materials Using Piezoelectric Transducers - ANSYS®

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Abstract

In this paper an integrated smart structure approach for condition monitoring application is modelled and simulated using ANSYS®. An array of piezoelectric transducer is embedded within the structure for both actuation and sensing. The Finite Element governing equation is derived by using Hamilton's principle for the conversion of the mechanical energy of the structure into the electrical energy of the Piezoelectric material. A computational program is applied for investigating the static and dynamic behavior of composite plates with Piezoelectric layers symmetrically bonded to the top and bottom surfaces. Debonding of piezoelectric sensors/actuators can result in significant changes to the static and dynamic responses. A set of numerical simulation is carried out and the results are compared with those from analytical formation in the literature and with ANSYS®17.0. Numerical results demonstrate the performance of the element and the global and local effects of debonding sensor/ actuators on the dynamic response of the adaptive laminate.
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Keywords: Finite Element Method, Composite Materials, Piezoelectric Sensor/actuator, ANSYS®.

1. Introduction

Currently composite materials are increasingly being used in aircraft primary structures.

Nomenclature

D	coefficient of piezoelectric strain constant	E	Young's modulus
G	Shear modulus	γ	Poisson's ratio
V	voltage applied		

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However, fibre reinforced materials are more complex. Composite structures have been established and used for current aviation, military, and civil applications over metals due to their higher stiffness to weight or strength-to-weight ratio, higher resistance to fatigue damage and harsh environments, repairable. Fiber reinforcement is chosen because most materials are much stronger in fiber form than in their bulk form. This attributed to the sharp reduction in the number of defects in the fibers compared to the bulk form. To monitor the damages of composite materials, the PZT network are essential. Currently, the applications of piezoelectric materials have extended widely in electromechanical and micro electromechanical sensors and actuators [1-3]. It is the capability of crystal to convert mechanical energy of distortion to electric charge. The crystals with piezoelectricity have also the capability of inverse effect – to change their shape concerning to the applied electric field.

2. Condition Monitoring

In the past three decades, the technology of structural health monitoring(SHM) has been broadly active to track physical behaviors (e.g., acceleration, strain and displacement) online in a continuous and real-time manner and to ensure that engineering structures are functioned in the specified tolerance and safe range. In addition, with the advances of innovative sensing and information processing technologies, SHM systems for various types of engineering constructions. An actual sensor could perform the following functions over its sensing characteristics viz (i) to screen the integrity of the structure uninterruptedly, to monitor the pre-existing damages, (iii) to forecast the inception and position of the damages in the structure. The basic requirements for such sensors are compactness, large area monitoring capability, minimal electrical interconnection, easily embeddable, and compatibility with composites and composite manufacturing.

The new field, termed “smart materials and structures” refers to structures that can evaluate their own heal, perform self-repair or can make serious changes in their behavior as situations change. Piezoelectric ceramic (PZT) materials have been broadly used in the design of many self-adaptive smart structures because of their exceptional electro-mechanical coupling behavior. The experimental results of several investigation groups have confirmed that piezoelectric material can be efficiently used for vibration control, noise suppression, precision alignment control, energy harvesting, sensing, and for damage detection applications. In these applications, PZT ceramics are commonly used due to their fairly low cost, high band-width and good actuation competences. But the major problems of these PZT are their high brittleness and low elasticity, which has blocked their wide applications in engineering. In order to overcome this problem piezo-composite [4] transducer was developed.

3. Finite Element Analysis

The ANSYS finite element methods were used for demonstrating and analysis of piezoelectric materials. The single piezoelectric sheet model was presented. The basic characteristic of the piezoelectric material was analyzed and the affecting factors of characteristics were derived. Currently, the finite element analysis becomes very striking for many researchers and is used for modeling piezoelectric sensors and actuators. In the present study, the mechanical characteristics and electrical response of the piezoelectric materials are analyzed.

Even though the transducers are basically a useful experimental tool, when involved in a complex construction like “smart structure”, a consistent computational model for the prediction of system behavior is needed. This paper deals with the numerical simulation of piezoelectric phenomena by the finite element method. Piezoelectric material by some of the finite elements have been already executed for commercial FEM packages such as ANSYS® or ABAQUS®. This paper attempts to present and compare the results of simple problems of piezoelectricity obtained by varies elements available in ANSYS® [4]. The piezoelectric properties were considered in the present finite element model is represented in Table 1.

Table 1. Piezoelectric properties [5] of PZT-based ceramics.

Properties		PIC 151	PZT4	PZT-5A	PZT-5H	PZT-8
Density kg/ m^3	ρ	7800	7500	7750	7600	7600
Dielectric loss factor	tanδ	0.02	0.05	0.02	0.02	0.06
Compliance (10^{-12} m^2 / N)	C_{11}	15.0	12.3	16.4	16.5	11.5
	C_{22}=C_{33}	19.0	15.5	18.8	20.7	13.5
	C_{12}=C_{21}	-4.50	-4.05	-5.74	-4.78	-3.70
	C_{13}=C_{31}	-5.70	-5.31	-7.22	-8.45	-4.80
	C_{23}=C_{32}	-5.70	-5.31	-7.22	-8.45	-4.80
	C_{44}=C_{55}	39.0	39.0	47.5	43.5	31.9
	C_{66}	49.4	39.0	47.5	43.5	31.9
Electric Permittivity 10^{-8} F/m	ε_{11}^{T}	1.75	1.45	1.73	3.13	1.29
	ε_{22}^{T}	1.75	1.45	1.73	3.13	1.29
	ε_{33}^{T}	2.12	1.3	1.7	3.4	1.00
Piezoelectric Strain Coefficients 10^{-10} m / V	e_{31}	-2.10	-1.23	-1.71	-2.74	-9.70
	e_{32}	-2.10	-1.23	-1.71	-2.74	-9.70
	e_{33}	5.0	2.89	3.74	5.93	2.25
	e_{24}	5.80	4.96	5.84	7.41	3.30
	e_{15}	5.80	4.96	5.84	7.41	3.30

3.1. Modeling of Piezoelectric Materials

The constitutive relation of piezoelectric behavior are described in Eqn (1) & Eqn (2),

$$\sigma = s\varepsilon - e^{T}E,$$
$$D = e\varepsilon + \mu E,$$

ζ - Stress Vector, D - Electric displacements, ε - strain vector, C - Elastic coefficients, e - stress piezoelectric matrix, μ - dielectric matrix with the coefficients of electric permittivity on its diagonal. Components of electric field intensity E is linked with the electric potential φ by relation shown in Eqn(3).

$$E=-\nabla\varphi$$

The system of equations represented in Eqn (1) & Eqn (2)

$$\begin{bmatrix}\sigma_{11}\\ \sigma_{22}\\ \sigma_{33}\\ \tau_{23}\\ \tau_{13}\\ \tau_{12}\\ D_1\\ D_2\\ D_3\end{bmatrix} = \begin{bmatrix} C_{11} & C_{12} & C_{12} & & & & & & -e_{31}\\ C_{21} & C_{22} & C_{23} & & & & & & -e_{32}\\ C_{21} & C_{32} & C_{22} & & & & & & -e_{33}\\ & & & C_{44} & & & & -e_{24} & \\ & & & & C_{55} & & -e_{15} & & \\ & & & & & C_{55} & & & \\ & & & & e_{15} & & \mu_{11} & & \\ & & & e_{24} & & & & \mu_{22} & \\ e_{31} & e_{32} & e_{33} & & & & & & \mu_{33}\end{bmatrix}\begin{bmatrix}\varepsilon_{11}\\ \varepsilon_{22}\\ \varepsilon_{33}\\ \gamma_{23}\\ \gamma_{13}\\ \gamma_{12}\\ E_1\\ E_2\\ E_3\end{bmatrix}$$

3.2. Finite Element formulation for Harmonic Analysis

The material properties taken into account for the present numerical analysis is listed in Table 2. Composites are orthotropic material, wherein the property varies along in three directions. The stiffness of a composite panel will often depend upon the orientation of the applied forces and moments.

Table 2. CFRP Material properties [5,6]

Properties	CFRP
Young's Modulus in x-direction (E_x)	125.485 GPa
Young's Modulus in y-direction (E_y)	8.067 GPa
Young's Modulus in z-direction (E_z)	8.067 GPa
Shear Modulus in x-y direction (G_{xy})	41.29 GPa
Shear Modulus in y-z direction (G_{yz})	2.42 GPa
Shear Modulus in z-x direction (G_{zx})	4.129 GPa
Poisson's ratio in x-y direction (γ_{xy})	0.0176
Poisson's ratio in y-z direction (γ_{yz})	0.0176
Poisson's ratio in z-x direction (γ_{zx})	0.457
Density	4.152 kg/m^3

3.3. Finite Element Modeling and Simulation of CFRP Plate

The present study deals with the finite element simulation CFRP with Harmonic responses were studied with the frequency range from 0 to 5000 HZ with 50 sub steps. The present analysis has been modelled and simulated in accordance to Table 2. The element type selected for this analysis is SOLID5. Anisotropic material properties [6,7] were applied. The size of the plate is considered 0.03 × 0.01 × 0.003 m. There are five piezoelectric materials with different grades were used in this study PIC 151, PZT4, PZT-5A, PZT-5H, PZT-8.

a b

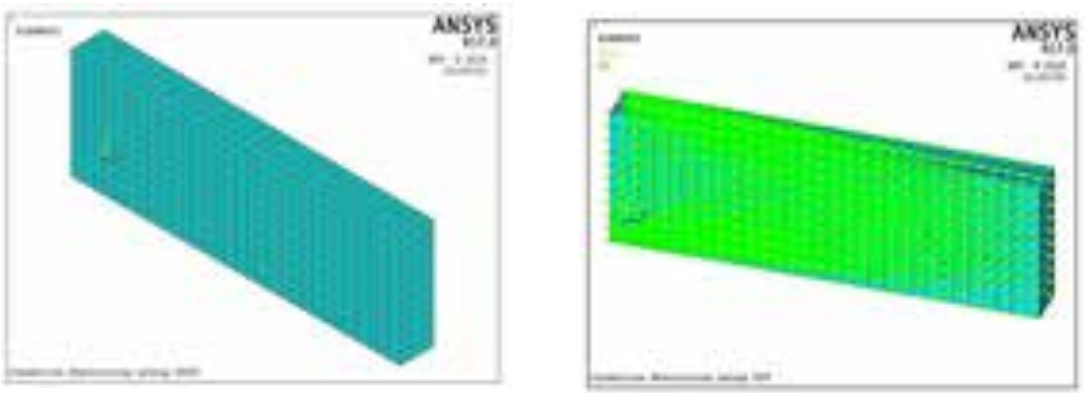

Fig. 1 (a) Finite Element Model (b) Finite Element Model CFRP and plate with PZT

The finite element model of the CFRP plate and CFRP plate with PZT are represented in Fig. 1.

4. Results and Discussions

The present study, the numerical software package ANSYS®17.0 is applied for study the effects of harmonic response for different piezoelectric materials and represented in Fig (2-8). The Fig. (8) shows the finite element result comparison of various PZT material with different grades, which is embedded in the Carbon fibre reinforced polymer structure. The load is varied from 0 to 5000 Hz with an input of 1Vfor all the material configurations.

a b

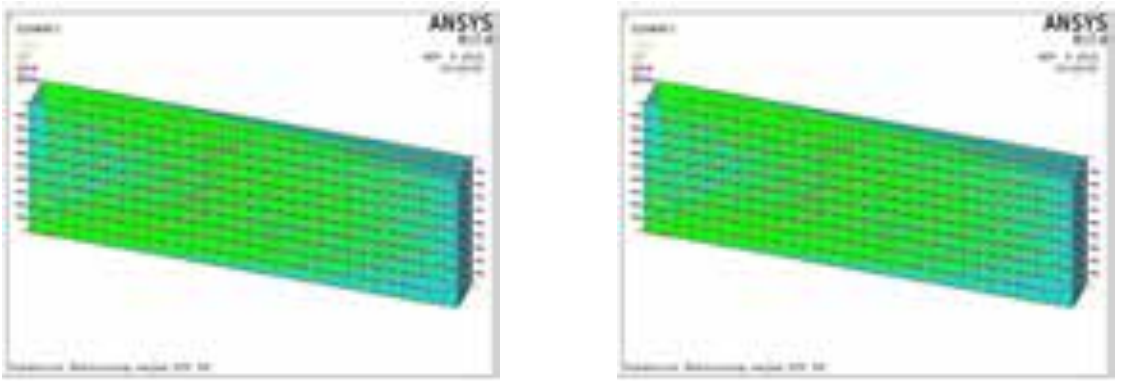

Fig. 2 (a) Input Voltage applied for the plate – PIC 151 model; (b) Input Voltage applied for the plate – PZT4,

a b

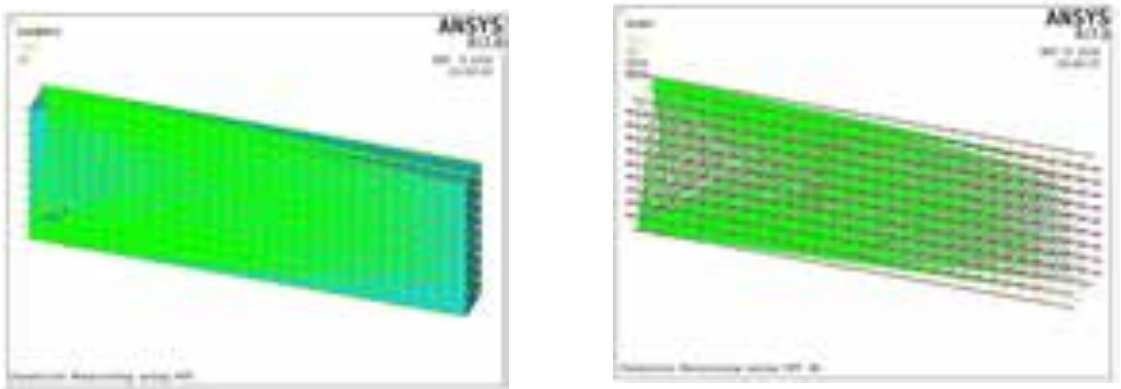

Fig. 3 (a) Finite Element Model of PZT 5 H; (b) Finite Element Model of PZT 5A,

a b

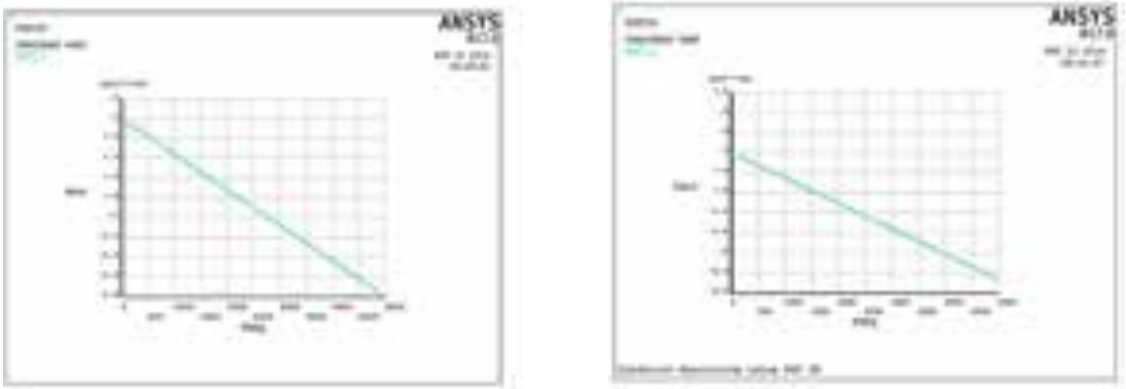

Fig. 4 (a) Von Mises Elastic Strain for PIC 151; (b) Von Mises Elastic Strain for PZT 5A

a b

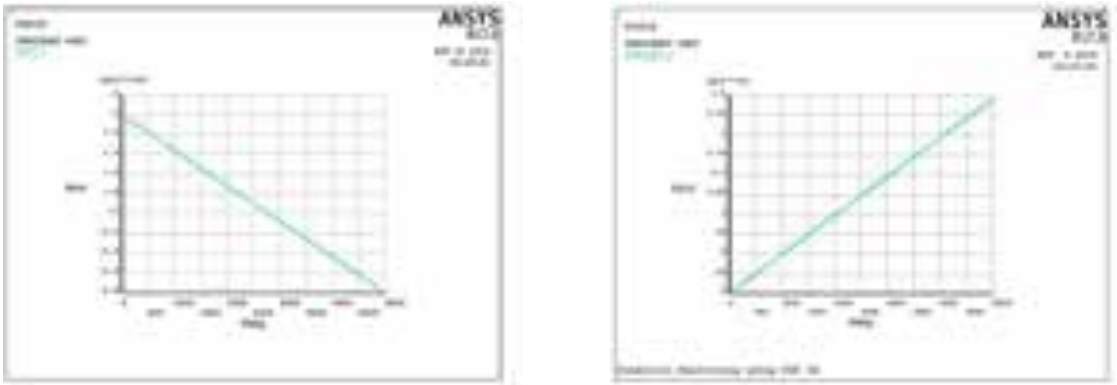

Fig. 5 (a) Elastic Strain for PZT; (b) Elastic Strain for PZT 8

a

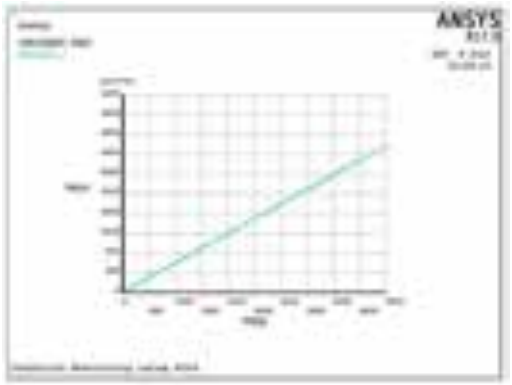

Fig. 6 Elastic Strain graph for PZT 5 H

a b

Fig. 7 (a) Current flow graph for PZT 8 plate; (b) Current flow graph for PIC 151 plate

a b

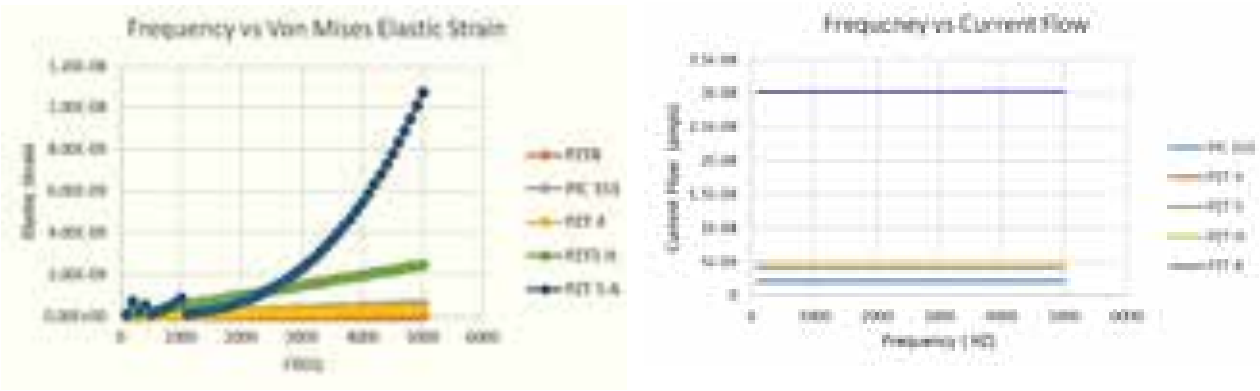

Fig. 8 (a) Frequency vs Von Mises Elastic Strain comparison plot; (b) Frequency vs Current Flow comparison plot

It is seen that when the frequency is increases for the material, it gives different proportion of response like Von Misses Elastic Strain, and Current flow over the entire plate. Based on the response we could conclude that the Elastic strain rate is minimum in the PZT 8, PIC 151, PZT4, PZT 5 H. The strain rate is maximum on PZT 5 A material. The fig. 8(b) shows the current flow range for the material. It has been observed that the current flow is maximum for PZT 8 material over the other counterparts.

Table 3. Finite Element result comparison of different Piezoelectric materials

Piezoelectric materials	Von Misses Elastic Strain at minimum frequency (100 Hz)	Von Misses Elastic Strain at maximum frequency (5000 Hz)	Current Flow (amps) at minimum frequency (100 Hz)	Current Flow (amps) at maximum frequency (5000 Hz)
PIC 151	1.02e-11	5.5e10	2.12e-9	2.12e-9
PZT4	5.94e-12	2.98e-10	4.03e-9	4.03e-9
PZT-5A	8.48e-11	1.07e-8	4.03e-9	4.03e-9
PZT-5H	4.91e-11	2.45e-9	4.80e-9	4.80e-9
PZT-8	6.28e-13	3.14e-11	3.02e-8	3.02e-8

5. Conclusion

The following conclusions are drawn from the present finite element study:

(1) A smart plate structure has been modelled and simulated with finite element capabilities.

(2) It has been found that ANSYS® FEA capabilities are compatible for simulating smart piezoelectric structures embedded PIC 151, PZT4, PZT-5A, PZT-5H, PZT-8.

(3) A comparative study of the finite element models with all the piezoelectric categories smart materials has been carried out.

(4) Finite element computations have been done for the frequency range from 0-5000 Hz.

(5) The nodal solutions are the suggestion for selecting the suitable piezoelectric grade for the fabrication of CFRP composite laminate with smart piezoelectric materials.

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FINITE ELEMENT MODLEING AND SIMULAITON OF COMPOSITE PIEZOELECTRIC TRANSDUCER CANTILEVER BEAM USING COMSOL® MULTIPHYSICS TOOL

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Abstract

In this paper, the linear and nonlinear behavior of composite piezoelectric transducer cantilever beam is modelled and simulated by using COMSOL® multiphysics Finite Element Tool. This analyses on a piezoelectric actuator based on the movement of a cantilever beam using Piezoelectric devices predefined multiphysics interface. The sandwich composite beam analyses were fully coupled to solve both the electric and mechanical parts of the problem simultaneously. Glass fiber is added for additional strength of the composite. The bending behavior of a cantilever beam is simulated under electromechanical interface to solve the coupled equations for the structural deformation. The Behavior of interaction of nonlinear electrostatic force with linear restoring force of the micro cantilever beam is simulated. Static analysis using COMSOL® multiphysics finite element package is done to validate the results. The behavior of piezoelectric actuator is analyzed through deflection analysis and Eigen frequency. It is concluded that, simulation results were almost agreeing with analytical predictions of nonlinear analysis. A micro actuator structure was designed and evaluated with different piezoelectric materials to achieve a high displacement with low excitation voltage.

Keywords : Piezoelectric, Cantilever beam, Static and Dynamics, COMSOL®

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Recent Advancements in Mechanical Engineering

Department of Mechanical Engineering

Pollution is one a major factor which affects the environment nowadays, resulting in greenhouse effect and global warming. One way of increasing efficiency is by inducting oxygen into the combustion chamber since oxygen is a combustion enhancer the amount of oxygen entering into the combustion chamber if increased it would result in better engine performance and lower emissions. A separate unit is provided for controlling the nitrogen and oxygen ratio input to a engine separate the nitrogen and oxygen and send the nitrogen to the storage tank or to the atmosphere as it unwanted for combustion of fuel in the engine cylinder. Replacement of thermal separation methods with membranes has great potential to reduce the energetic and environmental costs in a variety of industrial processes. A membrane separates the nitrogen and oxygen placed before the inlet of the carburettor. This system have been developed to meet current and future exhaust emission standards with optimum furl economy. The certain pressure level of the air is maintained by the compressor. The 12v dc electric source is provided by the battery for running the air compressor.

Key words: *Pollution, global warming, carburettor, nitrogen and oxygen.*

PERFORMANCE IMPROVEMENT OF SINGLE BASIN SINGLE SLOPE SOLAR STILL BY ENHANCING THE RATE OF CONDENSATION

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ABSTRACT

Water is the primary requirement of life in our universe. Though water covers about three-quarters of the earth's surface, only 3% of water is available in potable form. The demand for fresh - water have increased rapidly due to population growth and rapid industrialization. Solar still is one of the best solution to solve fresh water scarcity without the use of electrical energy. In this method the saline water is evaporated using thermal energy (solar) and the resulting vapor is collected and condensed as final product (fresh water). Major problem associated with conventional solar still is least productivity. Objective of this work is to overcome this problem by increasing rate of condensation. Modified still with in – built condenser is fabricated to increase the condensation area. Both conventional and the modified solar still were fabricated with same basin area and the performance will be compared.

Keywords: *Desalination, In- built condenser, Passive solar still, saline water, Solar energy.*

DESIGN AND FABRICATION AND EXPERIMENTATION OF SOLAR DRYER FOR DRYING GINGER

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ABSTRACT

Solar drying is the process of removing the moisture content with the help of solar radiation. Mixed mode forced convection solar crop dryer is designed and used for drying

ginger and other crops in an enclosed structure is presented. Designing dimensions with1 X 0.5 m collector area and 0.5X0.5 *m* chamber area for drying is fabricated. The entire setup is fabricated using plywood and covered using aluminium foil sheet. A thin sheet metal of 1X0.5 m is used to cover the tray, filled with heat storage material. Heat storage materials are used to improve the efficiency of the dryer. The air inlet and outlet area of the chamber is reduced so that the air stay period in both collector tray and drying chamber is increased. Increase in stay period in collector area improves the heat transfer rate to inlet air Efficiency attained is 23.15 %.

Key words: *Solar thermal energy, Solar radiation, collector tray, chamber, Temperature, Relative humidity, Latent heat.*

PERFORMANCE ENHANCEMENT OF SINGLE BASIN SINGLE SLOPE SOLAR STILL BY IMPROVING THE EVAPORATION RATE

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ABSTRACT

Solar desalination is one of the methods for converting the salt water into fresh water. It involves the two main processes – evaporation and condensation. In this work, single basin single slope solar still is used. To overcome the low productivity of solar still, the evaporation rate is improved in this work. Evaporation rate is improved by the agitation of the basin water. Also by using the energy absorbing material, the evaporation rate is improved. Iodine salt is preferred as an energy absorbing material instead of most common materials like charcoal, jute cloths. This experimentation is carried out by enhancing the evaporation rate and compared with the conventional solar still. The overall objective of this experiment is to increase the productivity in a cost – effective manner.In this work, 690 ppm content of water is converted to 290 ppm and the experimental result shows that the modified still enhanced the distillate productivity by 26% as compared to the conventional still.

Keywords: *solar desalination, single slope solar, jute cloths*

DETERMINATION OF BOILER EFFICIENCY AND ANALYSIS OF WATERWALLS

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ABSTRACT

On Edge Covering Chain of a Graph

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***Abstract*- In the study of domination in graphs, relationships between the concepts of maximal independent sets, minimal dominating sets and maximal irredundant sets are used to establish what is known as domination chain of parameters.**

$$ir(G) \le \gamma(G) \le i(G) \le \beta_0(G) \le \Gamma(G) \le IR(G)$$

In this paper,starting from the concept of edge cover, six graph theoretic parameters are introduced which obey a chain of inequalities,called as the edge covering chain of the graph G

***Key words*- vertex cover, enclave less set, co-irredundant set, edge cover, edge enclave less set, edge co-irredundant set**

I. INTRODUCTION

By a graph $G = (V, E)$ we mean a finite,undirected graph with neither loops nor multiple edges.The order and size of G are denoted by n and m respectively.For graph theoretic terminology we refer to Chartrand and Lesniak[1]. Since this paper considers a relatively large number of graph parameters and inequlities between them we start with the following definitions and theorems.

1. $\alpha(G)$,the vertex covering number equals the minimum number of vertices in a vertex cover,that is a set $S \subseteq V$ having the property that for every edge $uv \in E$, either u ∈ S or v ∈ S
2. Λ(G) ,the upper vertex covering number equals the maximum number of vertices in a minimal vertex cover of G
3. $\beta_0(G)$,the vertex independence number equals the maximum number of vertices in an independent set,that is a set of vertices, no two of which are adjacent.
4. $i(G)$,the lower independence number equals the minimum number of vertices in a maximal independent set
5. $\gamma(G)$, the domination number equals the minimum number of vertices in a dominating set,that is a set $S \subseteq V$ for which every vertex in V-S is adjacent to atleast one vertex in S
6. $\Gamma(G)$,the upper domination number equals the maximum number of vertices in a minimal dominating set.
7. [5] $\Psi(G)$,the upper enclaveless number equals the maximum number of vertices in a set S, suchthat S has no enclave,that is a vertex $v \in S$ such that $N[v] \subseteq S$
8. $\psi(G)$,the lower enclaveless number equals the minimum number of vertices in a maximal enclaveless set S
9. *ir(G)*,the irredundance number equals the minimum number of vertices in a maximal irredundant set in G ,that is a set $S \subseteq V$ suchthat every vertex $v \in S$ has a private neighbour.

10. *IR(G)*,the upper irredundance number equals the maximum number of vertices in an irredundant set

11. *cir(G)*,the co- irredundance number equals the minimum number of vertices in a co-irredundant set in G,that is V-Sis irredundant

12. *CIR(G)*,equals the maximum number of vertices in a minimal co-irredundant in G

Theorem1.1[2] For any graph G,

$$ir(G) \le \gamma(G) \le i(G) \le \beta_0(G) \le \Gamma(G) \le IR(G)$$

Cockayneet.al [3] completely characterized the domination chain

Theorem1.2 [4] For any graph G,

$$cir(G) \le \psi(G) \le \alpha(G) \le \Lambda(G) \le \Psi(G) \le CIR(G)$$

Which is known as the Covering chain of a Graph G. Arumugam et al [4] characterized the covering chain and proved that it is the dual of domination chain

II. The Edge covering chain of the graph G

Definition2.1: The subset T of E is an edgecover if every vertex is incident to atleast one edge in T. T is a minimal edge cover if it has no proper subset which is an edge cover.

We denote $\alpha'(G)$ and $\beta'(G)$ by the minimum cardinality and maximum cardinality of minimal edge cover and call them as edge covering numbers

Definition2.2: An edge $e = uv \in T$ is an edge enclave if $N[e] \subseteq T$ where N[e]=N[u]$\cup$N[v]

A subset $T \subseteq E$ is an edge enclaveless set if every edge in T is adjacent to some edge in $E - T$. T is called maximal edge enclaveless set if it is not a proper subset of some other edge enclaveless set.

We denote $\psi'(G)$ and $\Psi'(G)$ by minimum cardinality and maximum cardinality of a maximal edge enclaveless set of G and call them as enclaveless numbersof G.

Clearly the property of being an edge cover is superhereditary property and an edge cover T is minimal if and only if T is l – minimal.

Preposition2.3: An edge cover T of E is a minimal edge cover if and only if T is an edge cover and is edge enclaveless.

Proof: Let T be a minimal edge cover of G and let $e \in T$ Then T – {e} is not an edge cover of G and hence $N[e] \not\subset T$ and T has no edge enclave

Conversely suppose T is an edge cover and edge enclaveless set. Suppose T is not a minimal edge cover, then these exists an edge $e \in T$ such that T –{e} is an edge cover. Then ‘e’ is an edge enclave in T which is a contradiction. Thus T is a minimal edge cover of G.

Proposition2.4: Every minimal edge cover T is a graph G is a maximal edge enclaveless set of G.

Proof: Let T be a minimal edge cover of G. Then by the above proposition, T is an edge enclaveless set.

If T is not a maximal enclaveless set, then these exists an edge $e \in E-T$ such that T U{e} is edge enclaveless. Hence these exists an edge $e_1 \in N(e) \cap (E-T)$ and the edges e and e1are adjacent in E – T which is a contradiction.Thus T is a maximal edge enclaveless set of G.

Corollary2.5: For any graph G $\psi'(G) \le \alpha'(G) \le \beta'(G) \le \Psi'(G)$

We observe that the property of being an edge enclavelss set is hereditary. Hence an edge enclavelss set T is maximal if and only if T is l – maximal.

Definition2.6: A set $T \subseteq E$ is called edge co-irredundant if E-T is edge irreundant ,that is every edge in E-T has edge private neighbour. The edge co-irredundance number cir'(G) and the upperedge co-irredundance number CIR'(G) are defined by

$cir'G) = \min\{|T|: T$ is an edge co-irredundant set in G}

$CIR'(G) = \max\{|T|: T$ is a minimal edge co-irredundant set in G}

The property of being egde co-irredundant is super hereditary.Hence an edge co-irredubdant set is minimal if and only if T is 1-minimal

Proposition 2.7: An edge enclaveless set T is a maximal enclaveless set if and only if T is edge enclaveless and V-T is edge irredundant.

Proof: Let T be a maximal enclavelessset.Then for any $e \in E-T, T \cup \{e\}$ contains an edge enclave e_1. Hence $N[e_1] \subseteq T \cup \{e\}$ Then $e \in E-T$ has a private neighbor with respect to *E-T*. Thus E – T is edge irredundant.

Conversely assume that T is edge enclaveless and E-T is edge irredundant. Then for any $e \in E-T$ there exists $e_1 \in N[e]$ suchthat $N[e_1] \cap (E-T) = \{e\}$ .Then $e_1 \in T$ and e_1 is an edge enclave of $T \cup \{e\}$ .Therefore T is a maximal edge enclaveless set.

Proposition 2.8: Every maximal edge enclaveless set T in a graph G is a minimal edge co-irredundant set G.

Proof: It follows from above proposition that $E - T$ is edge irredundant and T is edge Co-irredundant.

If T is not a minimal edge co-irredundant set, then these exists $e \in T$ suchthat $T - \{e\}$ is an edge co-irredundant set. Hence $(E-T) \cup \{e\}$ is an edge – irredundant of G. Let e_1 be a edge private neighbor of 'e' with respect to $(E-T) \cup \{e\}$ .Clearly $e_1 \in T$ and $N[e_1] \subseteq T$. Thus e_1 is an edge enclave in T which is a contadiction

Corollary2.9: For any graph G, We have

$$cir'(G) \le \psi'(G) \le \alpha'(G) \le \Lambda'(G) \le \Psi'(G) \le CIR'(G)$$

which is known as the Edge covering chain of a graph G

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ANOTHER DECOMPOSITION OF CONTINUITY

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***Abstract*- In this paper we introduce M-closed set, $\alpha Cglc^{**}$- set, M-continuity and $\alpha Cglc^{**}$-continuity. Using this new continuity we obtain another decomposition of continuity in topological spaces.**

***Keywords:* M-closed sets, M-continuous maps, $\alpha Cglc^{**}$- sets, $\alpha Cglc^{**}$-continuous maps.**

2000 Mathematics Subject Classification 54C10.

I. INTRODUCTION

The decomposition of continuity is one of the many problems in general topology. Tong [5] produces a new decomposition of continuity using A-set and A-continuity. Ganster and Reilly [1] established a decomposition of continuity using pre-continuous and LC-continuous. Hatir and Noiri [3] have obtained some more decompositions of continuity. To obtain our decomposition of Continuity, we first introduce the notion of M-closed set, $\alpha Cglc^{**}$- set, M-continuity and $\alpha Cglc^{**}$-continuity. We prove that a map is continuous if and only if it is both M-continuous and $\alpha Cglc^{**}$-continuous.

II. PRELIMINARIES

Throughout this paper (X,τ) and (Y,σ) represents topological spaces on which no separation axioms are assumed unless otherwise mentioned.

***Definition 2.1**:* A subset A of a space (X,τ) is called

1. α -closed [4] (resp. α^*-set [2]) if cl(int(cl(A))) $\subseteq$ A (resp. int(cl(int(A)))=int(A)
2. C-set [2] if A=U $\bigcap$ V, where U is open and V is an α^*-set in (X,τ).
3. αCg -closed [1] (resp. M*-closed [6]) if $\alpha cl(A) \subseteq$ U (resp. $\alpha cl(A) \subseteq$ U) whenever A$\subseteq$ U and U is a C-set (resp. an αCg -open set) in (X,τ).

The complement of an α -closed (resp. αCg -closed, M*-closed) set is said to be an α -open (resp. αCg -open, M*-open) set.

Definition 2.2: A map $f:(X,\tau)\to(Y,\sigma)$ is said to be α -continuous [2] (resp. αCg -continuous [1], M*-continuous [7]) if $f^{-1}(V)$ is α -closed (resp. αCg -closed, M*-closed) in (X,τ) for each closed set V in (Y,σ).

III. M-CLOSED SET

Definition 3.1: A subset A of a topological space (X,τ) is called an M-closed set if $cl(A)\subseteq U$ whenever $A\subseteq U$ and U is αCg -open in (X,τ).

We denote the class of all M-closed sets in (X,τ) by $MC(X,\tau)$. That is $MC(X,\tau)=\{A\subseteq X : \text{A is M-closed}\}$.

Example 3.1: Let $X=\{a,b,c\}$ and $\tau=\{X,\phi,\{a,b\}\}$. Then $MC(X,\tau)=\{\phi,\{c\},\{a,c\},\{b,c\}X\}$

Theorem 3.1 : Every closed set is M-closed but not conversely.

Proof: If A is any closed ser in (X,τ) and U is any αCg - open such that $A\subseteq U$.

Then $cl(A)\subseteq U$, since $cl(A)=A$.

Example 3.2: Let $X=\{a,b,c\}$ and $\tau=\{X,\phi,\{a,b\}\}$. Then the set $\{a,c\}$ is M-closed but not closed.

Theorem 3.2: Every M-closed set is g-closed but not conversely.

Proof: Let A be any M-closed set in (X,τ) and U be any open such that $A\subseteq U$. Since every open set is αCg - open and A is M-closed, we have $cl(A)\subseteq U$ and hence A is g-closed.

Example 3.3: Let $X=\{a,b,c\}$ and $\tau=\{X,\phi,\{a\}\}$. Then the set $\{a,b\}$ is g-closed but not M-closed.The class of M-closed sets lies between the class of closed sets and the class of g -closed sets.

Definition 3.2 : A map $f:(X,\tau)\to(Y,\sigma)$ is said to be M- continuous if $f^{-1}(F)$ is M-closed in (X,τ) for each closed set F in (Y,σ)

Example 3.4: Let $X=Y=\{a,b,c\}$, $\tau=\{\phi,\{a,b\},X\}$ and $\sigma=\{\phi,\{a\},X\}$. Then the identity map $f:(X,\tau)\to(Y,\sigma)$ is M-continuous.

Theorem 3.3:

(i) Every continuous map is M-continuous but not conversely.

(ii) Every M-continuous map is g-continuous but not conversely.

Proof:

(i) The proof follows from the fact that every closed set is M-closed.

(ii) The proof follows from the fact that every M-closed set is g-closed.

Example 3.5:

i) Let $X=Y=\{a,b,c\}$, $\tau=\{\phi,\{a,b\},X\}$ and $\sigma=\{\phi,\{a\},X\}$. Then the identity map $f:(X,\tau)\to(Y,\sigma)$ is M-continuous but not continuous.

ii) Let $X=Y=\{a,b,c\}$, $\tau=\{\phi,\{a\},X\}$ and $\sigma=\{\phi,\{a,b\},X\}$. Then the identity map $f:(X,\tau)\to(Y,\sigma)$ is g-continuous but not M-continuous.

II. DECOMPOSITION

Definition 4.1: A subset A of (X,τ) is called an $\alpha Cglc^{**}$-set if A=U $\bigcap$ F where U is αCg -open and F is closed in (X,τ).

Example 4.1: Let $X=\{a,b,c\}$ and $\tau=\{X,\phi,\{a\}\}$. Then the set $A=\{b\}$ is $\alpha Cglc^{**}$.

Proposition 4.1:

1. Every closed set is $\alpha Cglc^{**}$ but not conversely.
2. Every αCg -open set is $\alpha Cglc^{**}$ but not conversely.

Example 4.2: Let (X,τ) be the topological space of Example 4.1. Then the set $B=\{a,b\}$ is $\alpha Cglc^{**}$ but not closed in (X,τ) and the set $C=\{b,c\}$ is $\alpha Cglc^{**}$ but not αCg -open in (X,τ)

Remark 4.1: The following example shows that M-closed sets are independent of $\alpha Cglc^{**}$-sets.

Example 4.3: Let us consider $X=\{a,b,c\}$ and $\tau=\{X,\phi,\{a,b\}\}$. Here $A=\{a,b\}$ is $\alpha Cglc^{**}$ but not a M-closed set and $B=\{b,c\}$ is M-closed but not an $\alpha Cglc^{**}$-set.

Proposition 4.2: Let (X,τ) be a topological space. Then a subset A of (X,τ) is closed if and only if it is both M-closed and $\alpha Cglc^{**}$-set.

Proof : Necessity: Follows from the fact that every closed set is M-closed and $\alpha Cglc^{**}$-set.

Sufficiency: Assume that A is both M-closed and $\alpha Cglc^{**}$-set. Then $A=U\bigcap F$ where U is αCg open and F is closed. Therefore $A\subseteq U$ and $A\subseteq F$. Since $A\subseteq U$, U is αCg -open and A is M closed, we have $cl(A)\subseteq U$. Also $cl(A)\subseteq cl(F)=F$. Thus $cl(A)\subseteq U\bigcap F=A$ and so $A=cl(A)$ That is, A is closed in (X,τ).

Proposition 4.3: A subset S of (X,τ) is $\alpha Cglc^{**}$-set in (X,τ) if and only if $S=A\bigcap cl(S)$, where A is αCg-open in (X,τ).

Proof: Assume that S is $\alpha Cglc^{**}$ in (X,τ). Then S=A $\bigcap$ F, where A is α Cg-open and F is closed in (X,τ). This implies $S\subseteq A$ and $S\subseteq F$. But $S\subseteq cl(S)\subseteq F$. So, $S\subseteq A\bigcap cl(S)\subseteq A\bigcap F=S$. Therefore $S\subseteq A\bigcap cl(S)$. The converse is trivial.

Definition 4.2 : A map $f:(X,\tau)\to(Y,\sigma)$ is said to be $\alpha Cglc^{**}$-continuous if for each closed set F in (Y,σ), $f^{-1}(F)$ is an $\alpha Cglc^{**}$-set in (X,τ).

Example 4.4 : Let $X=Y=\{a,b,c\}$, $\tau=\{X,\phi,\{a\},\{a,b\}\}$ and $\sigma=\{Y,\phi,\{a,b\}\}$. Then the identity map $f:(X,\tau)\to(Y,\sigma)$ is $\alpha Cglc^{**}$-continuous.

Theorem 4.1: Every continuous map is $\alpha Cglc^{**}$-continuous but not conversely.

Proof: Follows from the fact that every closed set is $\alpha Cglc^{**}$.

Example 4.5: Let $X=Y=\{a,b,c\}$, $\tau=\{X,\phi,\{a,b\}\}$ and $\sigma=\{Y,\phi,\{c\}\}$. Then the identity map $f:(X,\tau)\to(Y,\sigma)$ is $\alpha Cglc^{**}$-continuous but not a continuous map.

Remark 4.1: The following examples show that M-continuity and $\alpha Cglc^{**}$-continuity are independent.

Example 4.6: Let $X=\{a,b,c\}$, $\tau=\{X,\phi,\{a,b\}\}$ and $\sigma=\{Y,\phi,\{a\}\}$. Then the identity map $f:(X,\tau)\to(Y,\sigma)$ is M-continuous but not $\alpha Cglc^{**}$-continuous.

Example 4.7: Let $X=\{a,b,c\}$, $\tau=\{X,\phi,\{a\},\{a,b\}\}$ $\sigma=\{Y,\phi,\{b,c\}\}$. Then the identity map $f:(X,\tau)\to(Y,\sigma)$ is $\alpha Cglc^{**}$-continuous but not M-continuous.

Now we have the following decomposition for continuity.

Theorem 4.2: A map $f:(X,\tau)\to(Y,\sigma)$ is continuous if and only if it is both M-continuous and $\alpha Cglc^{**}$-continuous.

Proof: Assume f is continuous. Then by Proposition 4.1 and by Proposition 4.3, f is both M-continuous and $\alpha Cglc^{**}$-continuous.

Conversely, assume that f is both M-continuous and $\alpha Cglc^{**}$-continuous. Let F be a closed subset of (Y,σ).

Then $f^{-1}(F)$ is both M-closed and $\alpha Cglc^{**}$-set and so $f^{-1}(F)$ is closed by Proposition 4.3.

Definition 4.3: A map $f:(X,\tau)\to(Y,\sigma)$ is said to be an $\alpha Cglc^{**}$-closed map if for each closed set F in (X,τ), $f(F)$ is an $\alpha Cglc^{**}$-set in (Y,σ).

Theorem 4.3: A map $f:(X,\tau)\to(Y,\sigma)$ is closed if and only if it is both M-closed and $\alpha Cglc^{**}$-closed.

Proof: Similar to Theorem 4.2.

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Computational Model for Fuzzy Shortest Path Problem

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***Abstract*- This work deals with fuzzy shortest path problem where the fuzzy co efficient involves only in the objective function. The procedure starts with the construction of the penalty function in such a way that the equilibrium point converges to the solution of the fuzzy shortest path problem. Use of fuzzy norm which was introduced and dealt in Effati is manipulated. The efficiency and importance of the method is shown with the compromise example.**

I. INTRODUCTION

In the field of optimization, the concept of fuzzy sets are related when bellman and zadeh [2] experimented in their work. Followed by them many other researchers showed their significant interest to develop the optimization in fuzzy sense. Especially Zimmerman [3] experimented the fuzzy approach for solving multi-objective linear programming problems. Fuzzy linear programming problem with fuzzy constraints based on inequality are illustrated by Tanaka and Asai [4]. Ganesan and Veeramani [5] introduced a novel approach for solving a linear optimization problems which has symmetric trapezoidal fuzzy numbers without converting them to the crisp linear programming problems. Also many authors (Ebrahimnejad et al., [6]; Kumar et al., [7]; Jayalakshmi and Pandian [8]; Pandian [9]) introduced various approaches to solve fuzzy mathematical programming problems.

Solving the linear programming problems using penalty functions and Lagrange multipliers with the knowledge of neural networks started in 1986 by Tank and Hopfield [10]. They used the LP circuit in their approach. By improving their model, kennedy and chua [11] introduced another method to solve linear programming problems where the convergence of solutions is guaranteed. This insist most of the researchers (Maa and Shanblat [12], Xia [13], Nguyen [14], Malek and Yari [15], Malek and Alipour [16], Cichocki et al., [17], Effati et al., [18]) to turn their interest in solving linear as well as non-linear optimization problems using neural networks. Effati et al., [1] proposed two fuzzy neural networks for solving two types of fuzzy LP problems which are fuzzy shortest path problem and fuzzy maximum flow problem. Selvaraj and Pandian [19] constructed a crisp neural network to solve fully fuzzy LP problems.

In this work, the new fuzzy energy function is constructed using fuzzy norm and lagrange mulitiper. Then, we construct a new fuzzy neural network for finding an approximate optimal solution of fuzzy shortest path problems. The convergence of the fuzzy neural network to the equilibrium point is shown and also, the relation between equilibrium point of the fuzzy energy function and an optimal solution of the fuzzy shortest path problem is derived. Applicability of the method is shown by the fuzzy shortest path problem.

II. PRELIMINARIES

We need the following definitions and theorems which can be found in Madan M Gupta et al., [20], Effati et al., [1] and Pandian [9].

Definition 2.1: Let X be a classical non-empty set and a set $A \subseteq X$. A fuzzy set $\tilde{A}$ with the membership function $\mu(x)$ is defined as

$$\tilde{A} = \{ (x, \mu(x)) : x \in X \}$$

where $\mu(x)$ is a function from X to $[0,1]$.

Definition 2.2: The α -cut of a fuzzy set $\tilde{A}$ where $\alpha \in [0,1]$. is defined as the set ${}^{\alpha}\tilde{A} = \{x : \mu_{\tilde{a}}(x) \geq \alpha, x \in X\}$. It is also denoted by the interval ${}^{\alpha}\tilde{A} = [A^l, A^r]$ where A^l and A^l are the lower and upper bounds of the closed interval.

Definition 2.3: A real fuzzy number $\tilde{a} = (a_1, a_2, a_3, a_4)$ is a fuzzy set from the real line *R* with the membership function $\mu_{\tilde{a}}(x)$ satisfying the following conditions**:**

(i) $\mu_{\tilde{a}}(x)$ is a continuous mapping from *R* to the closed interval $[0,1]$.

(ii) $\mu_{\tilde{a}}(x) = 1$ at $x \in [a_2, a_3]$.

(iii) $\mu_{\tilde{a}}(x) = 0$ for every $x \in (-\infty, a_1] \cup [a_4, \infty)$.

(iv) $\mu_{\tilde{a}}(x)$ is strictly decreasing and continuous on $[a_3, a_4]$ and

(v) $\mu_{\tilde{a}}(x)$ is strictly increasing and continuous on $[a_1, a_2]$.

Definition 2.4: Let $\tilde{a} = (a_1, a_2, a_3, a_4)$ and $\tilde{b} = (b_1, b_2, b_3, b_4)$ be two trapezoidal fuzzy numbers. Then,

(i) $\tilde{a}$ and $\tilde{b}$ are said to be equal if $a_i = b_i$, $i = 1,2,3,4$ and

(ii) $\tilde{a}$ is said to be less than or equal $\tilde{b}$ if $a_i \leq b_i$, $i = 1,2,3,4$.

(iii) $\tilde{a}$ is said to be positive if $a_1 \geq 0$.

Definition 2.5: The α -cut of a trapezoidal fuzzy number $\tilde{a} = (a_1, a_2, a_3, a_4)$ where $\alpha \in [0,1]$. is given as ${}^{\alpha}\tilde{a} = [a_1 + \alpha(a_2 - a_1), a_4 - \alpha(a_4 - a_3)]$.

Theorem 2.1: *(Lyapunov function method)* Let x^* be an equilibrium point for the system $\frac{dx(t)}{dt} = f(x(t))$. Let $V : R^n \to R$ be a continuously differentiable function such that

(i) $V(x^*) = 0$ and $V(x) > 0$, $\forall x \neq x^*$

(ii) $V(x) \to \infty$ *when* $\|x\| \to \infty$ and

(iii) $\frac{dV(x)}{dt} < 0$ *for all* $x \neq x^*$.

Then, $x = x^*$ is globally asymptotically stable.

Definition 2.6: Any scalar function $V(x)$ that satisfies all the requirements of the Theorem 2.1. is called a Lyapunov function for the equilibrium state $x = x^*$.

Definition 2.7: Let $\tilde{a} = (\tilde{a}_1, \tilde{a}_2, ..., \tilde{a}_n)$ be a fuzzy vector which consists of fuzzy numbers. Then the fuzzy norm of $\tilde{a}$, $\|\tilde{a}\|_f$ is defined as

$$\|\tilde{a}\|_f = \left(\|\tilde{a}\|_l, \|\tilde{a}\|_u\right) = \left(\|a^l\|, \|a^r\|\right)$$

where $\|\tilde{a}\|_l$ and $\|\tilde{a}\|_u$ are Euclidean norms of the lower and upper values of the fuzzy vector $\tilde{a}$, $a^l = \left(a_1^l, a_2^l, ..., a_n^l\right)$ and $a^r = \left(a_1^r, a_2^r, ..., a_n^r\right)$ respectively.

Theorem 2.2: Let $\tilde{f}$ be a fuzzy differentiable function of $x \in \Omega \subseteq R$. If x is a point of local minimum, then $\tilde{\nabla}\tilde{f}(x) \approx \tilde{0}$.

A. Fuzzy shortest path problem

Consider a directed graph $G = \left(S,\ N\right)$ with n arcs, m nodes, and an arc length $\tilde{c}_{ij}$ is a fuzzy quantity combined with each arc $(i, j) \in N$. Our main aim is to find the shortest path from the source node to sink node that is, a path of least length from a precise source node to another sink node. The mathematical model of the given FSP problem can be written as a fuzzy LP problem as,

(FP) Minimize $\tilde{z} = \sum_{i=1}^{m}\sum_{j=1}^{m} \tilde{c}_{ij} x_{ij}$

subject to

$$\sum_{j=1}^{m} x_{ij} - \sum_{k=1}^{m} x_{ki} = \begin{cases} 1 & i = 1 \\ 0 & i = 2, 3, .., m-1 \\ -1 & i = m \end{cases}$$

$$x_{ij} \geq 0 \quad \forall\ i, j$$

where, for all i and j, $x_{ij} \in R, \tilde{c}_{ij} \in F(R)$, a set of all fuzzy numbers whose membership functions are linear. Also we define node- arc incidence matrix as A, $\tilde{c} = \begin{pmatrix} c_{11} & c_{12} & \cdots & c_{ij} & \cdots & c_{mm} \end{pmatrix}$ as cost matrix and $b = \begin{pmatrix} 1 & 0 & \cdots & 0 & -1 \end{pmatrix}^T$.

II. Neural network model

In this section, for solving the fuzzy shortest path problem, A new neural network namely, fuzzy neural network based on fuzzy norm introduced by Effati et al. [1] is introduced. A new fuzzy energy function is defined using Lagrange multiplier as follows:

$$\tilde{E}(x,y) = \tilde{c}^T x + \frac{1}{2} y^T \left\| Ax - b \right\|_f^2 , \; x \geq 0 \tag{2.1}$$

For minimizing the fuzzy energy function stated in (1), the following governing differential equation is obtained in fuzzy environment using the conjugate gradient learning algorithm

$$\frac{\tilde{d}}{dt}\begin{pmatrix} x \\ y \end{pmatrix} = -\tilde{\nabla}\tilde{E}(x,y) \;\; , \quad x, y \in R \tag{2.2}$$

where, $\tilde{\nabla}\tilde{E}$ is the gradient of the energy function $\tilde{E}$ in fuzzy environment, the α -cut of $\tilde{E}$, ${}^{\alpha}\tilde{E} = [{}^{\alpha}\tilde{E}^l, {}^{\alpha}\tilde{E}^r]$

Now, $\tilde{\nabla}\tilde{E} = \left(\frac{\tilde{\partial}\tilde{E}}{\partial x_1}, \frac{\tilde{\partial}\tilde{E}}{\partial x_2}, ..., \frac{\tilde{\partial}\tilde{E}}{\partial x_n} \right)$

where, $\frac{\tilde{\partial}\tilde{E}}{\partial x_i} = \left[\frac{\partial \tilde{E}^l}{\partial x_i}, \frac{\partial \tilde{E}^r}{\partial x_i} \right]$.

From (2), the following dynamic system of fuzzy differential equations is obtained.

$$\frac{\tilde{d}}{dt}\begin{pmatrix} x \\ y \end{pmatrix} = -\begin{pmatrix} \tilde{c}^T + y^T A^T (Ax - b) \\ Ax - b \end{pmatrix} \tag{2.3}$$

For computing purpose, the above fuzzy network can be represented by the following dynamic system using the α -cuts. Since the decision variables are crisp it is enough to consider only lower values of the α -cuts.

$$\frac{d^l}{dt}\begin{pmatrix} x \\ y \end{pmatrix} = -\begin{pmatrix} (c^l)^T + y^T A^T (Ax - b) \\ Ax - b \end{pmatrix} \tag{2.4}$$

By solving the system (2.4) for each value of α in [0,1], we obtain a minima for the fuzzy energy function $\tilde{E}(x,y)$

Now, we prove the stability of the proposed fuzzy neural network (2.4) which is used to solve the problem (FP).

Theorem 3.1: The fuzzy energy function $\tilde{E}(x,y)$ is a Lyapunov function for the fuzzy neural network (2.4).

Proof: Now, for every $k > 0$ and (x,y), $\tilde{E}(x,y)$ is always a positive fuzzy number.

Now, $\frac{d^r}{dt}(\tilde{E}(x,y)) = ((c^l)^T + y^T A^T (Ax - b)) \frac{d^r x}{dt} + (Ax - b) \frac{d^r y}{dt}$

$$= -\left(\frac{d^r x}{dt} \right)^2 - \left(\frac{d^r y}{dt} \right)^2 \quad < 0.$$

Since $\frac{d^l}{dt}\tilde{E}(x,y) \leq \frac{d^r}{dt}\tilde{E}(x,y)$, it follows that,

$$\frac{\tilde{d}}{dt}\tilde{E}(x,y)=\left[\frac{d^l}{dt}\tilde{E}(x,y),\frac{d^r}{dt}\tilde{E}(x,y)\right]<0.$$

That is, $\frac{\tilde{d}}{dt}\tilde{E}(x,y)<0.$ This shows that the proposed fuzzy neural network (2.4) is globally asymptotically stable. Therefore, the function $\tilde{E}(x,y)$ is a Lyapunov function for the system (2.4).

Hence the theorem is proved.

Now, we shall establish a relation between the equilibrium point of the fuzzy neural network (2.4) or the minima for the fuzzy energy function $\tilde{E}(x,y)$ and the optimal solution of the fuzzy shortest path problem (FP).

Theorem 3.2: If the fuzzy shortest path problem (FP) has an optimal solution and (x^*,y^*) is the equilibrium point for the fuzzy neural networks (2.4) for any $k>0$, then x^* will be the optimal solution for the problem (FP).

Proof: Now, since x^* is the equilibrium point for the fuzzy neural networks (2.4) for any $k>0$, we have $\tilde{\nabla}\tilde{E}(x^*,y^*)\approx\tilde{0}$ and (x^*,y^*) is a feasible solution to the problem (FP).

From the energy function (2.1) and since $\tilde{x}^*$ is a feasible solution to the problem (FP), we have $\tilde{E}(x^*,y^*)\approx\tilde{c}^T x^*$.

Since $\tilde{E}(x^*,y^*)$ is minimum for the network (2.4), the problem (FP) attains its minimum at (x^*,y^*).

Hence, the theorem is proved.

Remark 2.1: From the above theorem, we can assure that the proposed fuzzy neural network (2.4) will converge to the optimum solution of the problem (FP) if it exists.

III. Numerical Example

Example 3.1: consider a FSP problem shown in Figure 1.

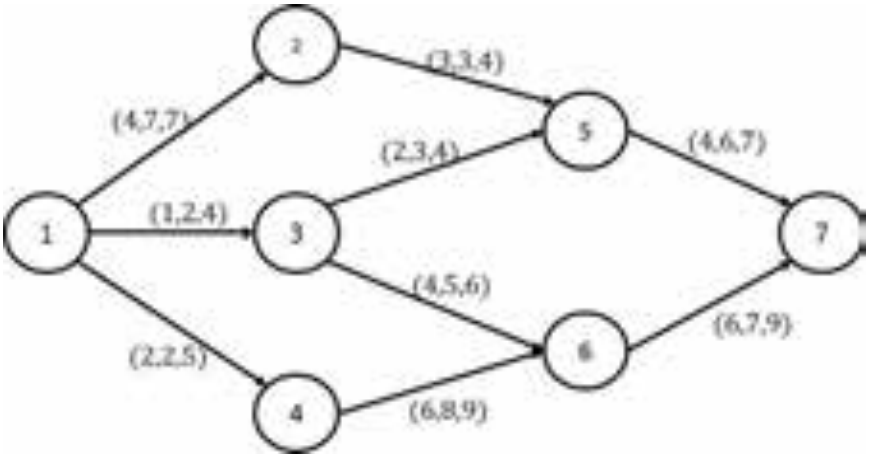

Figure 1. *Fuzzy shortest path problem.*

Now, Mathematical model of the fuzzy shortest path problem (Figure 3.1) is represented as a fuzzy LP model which is given below:

Minimize $\tilde{z} = (4,7,7)x_{12} + (1,2,4)x_{13} + (2,2,5)x_{14} + (3,3,4)x_{25} + (2,3,4)x_{35}$

$$+ (4,5,6)x_{36} + (6,8,9)x_{46} + (4,6,7)x_{57} + (6,7,9)x_{67}$$

subject to :

$$\sum_{j=1}^{7} x_{ij} - \sum_{k=1}^{7} x_{ki} = \begin{cases} 1 & i = 1 \\ 0 & i = 2,3,..,6 \\ -1 & i = 7 \end{cases}$$

$$x_{ij} \geq 0 \quad \text{for all} \, i, j$$

Following left values are obtained through our proposed network for each $\alpha \in [0,1]$. These values become our required solution to the given problem.

TABLE I
Solution for FSP problem at each alpha level

α	x_{12}^{l}	x_{13}^{l}	x_{14}^{l}	x_{25}^{l}	x_{35}^{l}	x_{36}^{l}	x_{46}^{l}	x_{57}^{l}	x_{67}^{l}
0	0	.9976	.0005	0	.9966	0	0	.9968	0
0.1	0	.9974	.0006	0	.9962	0	0	.9965	0
0.2	0	.9970	.0008	0	.9957	0	0	.9961	0
0.3	0	.9966	.0009	0	.9953	0	0	.9957	0
0.4	0	.9962	.0011	0	.9947	0	0	.9953	0
0.5	0	.9957	.0012	0	.9942	0	0	.9948	0
0.6	0	.9953	.0014	0	.9937	0	0	.9944	0
0.7	0	.9949	.0016	0	.9931	0	0	.9939	0
0.8	0	.9944	.0018	0	.9925	0	0	.9933	0
0.9	0	.9939	.0020	0	.9919	0	0	.9929	0
1	0	.9933	.0023	0	.9912	0	0	.9922	0

From Table, it can be concluded (by rounding off) that the solution to the given problem is $x_{12} = x_{14} = x_{25} = x_{36} = x_{46} = x_{67} = 0$ and $x_{13} = x_{35} = x_{57} = 1$, the required shortest path is $(1) \to (3) \to (5) \to (7)$ and required minimum distance is (7, 11, 15).

Now, the following figures Figure 2 and Figure 3 shows that the convergence of all decision variables in the network at $\alpha = 0$ and $\alpha = 1$ respectively.

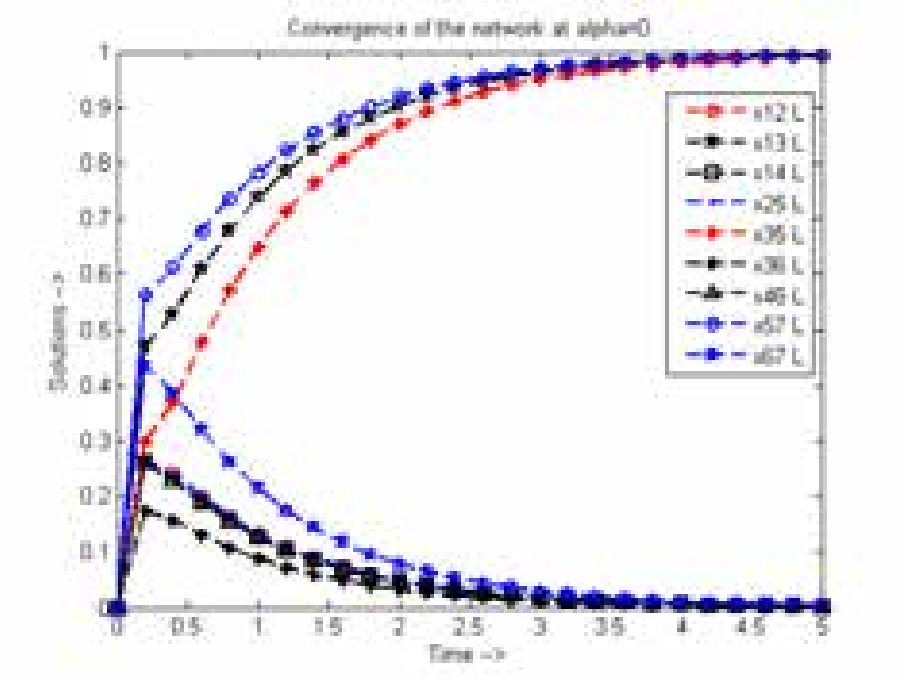

Figure 2. *Network behaviour for Eg.1 at alpha=0.*

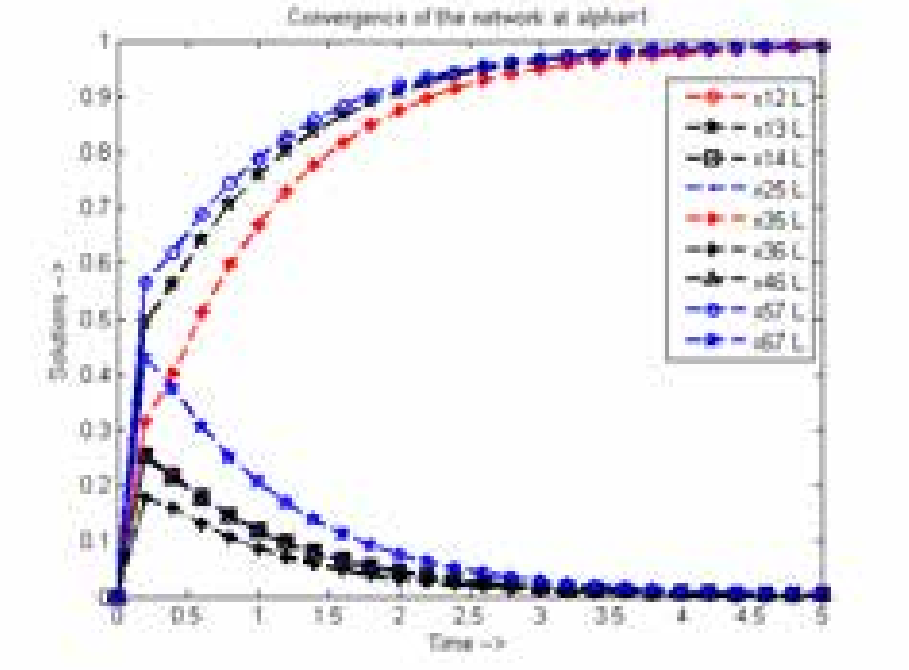

Figure 3. *Network behaviour for Eg.1 at alpha=1.*

Remark 3.1: The optimum solution got by the proposed fuzzy network (2.4) for the Example 3.1. is same as the optimum obtained in Effati et al. [1].

IV. Conclusion

In this paper, fuzzy shortest path problem where the fuzzy co efficient involves only in the objective function is solved using the lagrangian function method. Constructed a new fuzzy function using fuzzy norm which was introduced and dealt with Effati [1] . The stability of the proposed method is proved using lyapunov function method and the efficiency of the method is illustrated through a sample fuzzy shortest path problem.

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2.Antioxidant and DNA Interaction Studies Of Bioactive Cobalt Complex Using2-((4-Amino-6-Chloropyrimidin-2-Ylimino)Methyl)-4-Nitrophenol

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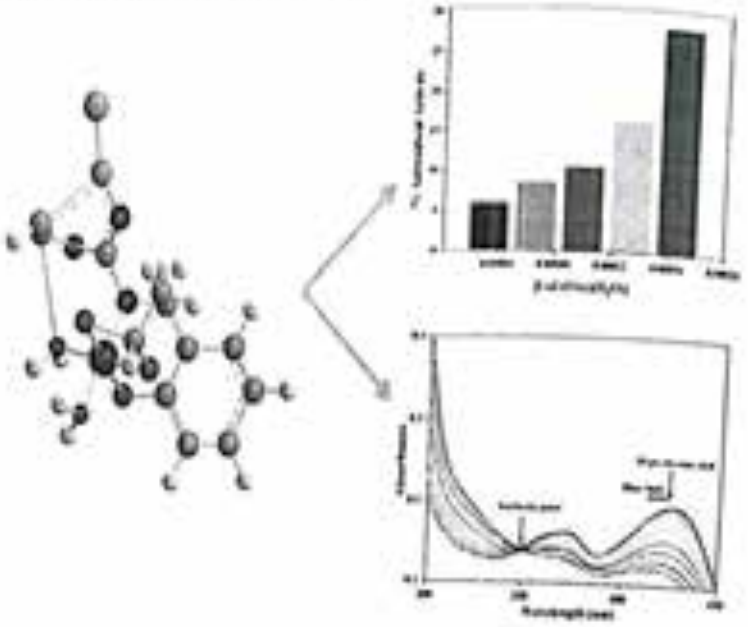
Bioactive Cobalt complex had been synthesized using pyrimidine derivative Schiff base 2 - (4-amino-6 - chloropyrimidin - 2 - ylimino) methyl)-4 -nitrophenol. Structural characterization of the Schiff base and Cobalt complex was assessed by various spectral techniques. The antibacterial activity was evaluated by disc diffusion method. Gel electrophoresis technique using Calf Thymus DNA was analyzed for the Schiff base and complex. Herring Sperm DNA was interacted with cobalt complex with K_b=1.69x10^5, 2.17x10^{5}M^{-1} in intercalative mode by absorption and also viscous in nature.High antioxidant activity of cobalt complex was confirmed by IC_{50}=0.14µM using DPPH radical.



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2-((Z)-(4-AMINO-6-CHLOROPYRIMIDIN-2-YLIMINO)METHYL)-4-
NITROPHENOL USING CT DNA AND DPPH RADICAL

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Cu(II) and Zn(II) complexes have been synthesized by pyrimidine derivati
Schiff base 2-((4-amino-6-chloropyrimidin-2-ylimino)methyl)-4-nitrophenol using 2,
diamino-4-chloropyrimidine and 5-nitrosalicylaldehyde. The octahedral structure of th
Cu(II) and Zn(II) complexes with 1:2 composition has been confirmed by UV-Visible,
FT-IR, ^{1}H-NMR, EI-Mass, EPR spectral techniques. Cu(II) and Zn(II) complexes act a
good antimicrobial agents than Schiff base. DNA cleavage study has been revealed by ge
electrophoresis technique. Cu(II) complex has the capacity to cleave the DNA. Th
interaction of Calf Thymus (CT) DNA with metal complexes has been carried out by
electronic absorption and viscometric methods. The CT DNA has been interacted wit
Cu(II) and Zn(II) complexes with binding constant $K_b = 6.72 \times 10^3 - 7.45 \times 10^5\ M^{-1}$ a
intercalative mode and also viscous in nature. Anticoxidant activity of the Schiff base an
metal complexes has been analyzed using DPPH assay. Cu(II) and Zn(II) complexes ha
increased the scavenging effect with $SC_{50} = 0.02 - 0.43\mu M$.