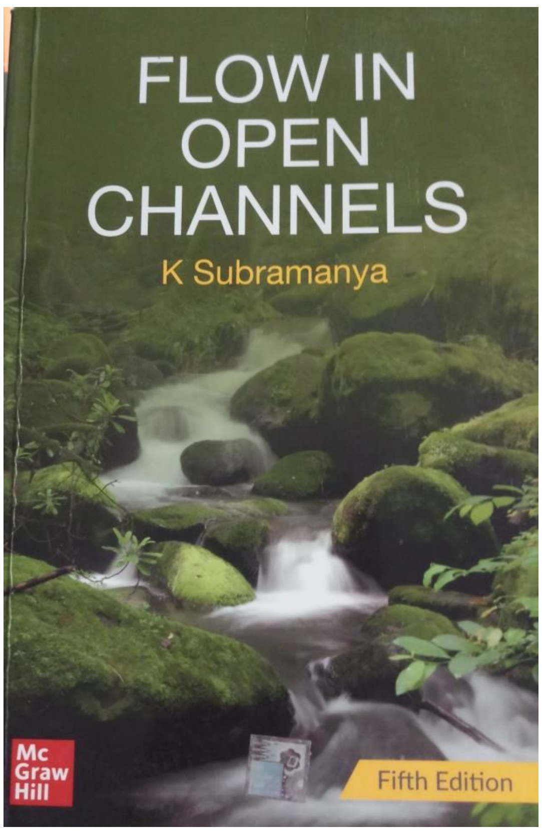
RAMCO INSTITUTE OF TECHNOLOGY
Department of Mathematics

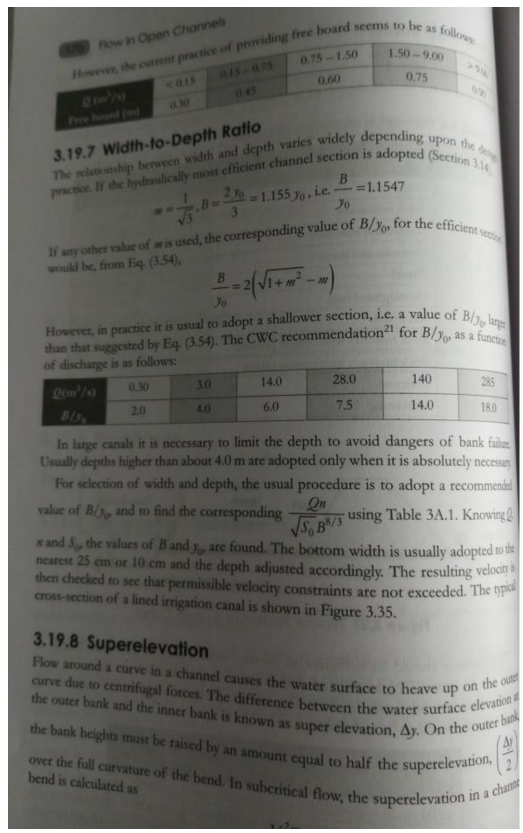
Academic Year: 2020 - 2021 (Even Semester)

<u>Assignment in Engineering Application</u>

Degree, Semester & Branch: IV Semester B.E. CIVIL
Course Code & Title: MA8491 Numerical Methods
Name of the Faculty member: Dr. T. Manimaran

Selected problems from their Engineering books and asked the students to solve using numerical techniques.




Flow in Open Channels

However, the current practice of providing free board seems to be as follows:

$Q\ (m^3/s)$	< 0.15	0.15 – 0.75	0.75 – 1.50	1.50 – 9.00	> 9.0
Free board (m)	0.30	0.45	0.60	0.75	0.90

3.19.7 Width-to-Depth Ratio

The relationship between width and depth varies widely depending upon the design practice. If the hydraulically most efficient channel section is adopted (Section 3.14),

$$m = \frac{1}{\sqrt{3}},\ B = \frac{2y_0}{3} = 1.155\,y_0,\ \text{i.e.}\ \frac{B}{y_0} = 1.1547$$

If any other value of m is used, the corresponding value of B/y_0, for the efficient section would be, from Eq. (3.54),

$$\frac{B}{y_0} = 2\left(\sqrt{1+m^2} - m\right)$$

However, in practice it is usual to adopt a shallower section, i.e. a value of B/y_0, larger than that suggested by Eq. (3.54). The CWC recommendation[21] for B/y_0, as a function of discharge is as follows:

$Q(m^3/s)$	0.30	3.0	14.0	28.0	140	285
B/y_0	2.0	4.0	6.0	7.5	14.0	18.0

In large canals it is necessary to limit the depth to avoid dangers of bank failure. Usually depths higher than about 4.0 m are adopted only when it is absolutely necessary.

For selection of width and depth, the usual procedure is to adopt a recommended value of B/y_0, and to find the corresponding $\frac{Qn}{\sqrt{S_0}B^{8/3}}$ using Table 3A.1. Knowing Q, n and S_0, the values of B and y_0, are found. The bottom width is usually adopted to the nearest 25 cm or 10 cm and the depth adjusted accordingly. The resulting velocity is then checked to see that permissible velocity constraints are not exceeded. The typical cross-section of a lined irrigation canal is shown in Figure 3.35.

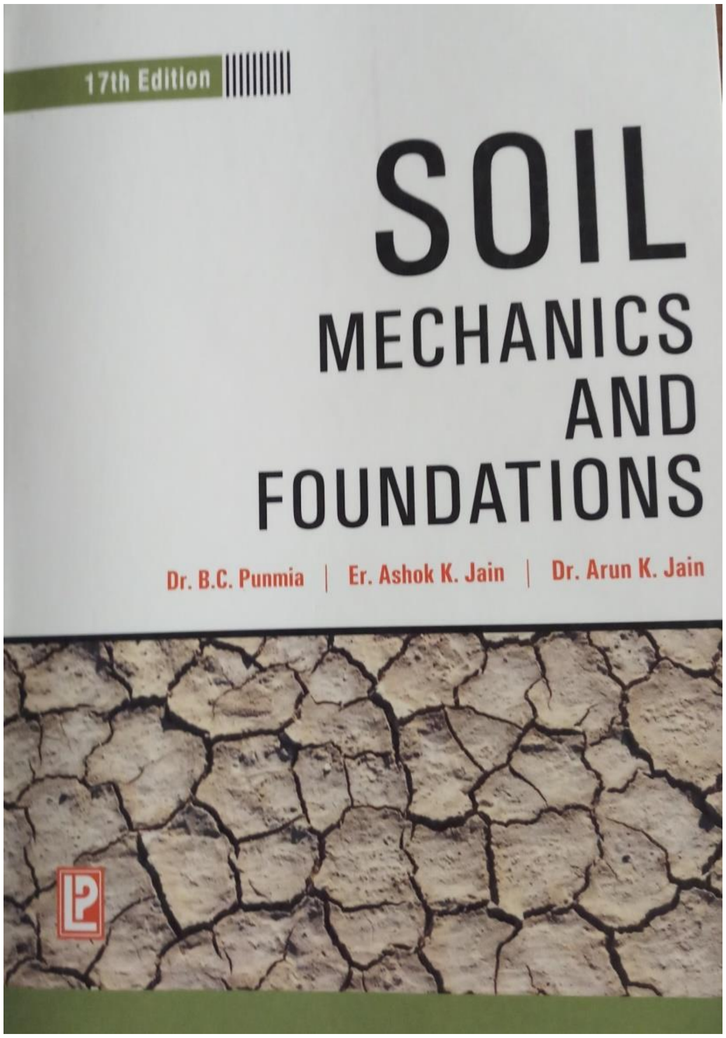
3.19.8 Superelevation

Flow around a curve in a channel causes the water surface to heave up on the outer curve due to centrifugal forces. The difference between the water surface elevation at the outer bank and the inner bank is known as super elevation, Δy. On the outer bank the bank heights must be raised by an amount equal to half the superelevation, $\left(\frac{\Delta y}{2}\right)$ over the full curvature of the bend. In subcritical flow, the superelevation in a channel bend is calculated as

Problem:

Find the value of y when x = 5 using Lagrange's interpolation formula from the following data. Also check the actual value.

x	0.3	3.0	14.0	28.0	140	285
y	2.0	4.0	6.0	7.5	14.0	18.0



The accuracy of the result will depend upon the size of the area unit chosen the length of the side of the small area unit is less than one-third of the depth at wh vertical pressure is required, the error involved in the result is within 3 percent

13.9. NEWMARK'S INFLUENCE CHART

A more accurate method of determining the vertical stress at any point under a unifo loaded area of *any shape* is with the help of *influence chart* or *influence diagram* originally suggested by Newmark (1942). A chart, consisting of number of circles and radiating lines, is so prepared that the influence of each *area unit* (formed in the shape of a sector between two concentric circles and two adjacent radial lines) is the same at the centre of the circles, *i.e.*, each area unit causes the equal vertical stress at the centre of the diagram.

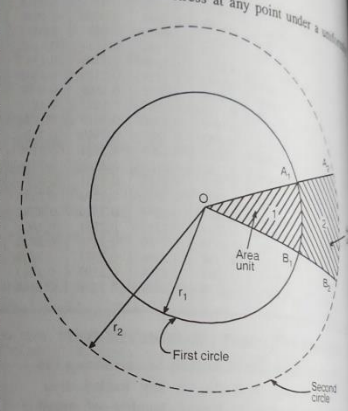


FIG. 13.14. PREPARATION OF INFLUENCE CHART

Let a uniformly loaded circular area of radius r_1 cm be divided into 20 sectors (area units) as shown in Fig. 13.14. If q is the intensity of loading, and σ_z is the vertical pressure at a depth z below the centre of the area, each unit such as $OA_1 B_1$ exerts a pressure equal to $\sigma_z/20$ at the centre.

Hence, from Eq. 13.15.
$$\frac{\sigma_z}{20} = \frac{q}{20}\left[1 - \left\{\frac{1}{1+\left(\frac{r_1}{z}\right)^2}\right\}^{3/2}\right] = i_f\, q \qquad ...(13.2$$

where
$$i_f = \text{influence value} = \frac{1}{20}\left[\left\{1 - \frac{1}{1+\left(\frac{r_1}{z}\right)^2}\right\}^{3/2}\right]$$

If i_f be made equal to an arbitrarily fixed value, say 0.005, we have
$$\frac{q}{20}\left[1 - \left\{\frac{1}{1+\left(\frac{r_1}{z}\right)^2}\right\}^{3/2}\right] = 0.005\, q \qquad ...(13.3$$

Selecting the value of $z=5$ cm (say), the value of r_1 solved from Eq. 13.30 co out be 1.35 cm. Hence if a circle is drawn with radius $r_1 = 1.35$ cm and divided in

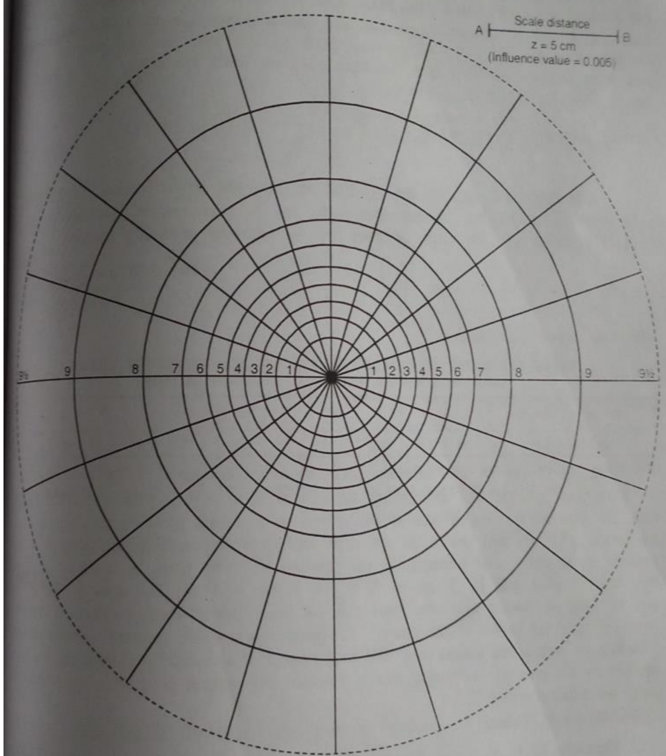


FIG. 13.15. NEWMARK'S INFLUENCE CHART

20 equal area units, each area unit will exert a pressure equal to 0.005 q intensity at a depth of 5 cm.

Let the radius of second concentric circle be equal to r_2 cm. By extending the twenty radial lines, the space between the two concentric circles is again divided into 20 equal area units ; $A_1 A_2 B_2 B_1$ is one such area unit. The vertical pressure, at the centre, due to each of these area units is to be of intensity 0.005 q. Therefore, the total pressure due to area units $O A_1 B_1$ and $A_1 A_2 B_2 B_1$ at depth $z = 5$ cm below the centre is $2 \times 0.005\, q$. Hence from Eq. 13.15 :

Vertical pressure due to $OA_2 B_2 = \frac{q}{20}\left[1 - \left\{\frac{1}{1+\left(\frac{r_2}{z}\right)^2}\right\}^{3/2}\right] = 2 \times 0.005\, q$

Substituting $z = 5$ cm, we get $r_2 = 2.00$ cm from the above relation. Similarly, the radii of 3rd, 4th 5th 6th 7th 8th, 9th circles can be calculated, as tabulated in Table 13.8. The radius of 10th circle is given by the following governing equation :

$$\frac{q}{20}\left[1 - \left\{\frac{1}{1+\left(\frac{r_{10}}{z}\right)^2}\right\}^{3/2}\right] = 10 \times 0.005\, q = \frac{q}{20}$$

From the above r_{10} = infinity.

TABLE 13.8 RADII OF CONCENTRIC CIRCLES FOR INFLUENCE CHART
(z=5 cm; i_f = 0.005; each circle divided into 20 parts)

Number of circles	1	2	3	4	5	6	7	8	9	$9\frac{1}{2}$	10
Radius (cm)	1.35	2.00	2.59	3.18	3.83	4.59	5.54	6.94	9.54	12.62	∞

Fig. 13.15. shows the influence chart drawn on the basis of Table 13.8.

To use the chart for determining the vertical stress at any point under the loaded area, the plan of the loaded area is first drawn on a tracing paper to such a scale that the length AB (=5 cm) drawn on the chart represents the depth to the point at which pressure is required. For example, if the pressure is to be found at a depth of 5 m, the scale of plan will be 5 cm = 5 m, or 1 cm = 1 m. The plan of the loaded area is then so placed over the chart that the point below which pressure is required coincides with the centre of the chart . The point below which pressure is required may lie within or outside the loaded area. The total number of area units (including the fractions) covered by the plan of the loaded area is counted. The vertical pressure is then calculated from the relation :

$\sigma_A = 0.005\, q \times N_A$ (where N_A = number of area units under the loaded area). ...(13.31)

Example 13.3. *A rectangular area 2 m × 4 m carries a uniform load of 80 kN/m² at the ground surface. Find the vertical pressures at 5 m below the centre and corner of the loaded area.*

Solution. (*a*) For the point under the centre of the area, there will be influence of four rectangles of size 1 m × 2 m, having a common corner at the centre of the loaded rectangle.

Problem:

Using Newton's interpolation formula find the values of y(1.5) and y(7.5) from the following table. Also check the actual values.

x	1	2	3	4	5	6	7	8
y	1.35	2.00	2.59	3.18	3.83	4.59	5.54	6.94