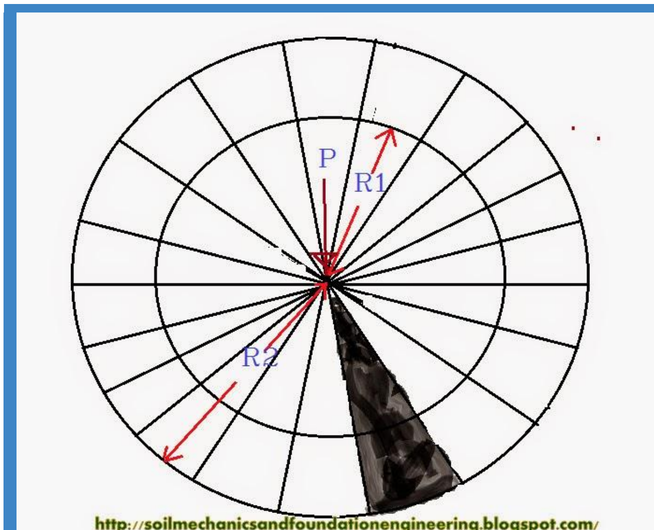
Newmark's chart

One can find out the stresses for the rectangular, circular or strip loading using the boussinesq's equation, but Newmark's influence charts were prepared to calculate the stress below an irregular shaped uniformly loaded areas. In such cases, these charts are extremely useful.

Newmark's charts are based on the vertical stress at a point P below the center of a circular uniformly loaded area.



Concentric circles for R1 and R2 (Newmark's Chart)

Consider a circle of radius R1, divided into 20 equal sectors. The vertical stress at a point below the center of the circle at depth z due to a uniform load on one sector will be equal to 1/20th of that due to the load on the entire circle.

$$\sigma_z = \frac{1}{20} q \left[1 - \left\{ \frac{1}{1 + [R_1/z]^2} \right\} \right]$$

Stress at a depth of z due to load on one sector of a 20 sectored circle

If in above equation, stress is given as arbitrary value, say 0.005.q, we can solve the equation to get,

$R1/z = 0.270$

Thus every twentieth sector of the circle, with radius R1 equal to 0.270.z would produce a stress of 0.005.q at a depth z from its center.

Now consider the second concentric circle with radius R2, in this circle, suppose the area of the strip excluding the area under the strip of radius R1, produces a stress at point P, equal to 0.005.q, then the total stress at P would be equal to 2*0.005.q.

Putting these values in above equation, R2/z = 0.40, In other words, the radius of the second circle, should be equal to 0.40.q.

Similarly, the values of the Radii of 3rd to 9th circle can be determined. The values are 0.60.z, 0.77.z, 0.92.z, 1.11.z, 1.39.z and 1.91.z. The radii of 9.5th circle is 2.54.z.

The radii for the 10th circle when calculated comes to infinity.

Therefore the 10th circle can not be drawn.

Remember each enclosed area in between the different circles and the sector lines has an influence of 0.005.q. There are 20 sectors and 9 circles, and thus the Newmark's influence chart is ready.

Stress Isobar or pressure bulb

An 'isobar' is a stress contour or a curve which connects all points below the ground surface at which the vertical pressure is the same. An isobar is a spatial curved surface and resembles a bulb in shape. The stress isobar is also called 'pressure bulb'.

Any number of pressure bulb may be drawn for any applied load, since each one corresponds to an arbitrarily chosen value of stress. The isobar of a particular intensity can be obtained by:

$$\sigma_z = \frac{I_B\, Q}{Z^2}$$

An isobar consisting of a system of isobars appears somewhat as shown in Fig.3.3.

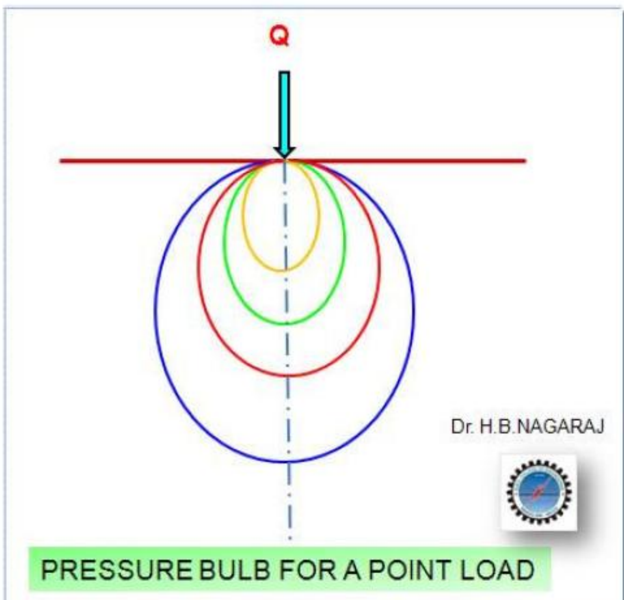


Fig. 3.3 Pressure bulb for a point load

3.6.1 Procedure

The procedure for plotting an isobar is as follows:

Let it be required to plot an isobar for which $\sigma_z = 0.1Q$ per unit area (10 % isobar)

We know that

$$\sigma_z = \frac{I_B\, Q}{Z^2}$$

$$0.1Q = \frac{I_B\,Q}{Z^2}$$

$$I_B = 0.1Z^2$$

Assuming various values of z, the corresponding I_B values are computed. For the values of I_B, the corresponding r/z values are determined and hence the values of r are obtained.

An isobar is symmetrical about the load axis, the other half can be drawn from symmetry.

When r = 0, I_B = 0.4775; the isobar crosses the line of action of the load at a depth of

$$Z=\sqrt{\frac{I_B}{0.1}} = \sqrt{\frac{0.4775}{0.1}} = \sqrt{4.775} = 2.185 \text{ units}$$

The shape of an isobar approaches a lemniscates curve (not circle) as shown in Fig.3.3

The calculations are best performed in the form of a table as given below:

When r = 0, $I_B = \frac{3}{2\pi}\left(\frac{1}{(1+(\frac{r}{z})^2)^{\frac{5}{2}}}\right)$

$$= \frac{3}{2\pi}$$

$$= 0.4775$$

Table 3.1 Data for isobar of σ_z = 0.1Q per unit area

Depth Z (units)	Influence coefficient I_B	r/Z	r (units)	σ_z
0.5	0.0250	1.501	0.750	0.1Q
1.0	0.1000	0.932	0.932	0.1Q
1.5	0.2550	0.593	0.890	0.1Q
2.0	0.4000	0.271	0.542	0.1Q
2.185	0.4775	0	0	0.1Q