

GEOMETRIC STRESS CONCENTRATIONS

TWO EQUAL UNREINFORCED CIRCULAR HOLES IN INFINITE FLAT PLATES

1. NOTATION

p	distance between hole centres	m	in
f_1, f_2	principal stresses in plane of plate, remote from holes, f_1 being numerically greater than or equal to f_2	N/m ²	lbf/in ²
f_m	maximum or minimum direct stress at boundary of each hole	N/m ²	lbf/in ²
r	radius of each hole	m	in
θ	acute angle between line connecting hole centres and direction of f_1	degree	degree
Convention:	Tensile stresses are positive. Compressive stresses are negative.		

Both SI and British units are quoted but any coherent system of units may be used.

2. NOTES

Figures 1 to 7 show the two values of f_m/f_1 plotted against r/p for various values of f_2/f_1 ; each figure relates to a different value of θ .

In the vicinity of the two holes the two values of f_m are extreme stresses acting in the plate.

The curves apply strictly to infinite plates where f_1 and f_2 are uniform in a region remote from the holes. However, for finite plates insignificant error will result provided that no plate boundary is closer than $4r$ to the centre of either hole, the stresses f_1 and f_2 being based upon the gross cross sections. A discontinuity in the slope of a curve indicates an abrupt change in the position of f_m . Such discontinuities occur in Figures 1 and 7 only.

Further data on stress concentration may be located by reference to the Engineering Sciences Data Index.

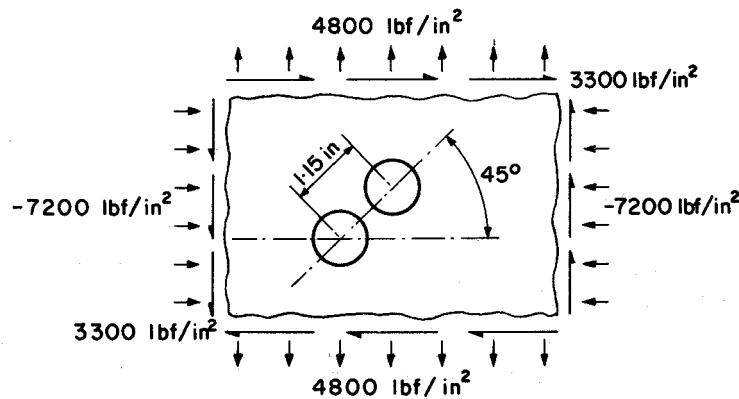
3. DERIVATION

- HADDON, R.A. Stresses in an infinite plate with two unequal circular holes. *Q. Jl Mech. appl. Math.*, Vol. 20, No. 3, pp 277-291, August 1967.

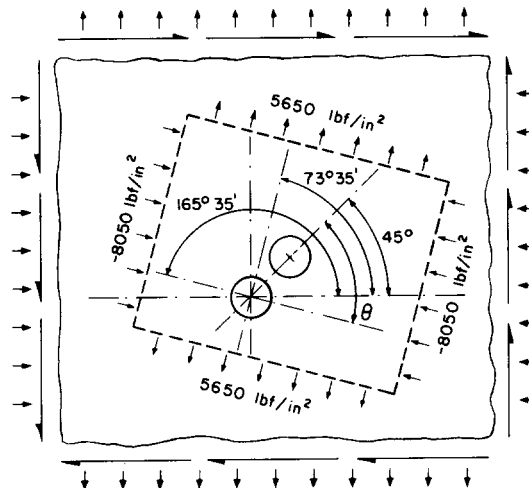
Issued June 1967

4. EXAMPLE

The figure below illustrates a portion of a loaded plate that contains two 1.0 in diameter holes. It is required to find the maximum and minimum stresses in the vicinity of the holes.



Resolution of the applied stresses gives the principal stresses shown in the following diagram.



Thus, $f_1 = -8050 \text{ lbf/in}^2$, $f_2 = 5650 \text{ lbf/in}^2$

and $\theta = 180^\circ - 165^\circ 35' + 45^\circ = 59^\circ 25'$.

Now $\frac{r}{p} = \frac{0.5}{1.15} = 0.435$ and $\frac{f_2}{f_1} = \frac{5650}{-8050} = -0.702$,

so from Figure 5, interpolating for f_2/f_1 , it is found that

$$\frac{f_m}{f_1} = 6.9 \quad \text{and} \quad -3.7.$$

Therefore, $f_m = -8050 \times 6.9 = -55\,500 \text{ lbf/in}^2$

and $f_m = (-8050) \times (-3.7) = 29\,800 \text{ lbf/in}^2$.

The extreme stresses at each hole boundary are therefore 55 500 lbf/in² (compression) and 29 800 lbf/in² (tension).

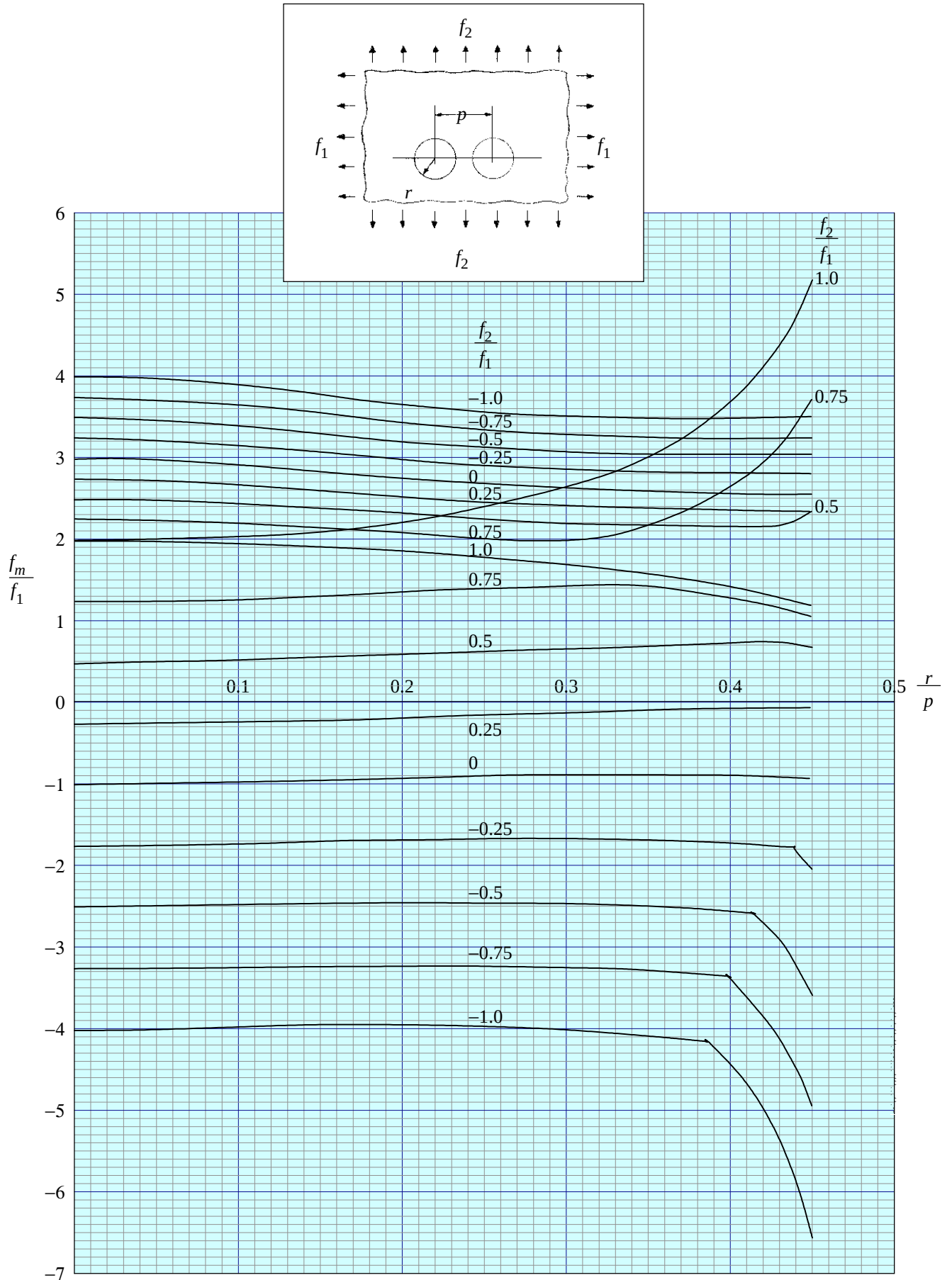


FIGURE 1 $\theta = 0^\circ$

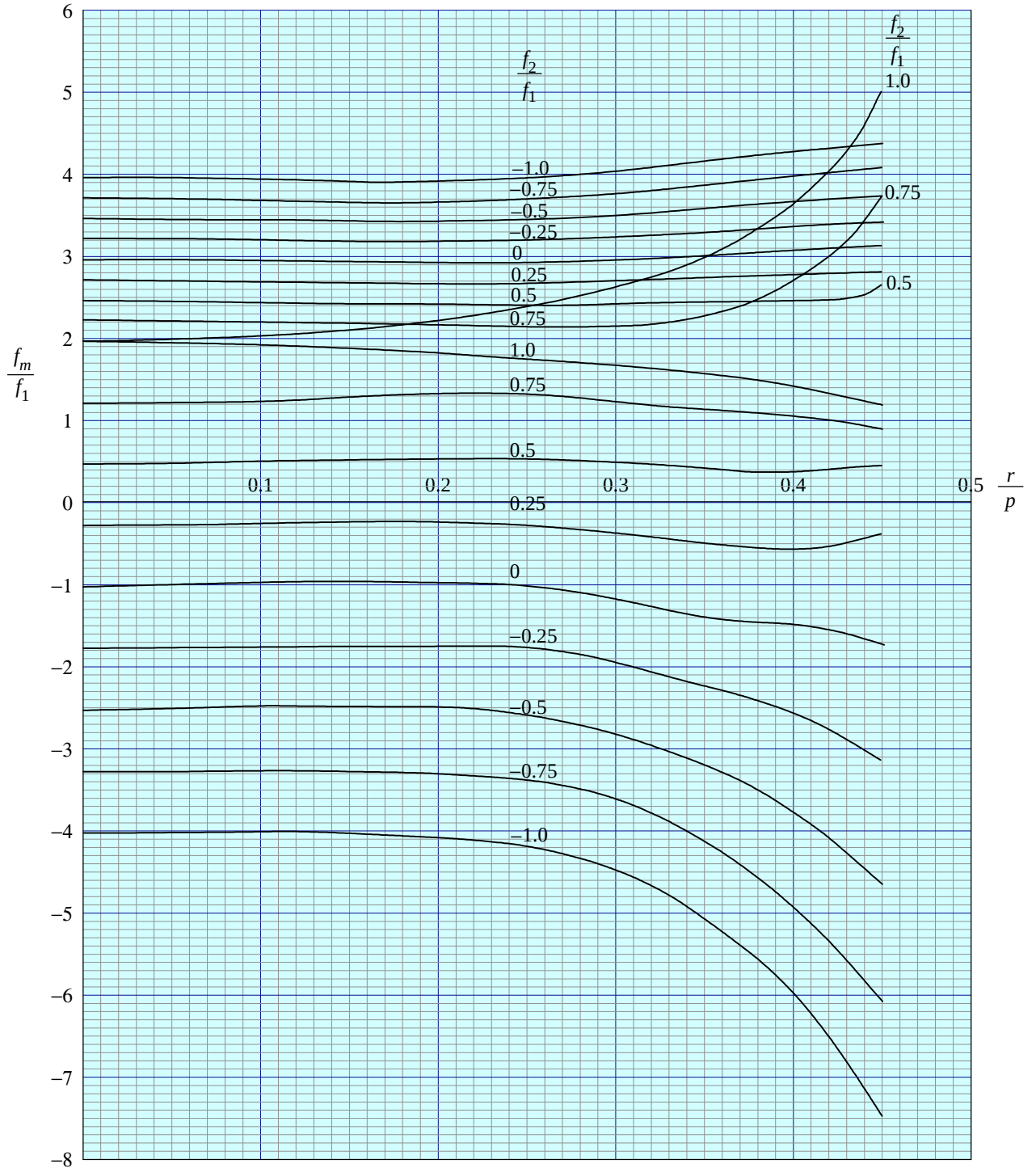
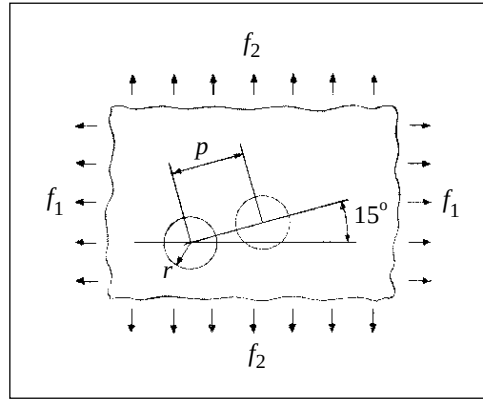


FIGURE 2 $\theta = 15^\circ$