PENETRATION OF A CONCAVE DIE INTO A PLASTIC MEDIUM

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In [1] Kuznetsov discusses the problem of the frictionless penetration of a concave die into a medium (Fig. 1) bounded by an arbitrary smooth convex curve AB, symmetrical about the y axis, and two straight lines AC and BD tangent to AB at the points A, B. Kuznetsov assumes that the least value of the limiting load is given by the solution corresponding to unilateral expulsion of material (Fig. 1). He did not observe that in this case to the asymmetric field there corresponds an asymmetrically applied load. The stresses and forces are given by the following relations:

$$\sigma_n = -2k\,(1 + {}^1/_2\pi - \psi_A + \psi)\,, \tag{1}$$

$$P_y = \int_{-\psi_A}^{\psi_A} \sigma_n \cos\psi r\,(\psi)\,d\psi = -4kx\,(1 + {}^1/_2\pi - \psi_A) - \int_{-\psi_A}^{\psi_A} \psi \cos\psi r\,(\psi)\,d\psi\,, \tag{2}$$

$$P_x = \int_{-\psi_A}^{\psi_A} \sigma_n \sin\psi r\,(\psi)\,d\psi = -4ky\,(1 + {}^1/_2\pi - \psi_A) - \int_{-\psi_A}^{\psi_A} \psi \sin\psi r\,(\psi)\,d\psi\,, \tag{3}$$

$$P_1 = -\sqrt{P_x^2 + P_y^2}\,. \tag{4}$$

The problem is solved more simply by constructing the field shown in Fig. 2. The load

$$P_2 = -4kx\,(1 + {}^1/_2\pi - \psi_A) \tag{5}$$

Comparing (2), (4), and (5), one easily sees that $P_1 > P_y = P_2$ always.

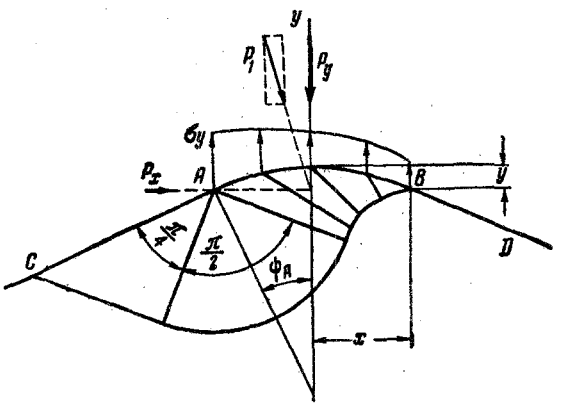

Fig. 1

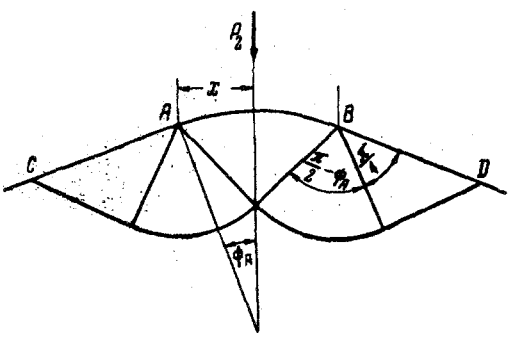

Fig. 2

REFERENCES

1. A. I. Kuznetsov, "Notes on the theory of penetration of a die into a plastic medium," PMTF, No. 1, 1962.

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