Extrusion of square billet through cosine die.

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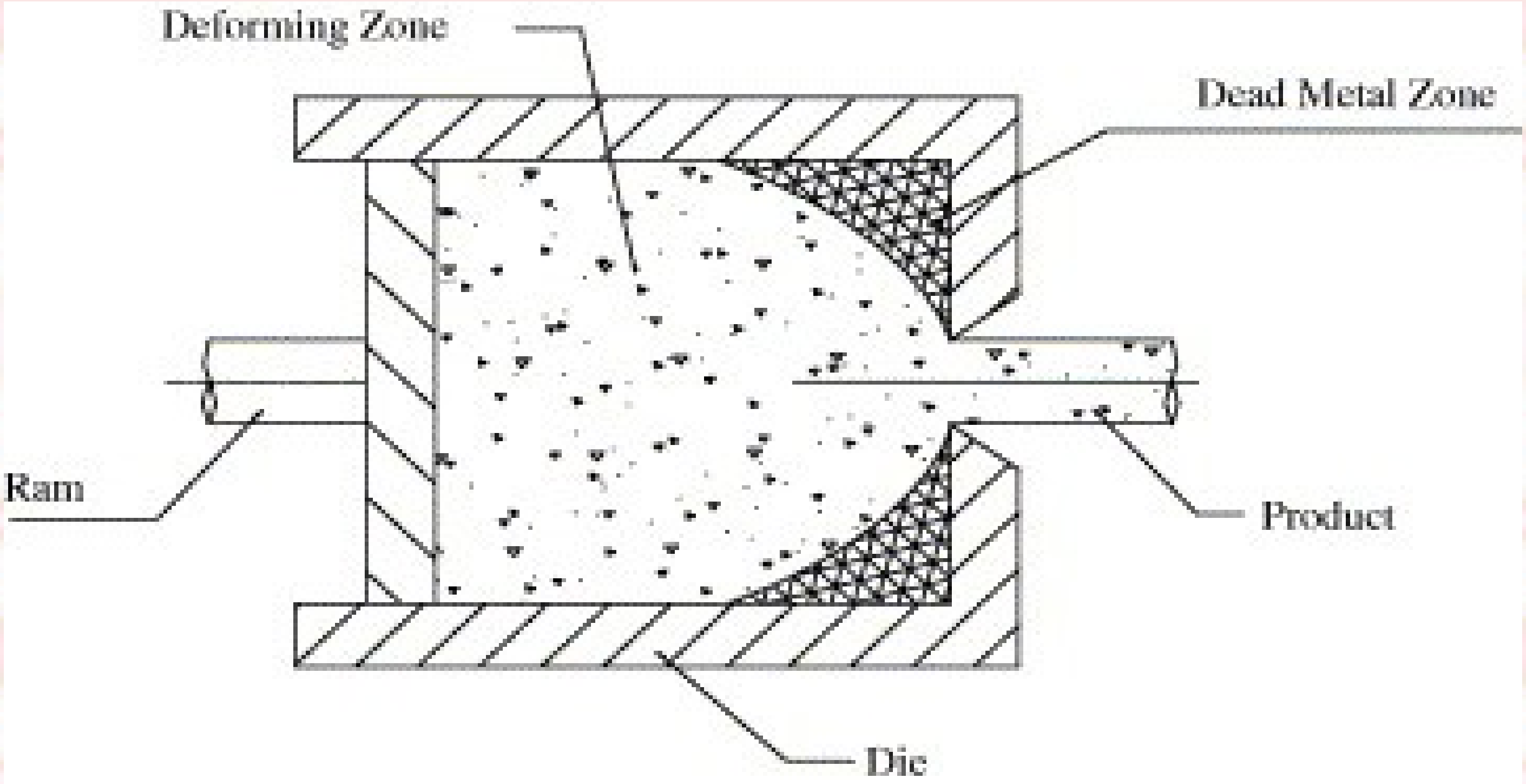
Table of contents:-

Introduction

- extrusion:-a process by which a block of metal is reduced in cross section by forcing it through a die orifice under high pressure.
- Factors affecting extrusion process are die profile , friction factor, extrusion pressure & temperature.
- Dead metal zone, redundant work .
- Its dependence on die profile .it also optimizes the extrusion pressure.

Introduction



Methods for analysis of extrusion process

- Upper bound method
- Lower bound method
- Slip line field method

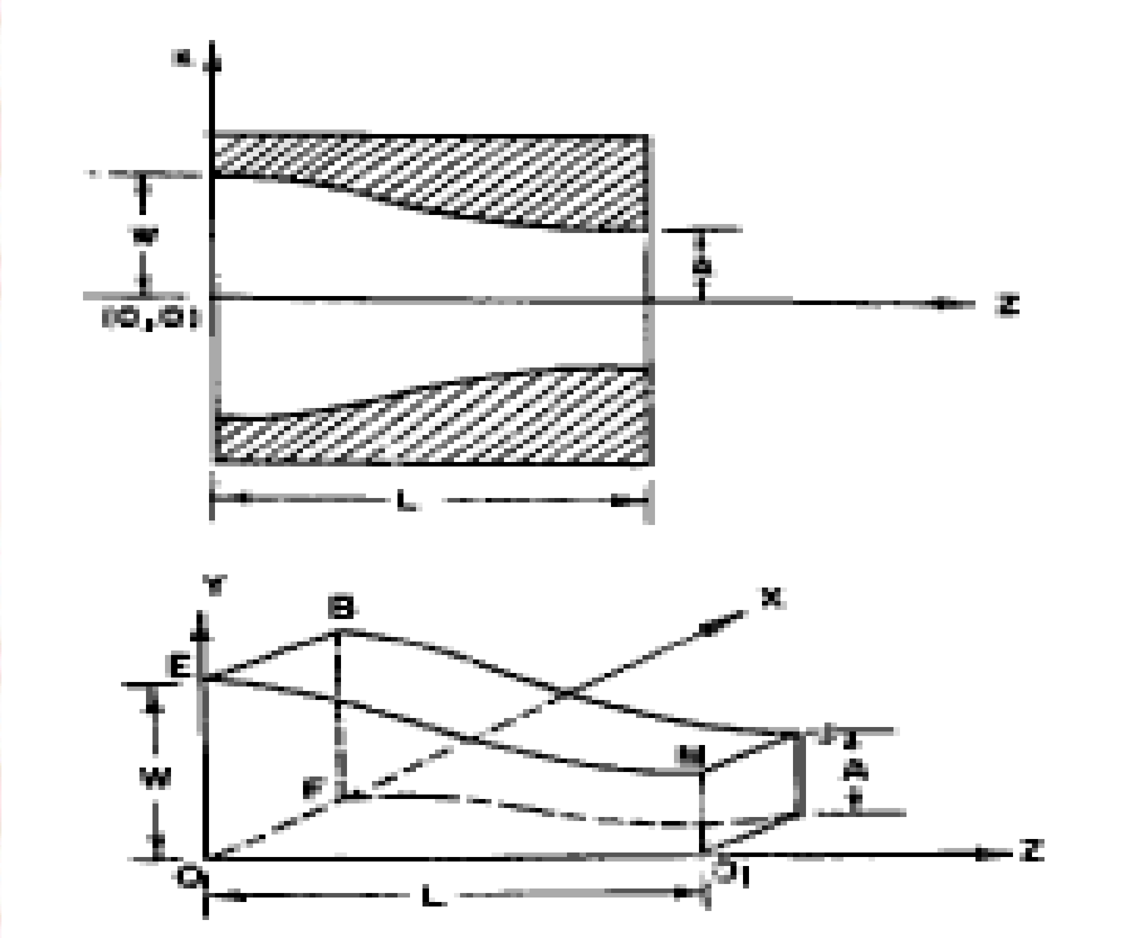
Upper bound method:- *It states that among all kinematically admissible velocity fields the actual one minimizes the expression*

$$J = (2\sigma_0/\sqrt{3})\int \sqrt{(\dot{\varepsilon}_{ij}\dot{\varepsilon}_{ij})}\,\mathrm{d}V + (\sigma_0/\sqrt{3})\int |\Delta V|_s\,\mathrm{d}S + (m\sigma_0/\sqrt{3})\int |\Delta V|_{sf}\,\mathrm{d}S_f$$

Dual Stream functions:-

- It represents class of surface in 3D called stream surfaces.
- It should be continuous & satisfying the b.c. On velocity.
- It should also satisfy the incomprehensibil-ity conditions.
- It is used to determine the velocity com-ponents.
- Its function of die profile function.

Profile of die in 2D & 3D



Stream function & velocity com-ponents:-

$$\varphi_1 = x/F(z)$$

$$\varphi_2 = W^2 V_b y/F(z)$$

$$V_x = (\partial\varphi_2/\partial y)(\partial\varphi_1/\partial z) - (\partial\varphi_1/\partial y)(\partial\varphi_2/\partial z)$$

$$V_y = (\partial\varphi_2/\partial z)(\partial\varphi_1/\partial x) - (\partial\varphi_1/\partial z)(\partial\varphi_2/\partial x)$$

$$V_z = (\partial\varphi_2/\partial x)(\partial\varphi_1/\partial y) - (\partial\varphi_1/\partial x)(\partial\varphi_2/\partial y)$$

Velocity & strain components:-

$V_x = W^2 V_b x F'/F^3$

$V_y = W^2 V_b y F'/F^3$

$V_z = W^2 V_b/F^2$

where $F = F(z)$ and $F' = dF/dz$.

$\varepsilon_{xx} = (W^2 V_b F')/F^3$

$\varepsilon_{yy} = (W^2 V_b F')/F^3$

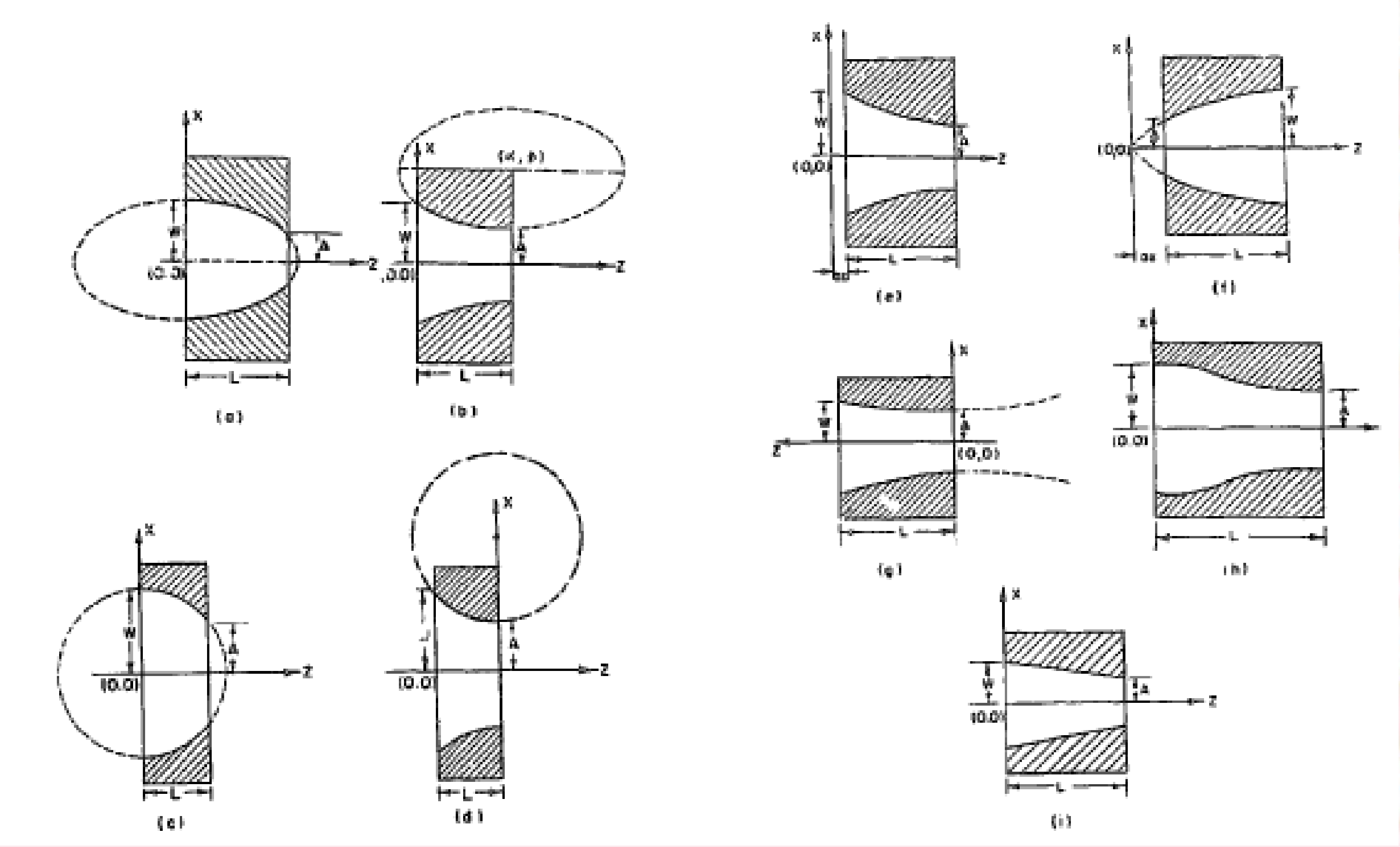
$\varepsilon_{zz} = (-2W^2 V_b F')/F^3$

$\varepsilon_{xy} = \varepsilon_{yx} = 0$

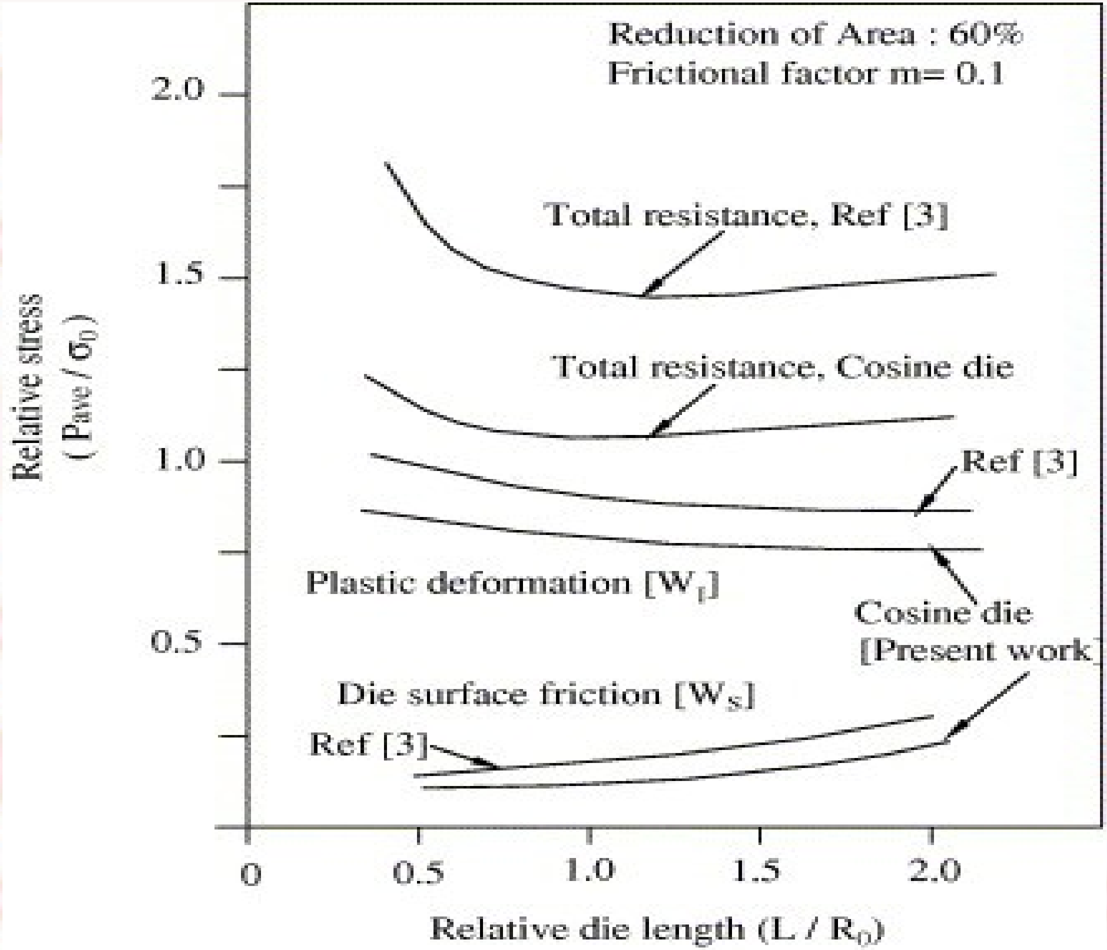
$\varepsilon_{yz} = \varepsilon_{zy} = (1/2) W^2 V_b y[(F''/F^3) - (3(F')^2/F^4)]$

$\varepsilon_{zx} = \varepsilon_{xz} = (1/2)\ W^2 V_b x[(F''/F^3) - (3(F')^2/F^4)]$

Various die profile shapes:-

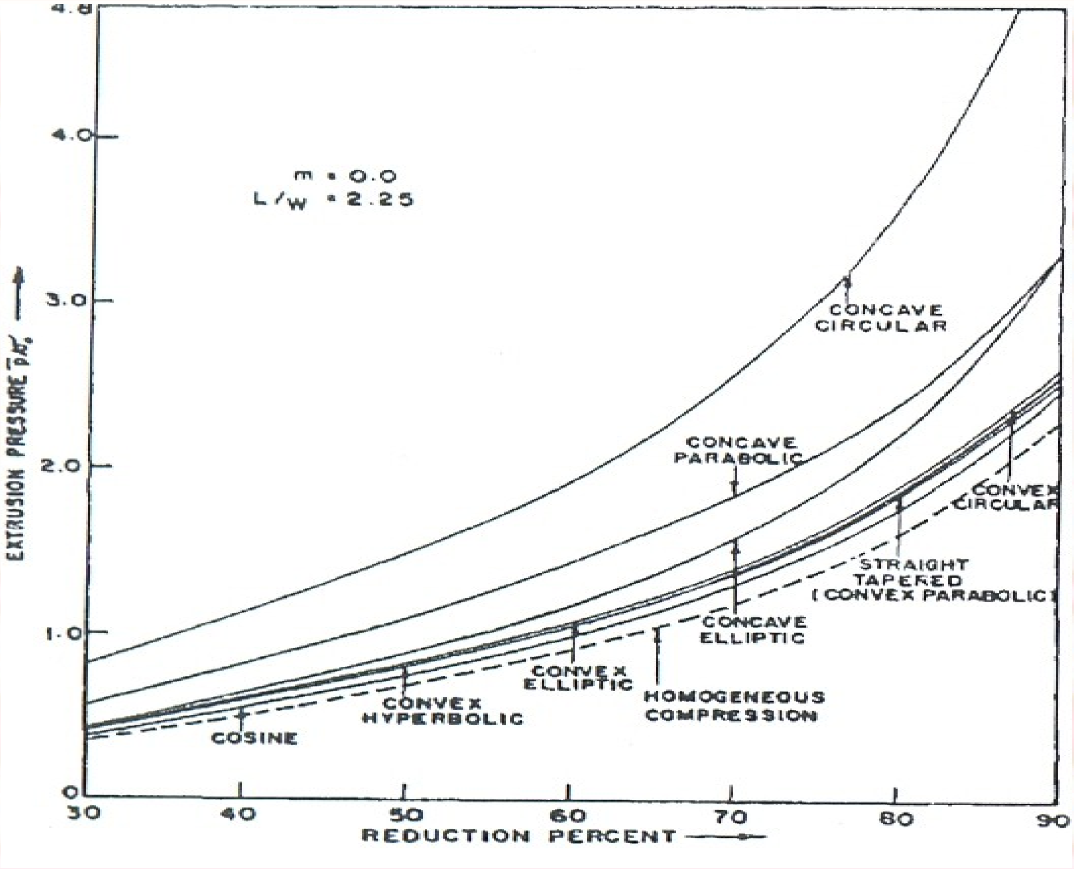


Result & discussion



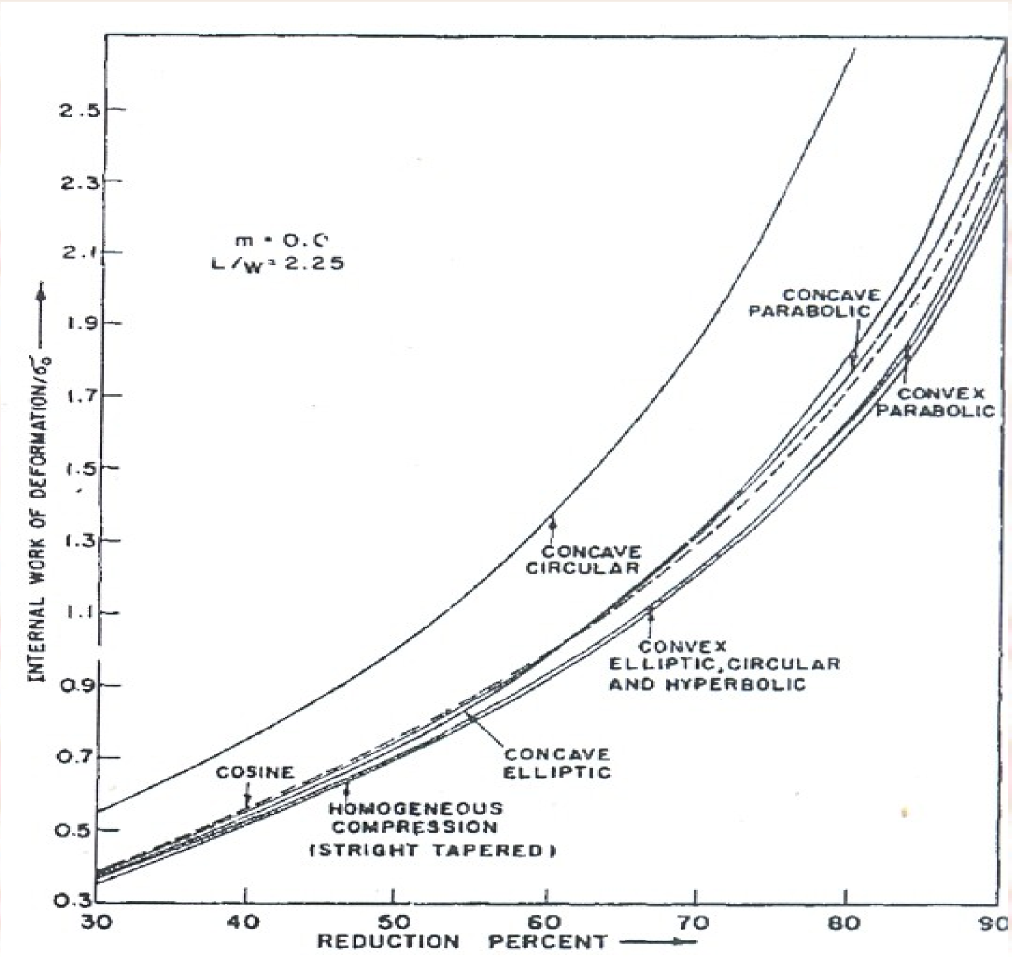
- The power consumed due to plastic deformation ,die surface & total power consumption are compared for the cosine with straightly conversing die.

Result & discussion



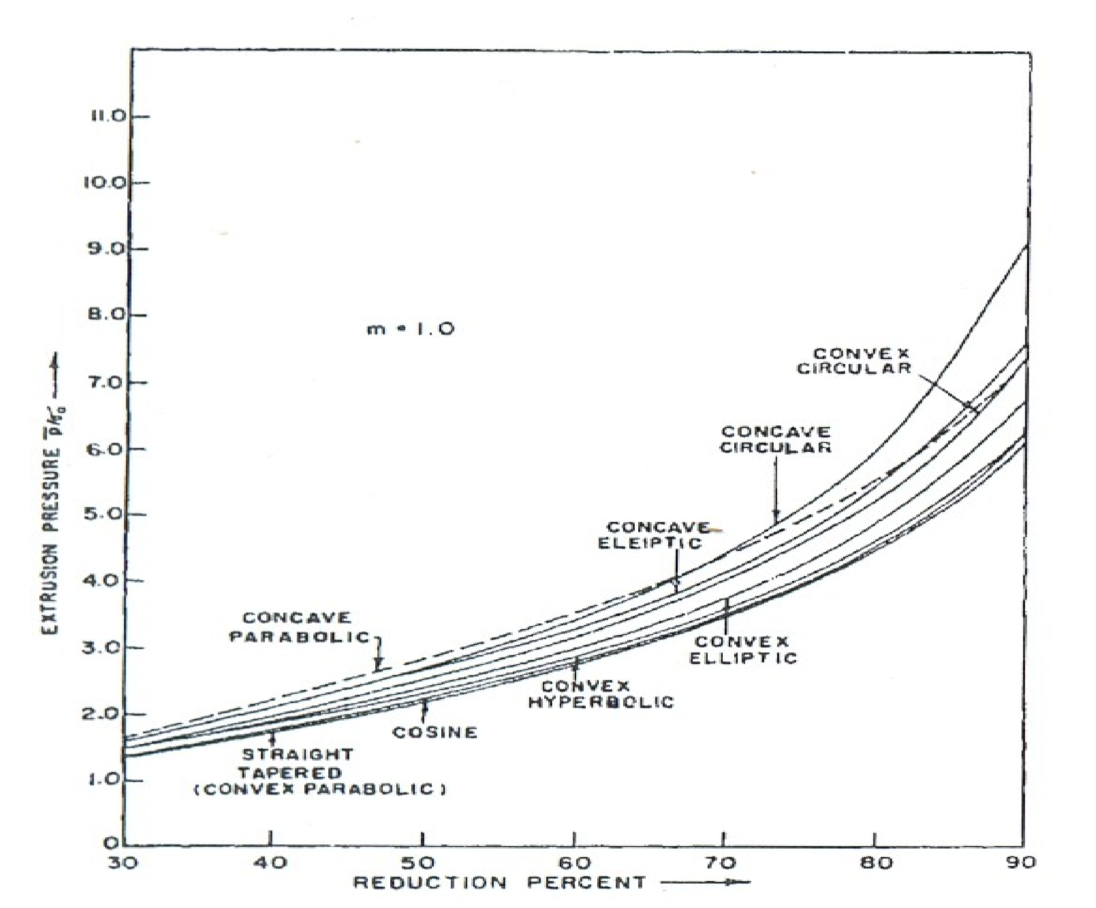
- Shows the variation of extrusion pressure with percentage reduction for smooth dies(m=0)

Result & discussion



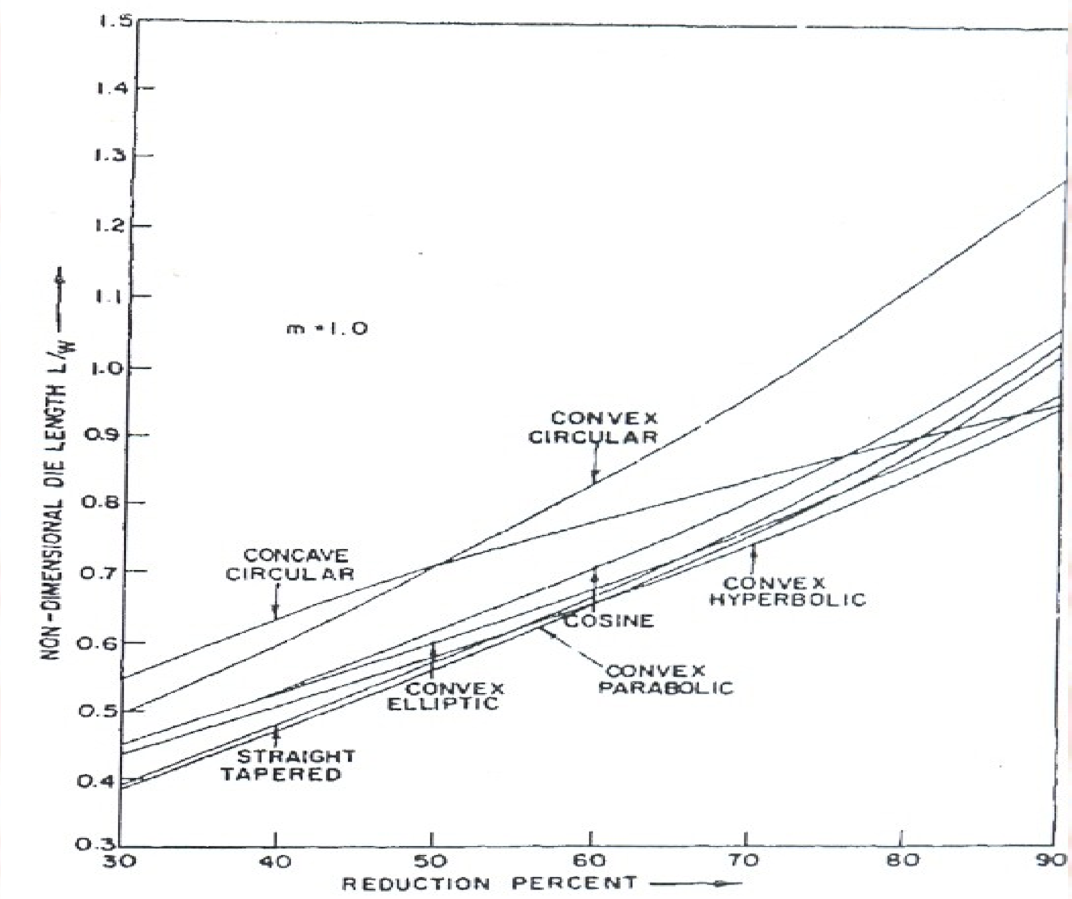
- Shows the variation of internal work of deforma-tion with percentage reduction for smooth dies(m=0)

Result & discussion



- Shows the variation of extrusion pressure with percentage reduction for dies with sticking friction(m=1)

Result & discussion



- Shows the variation of non dimensional length with percentage reduction for dies with sticking friction(m=1)

conclusion

- Cosine dies are superior to other dies.
- It needs lower plastic deformation work,die surface friction and total power consumption .
- Upper-bound loads for the extrusion of square sectionsfrom square billets have been computed using thedual-stream-function method for a number of concave and convex dies. It is seen that a cosine die yields thelowest extrusion pressure under frictionless conditions(m = 0), whilst under sticking-friction conditions (m =1.0) a straight-tapered die provides the least pressure.

conclusion

- The internal work of deformation is found to be minimum and nearly equal to that for homogeneous compression for a straight tapered die for m = 0. It is also seen that the upper bounds calculated for concave dies are always greater than those for convex dies, due to the greater deformation volumes enclosed by these latter dies.

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Thank You

Questions?