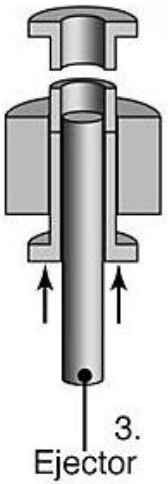
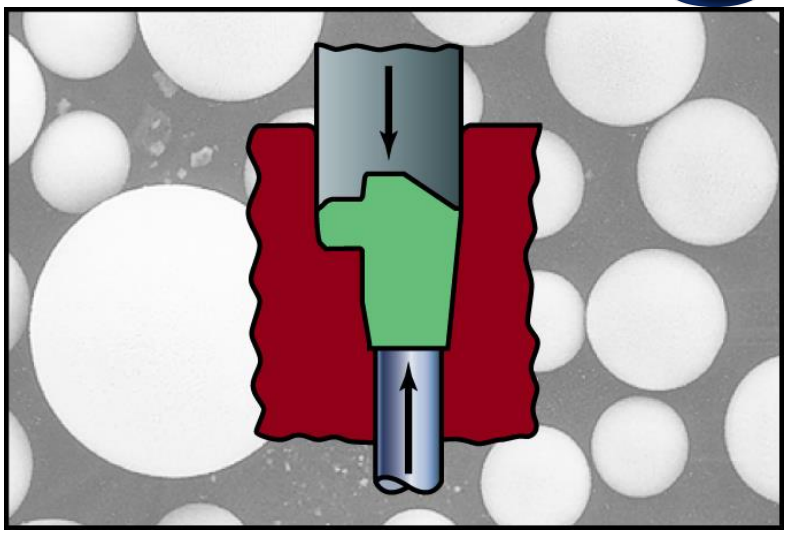


Lecture # 8

POWDER METALLURGY

Die design



Dr. Mohammed Gamil

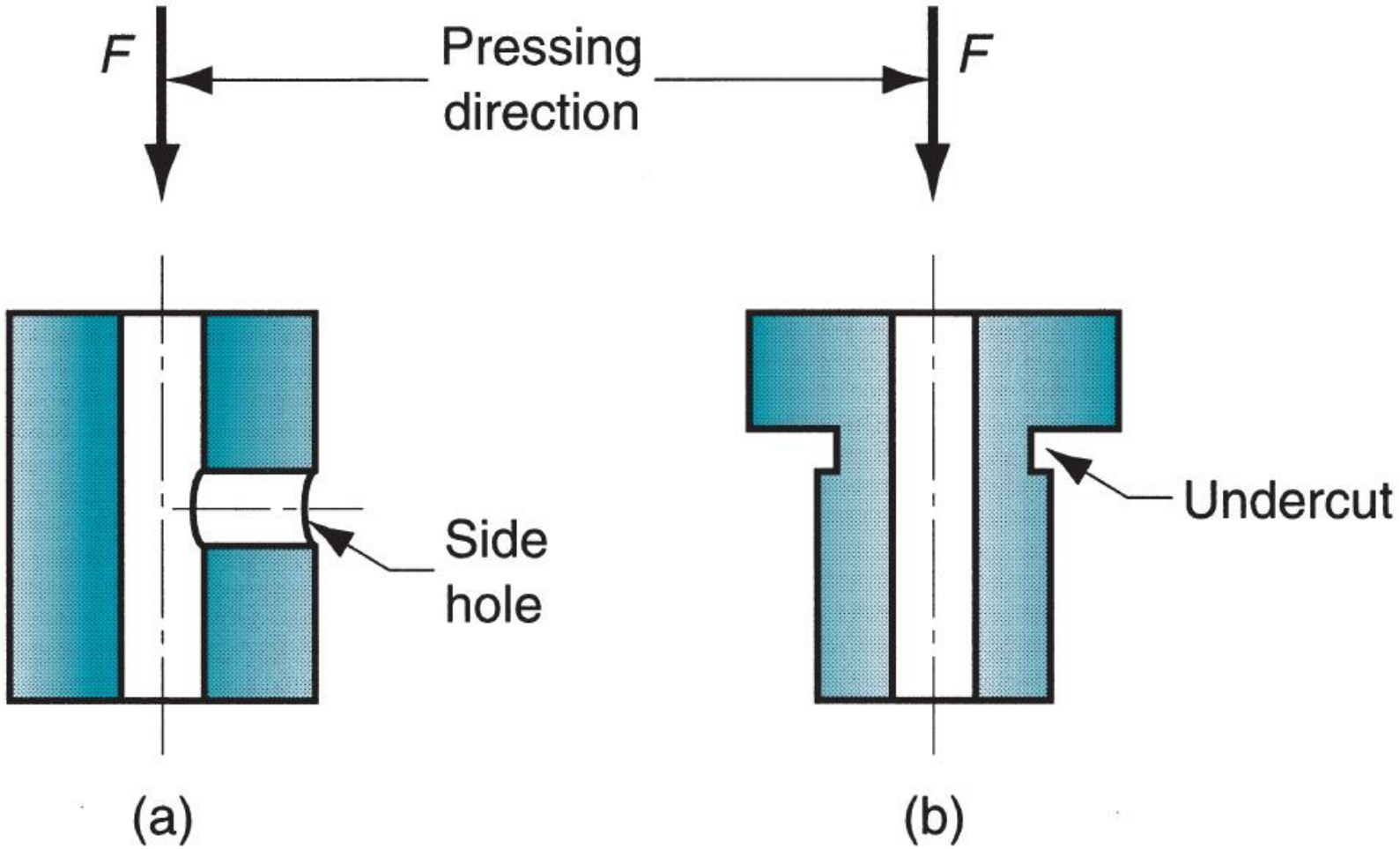
Design Guidelines for PM Parts

- Economics usually require large quantities to justify cost of equipment and special tooling.
- Minimum quantities of 10,000 units are suggested.
- The shape of the compact must be kept as simple and uniform as possible.
- Provision must be made for ejection of the green compact without damaging the compact.
- This generally means that part must have vertical or near-vertical sides, although steps are allowed.

Design Guidelines for PM Parts (Cont.)

- P/M parts should be made with the widest acceptable tolerances to maximize tool life.
- Design features such as undercuts and holes on the part sides must be avoided.
- Vertical undercuts and holes are permissible because they do not interfere with ejection.
- Vertical holes can be of cross-sectional shapes other than round without significant difficulty.

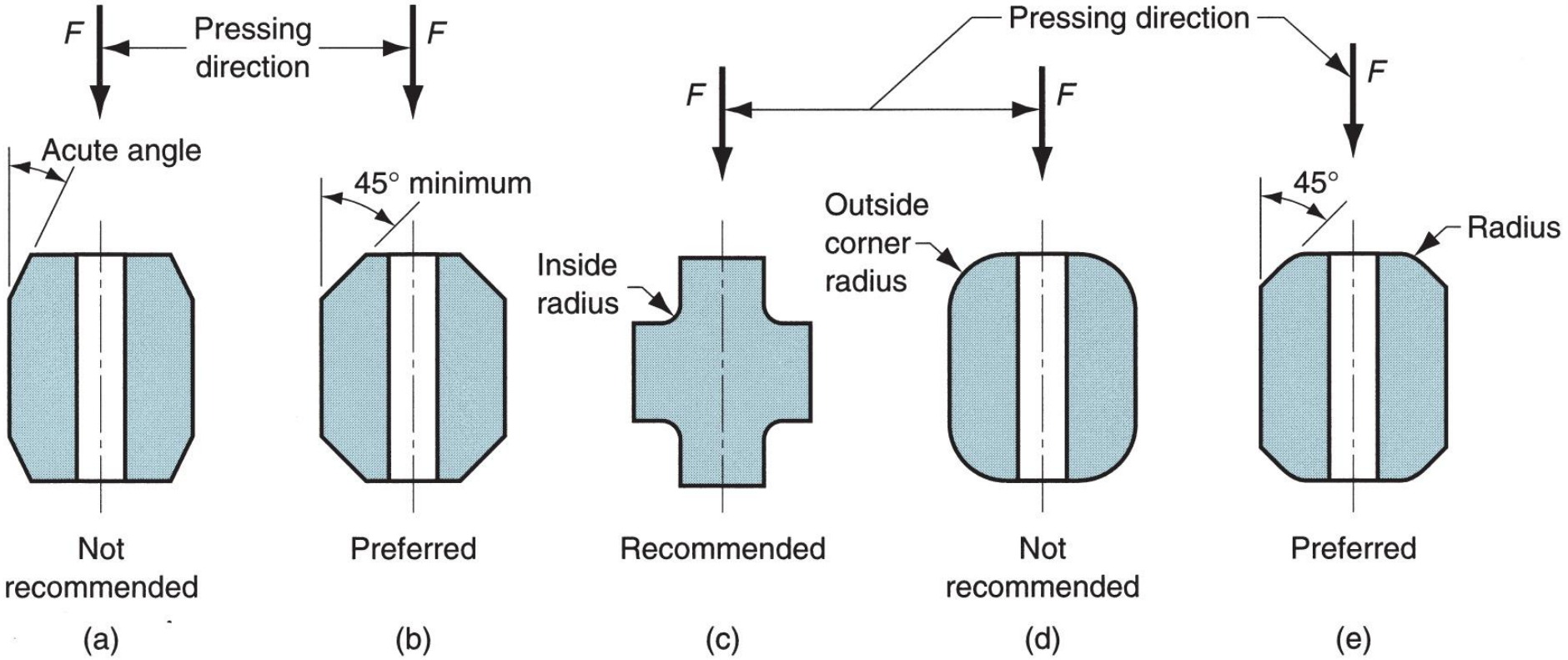
Design Guidelines for PM Parts (Cont.)



Design Guidelines for PM Parts (Cont.)

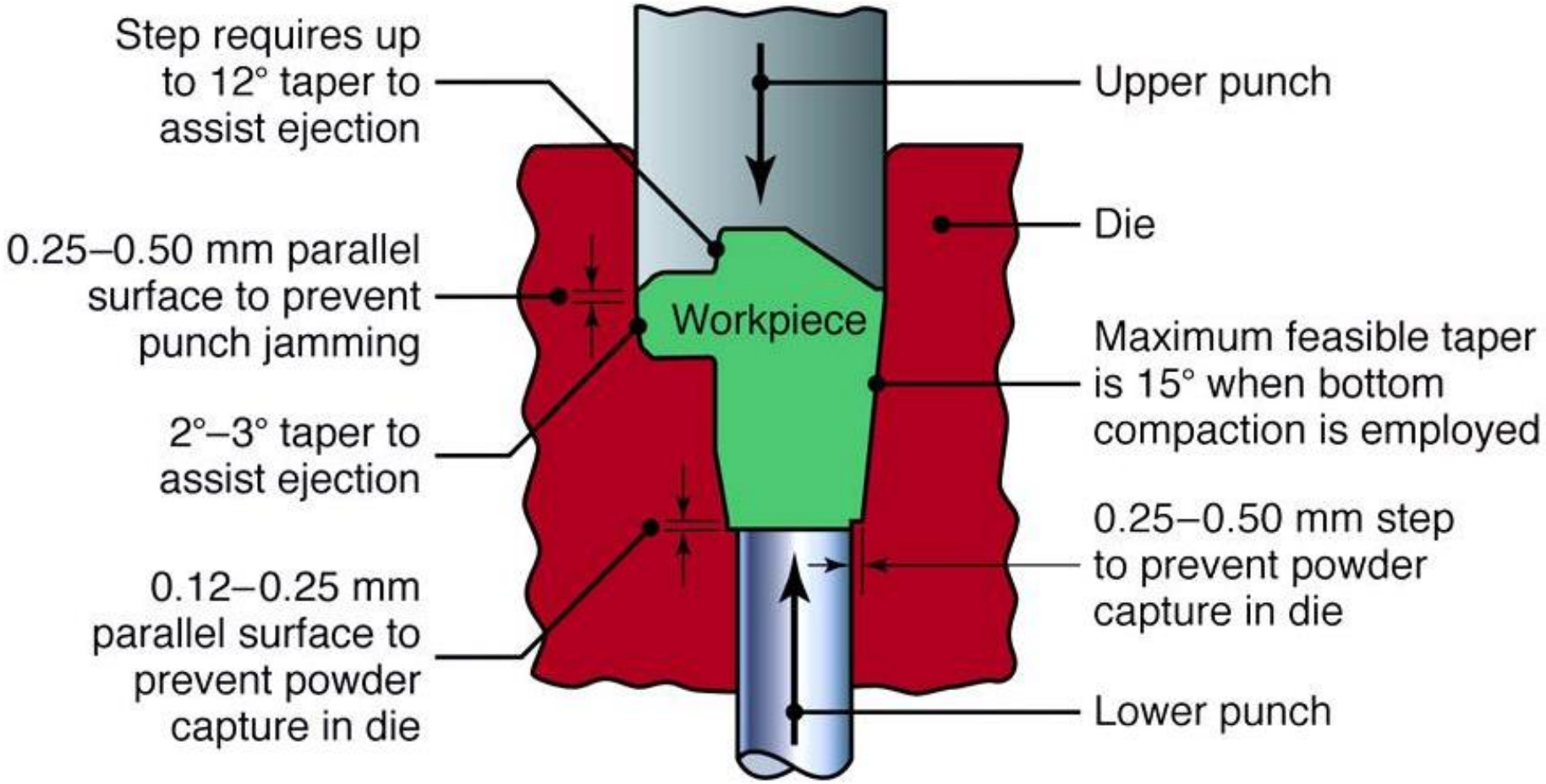
- Screw threads cannot be fabricated by PM; if required, they must be machined into the part.
- Chamfers and corner radii are possible by PM pressing, but problems arise in punch rigidity when angles are too acute.
- Wall thickness should be a minimum of **1.5 mm** (0.060 in) between holes or a hole and outside wall.
- Minimum recommended hole diameter is 1.5 mm (0.060 in).

Design Guidelines for PM Parts (Cont.)

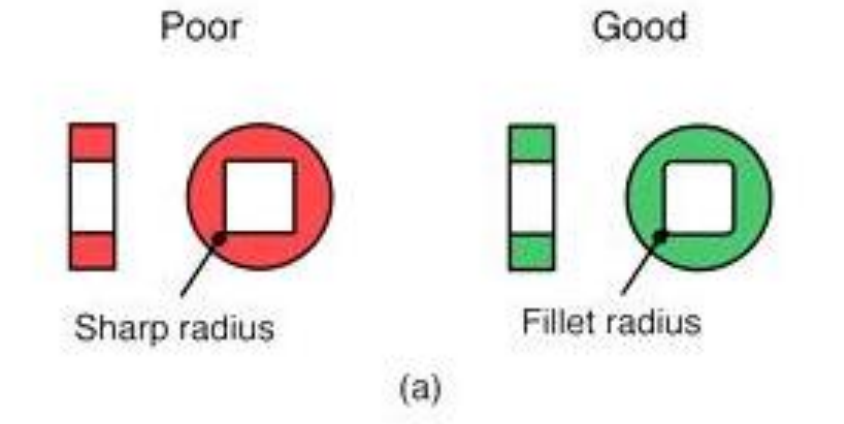


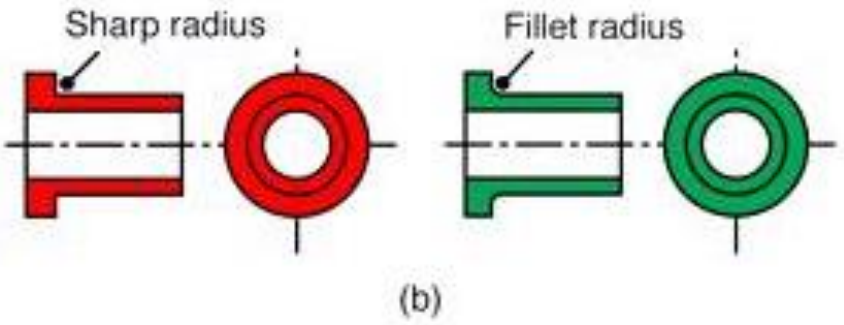
Chamfers and corner radii are accomplished but certain rules should be observed: (a) avoid acute angles; (b) larger angles preferred for punch rigidity; (c) inside radius is desirable; (d) avoid full outside corner radius because punch is fragile at edge; (e) problem solved by combining radius and chamfer

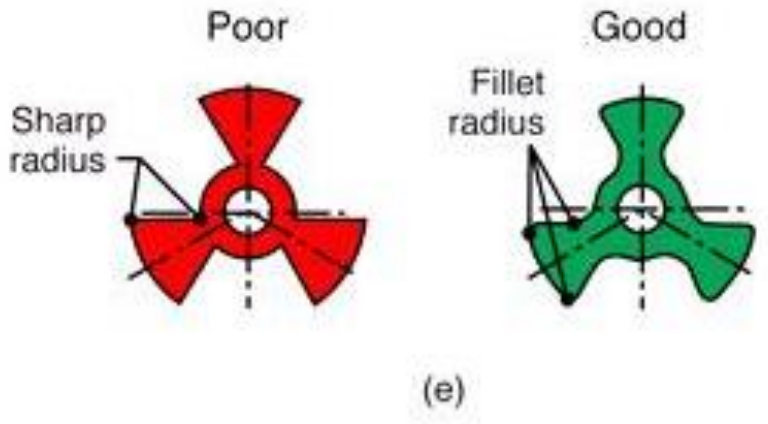
Design Guidelines for PM Parts (Cont.)

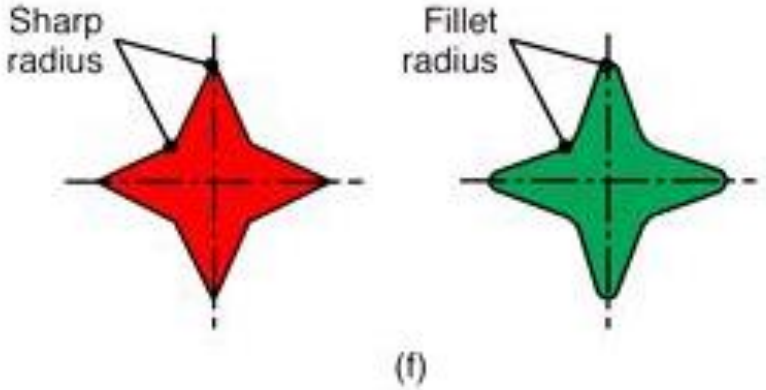


Poor and Good Designs of P/M Parts

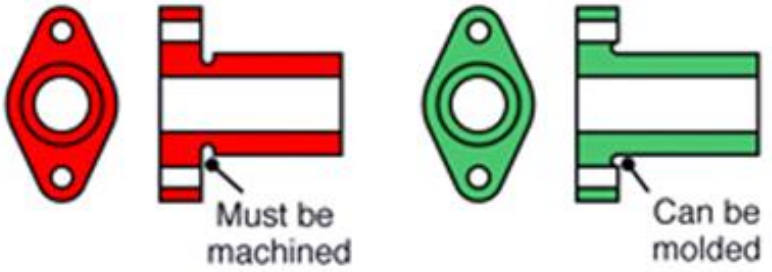




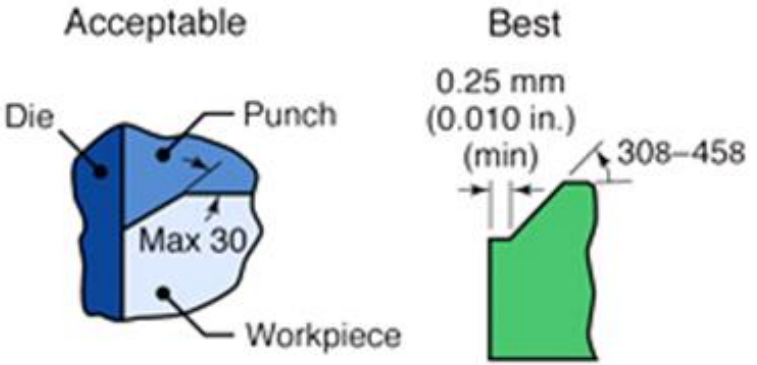




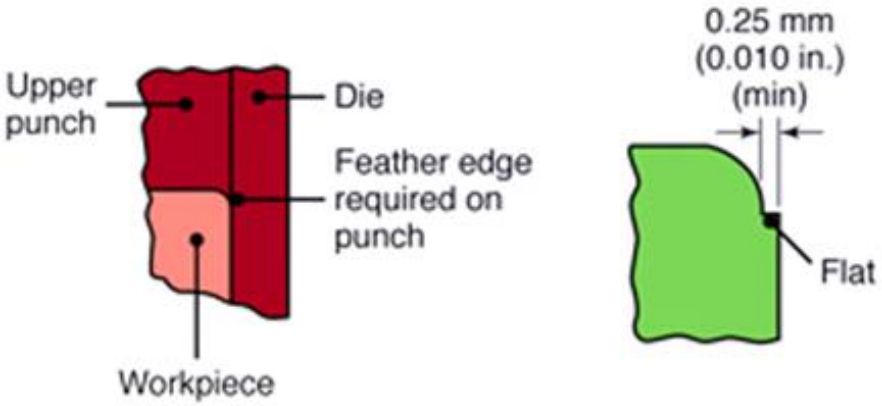
Poor and Good Designs of P/M Parts (Cont.)



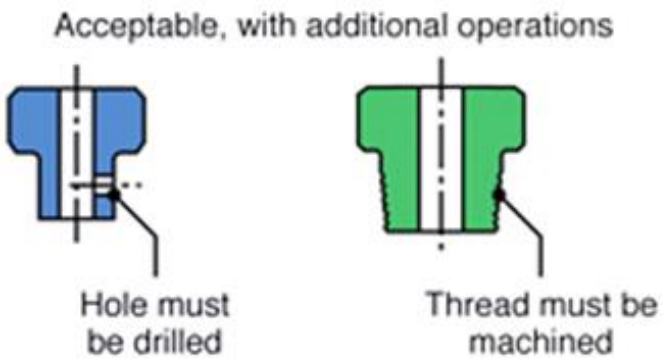
(c)



(g)

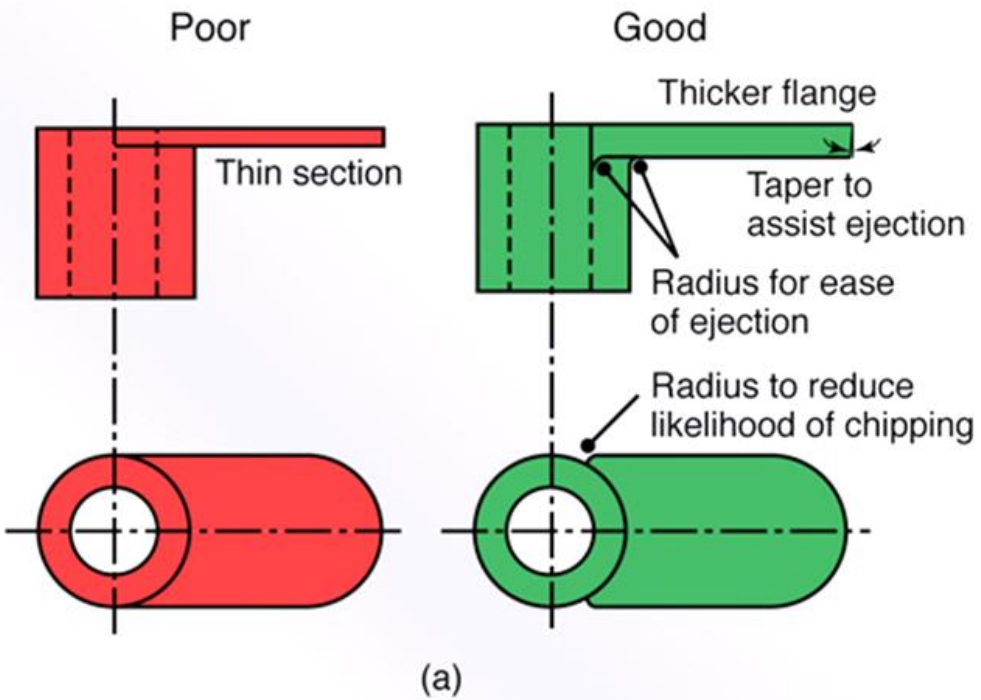


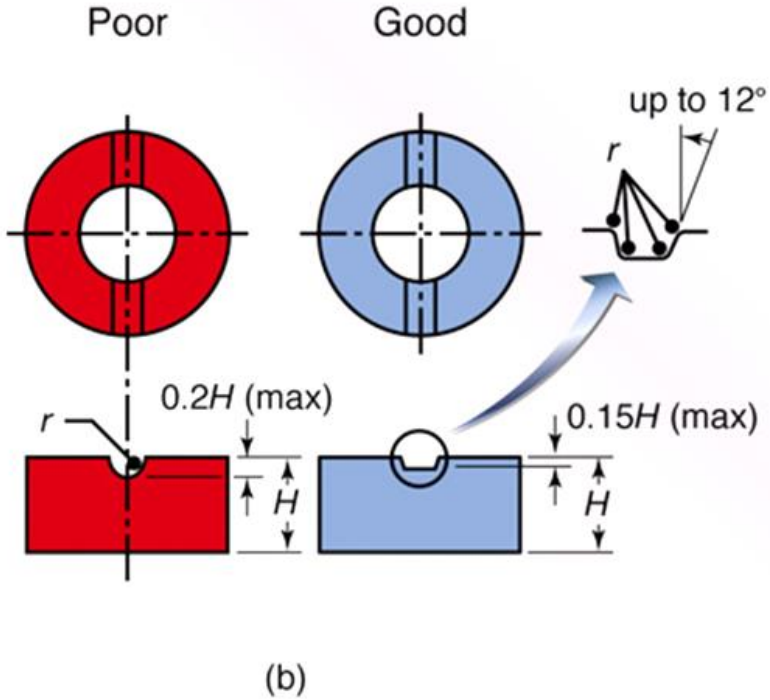
(d)



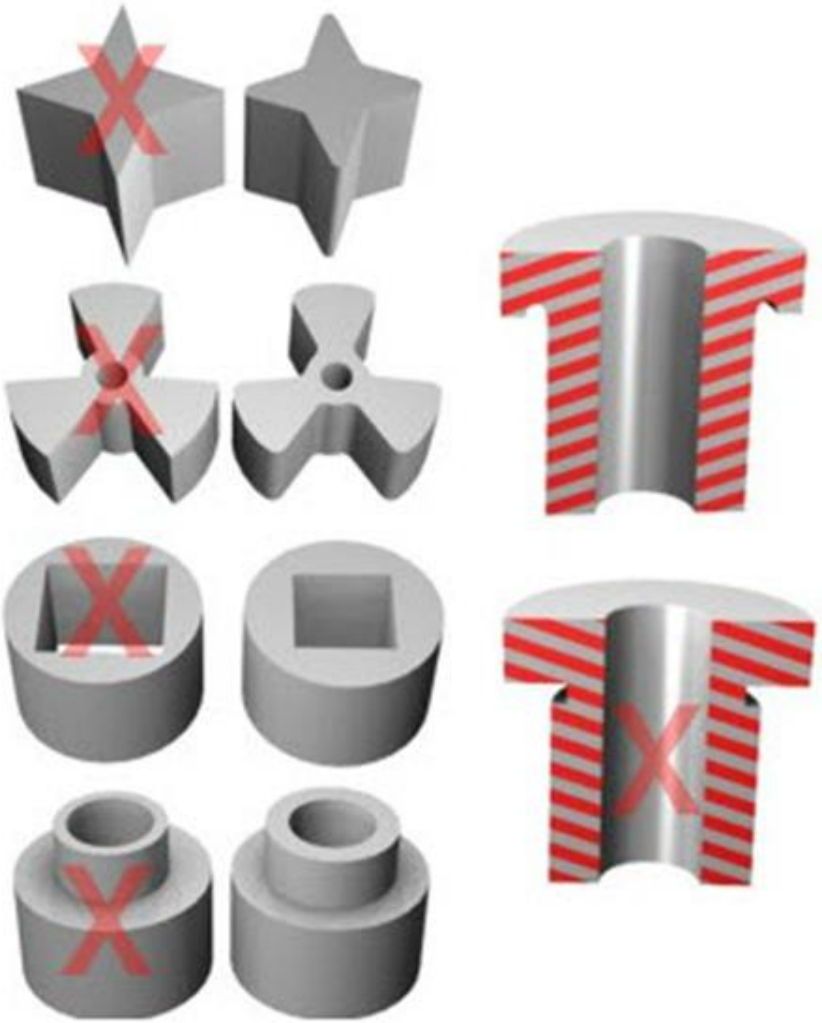
(h)

Poor and Good Designs of P/M Parts (Cont.)

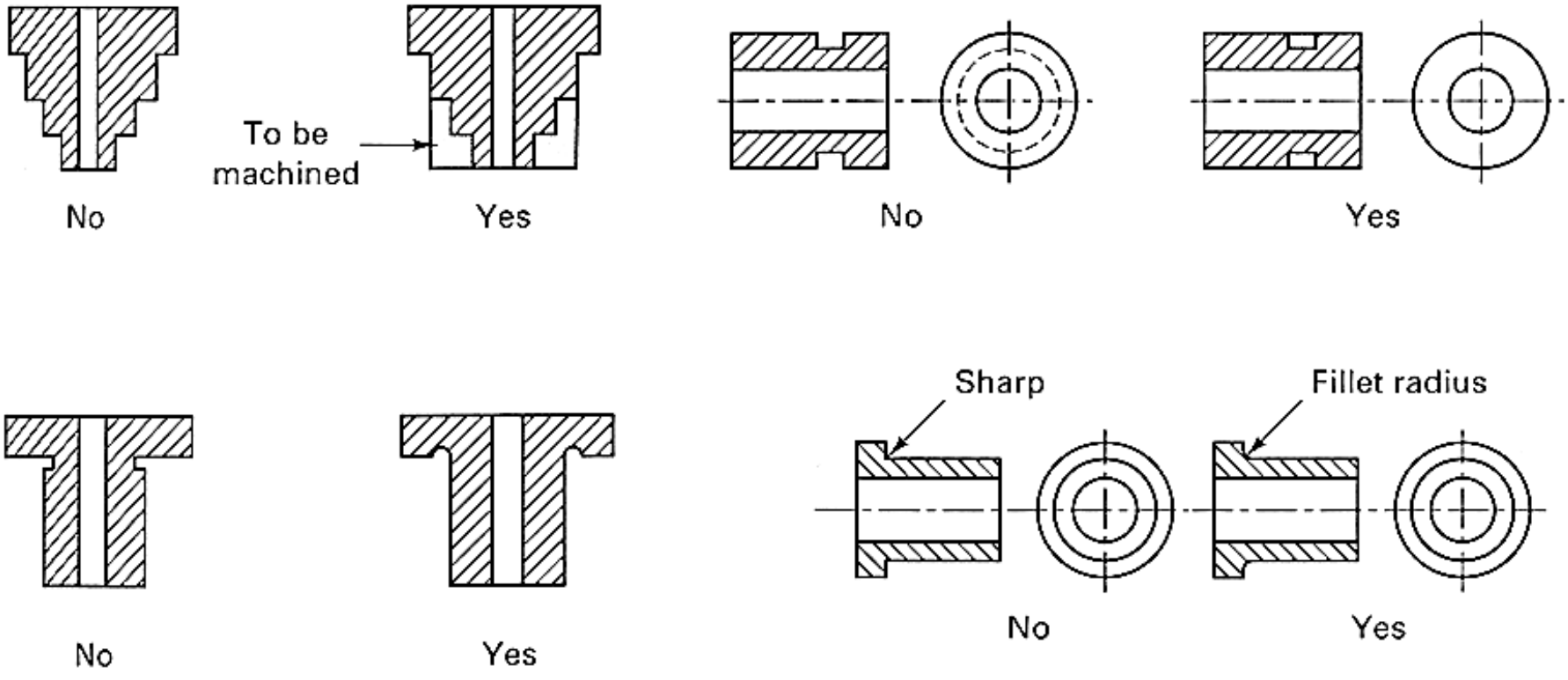




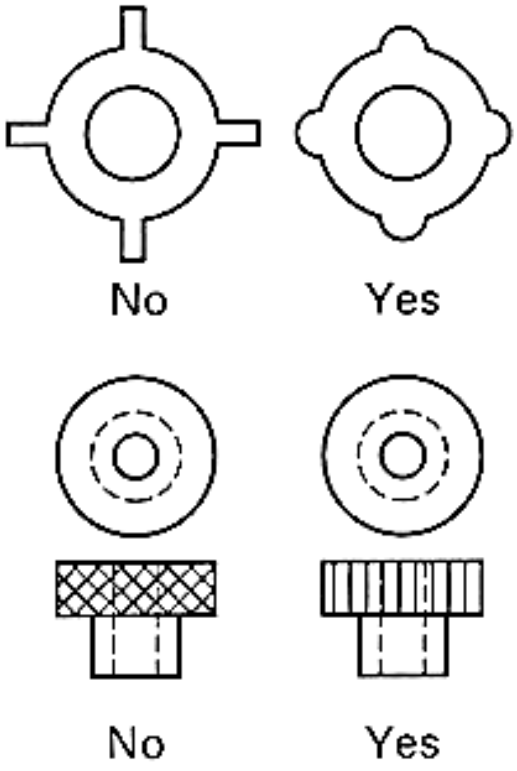
Poor and Good Designs of P/M Parts (Cont.)

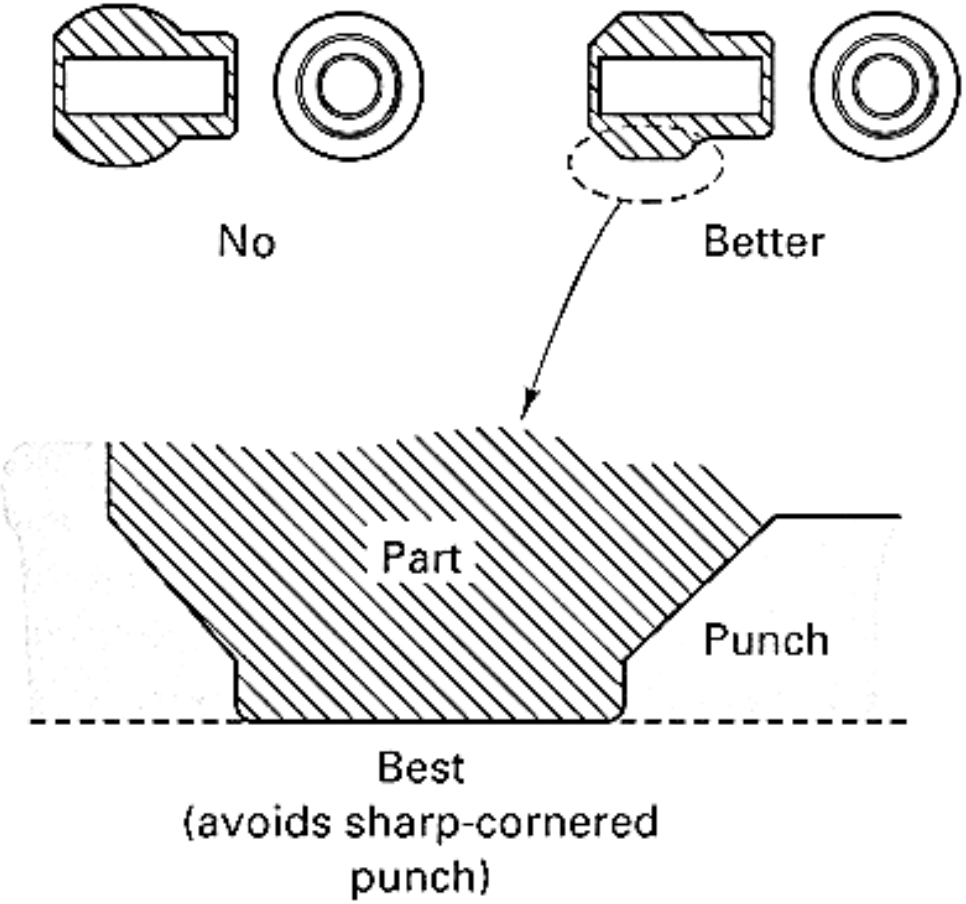


Poor and Good Designs of P/M Parts (Cont.)

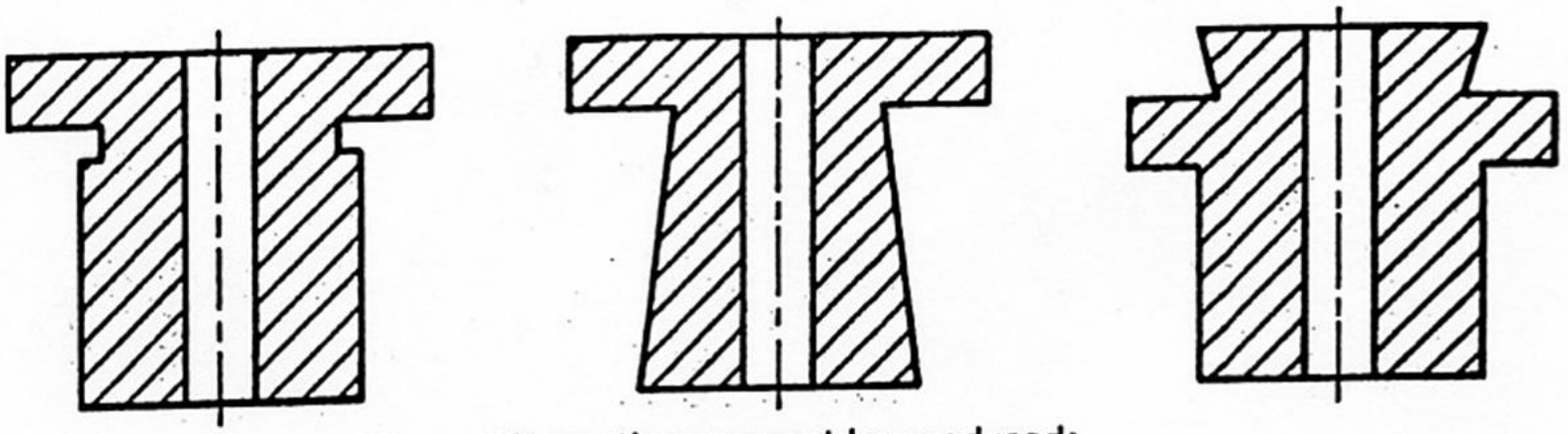


Poor and Good Designs of P/M Parts (Cont.)

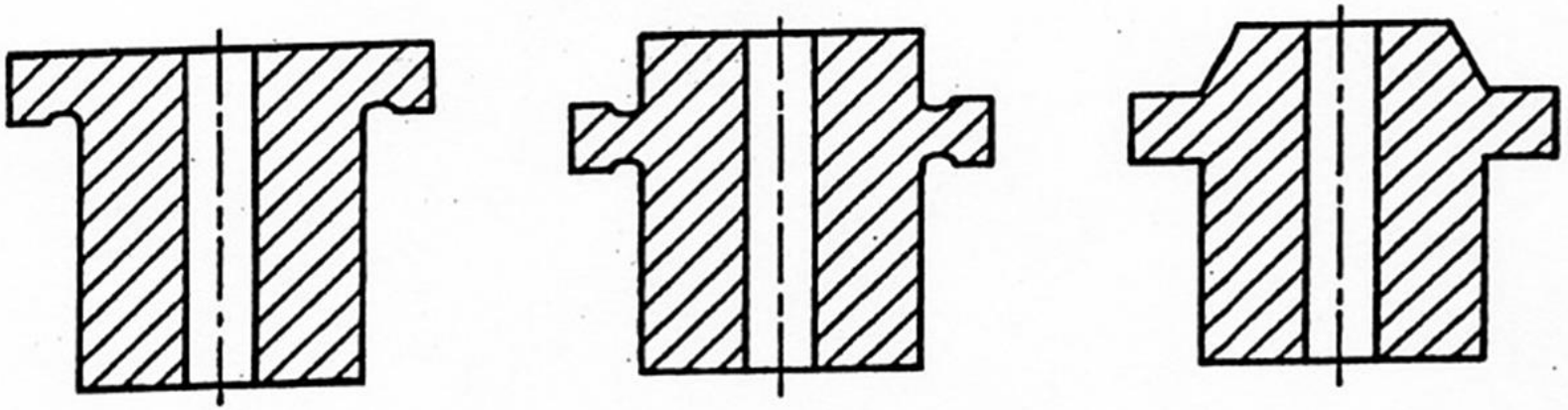




Poor and Good Designs of P/M Parts (Cont.)



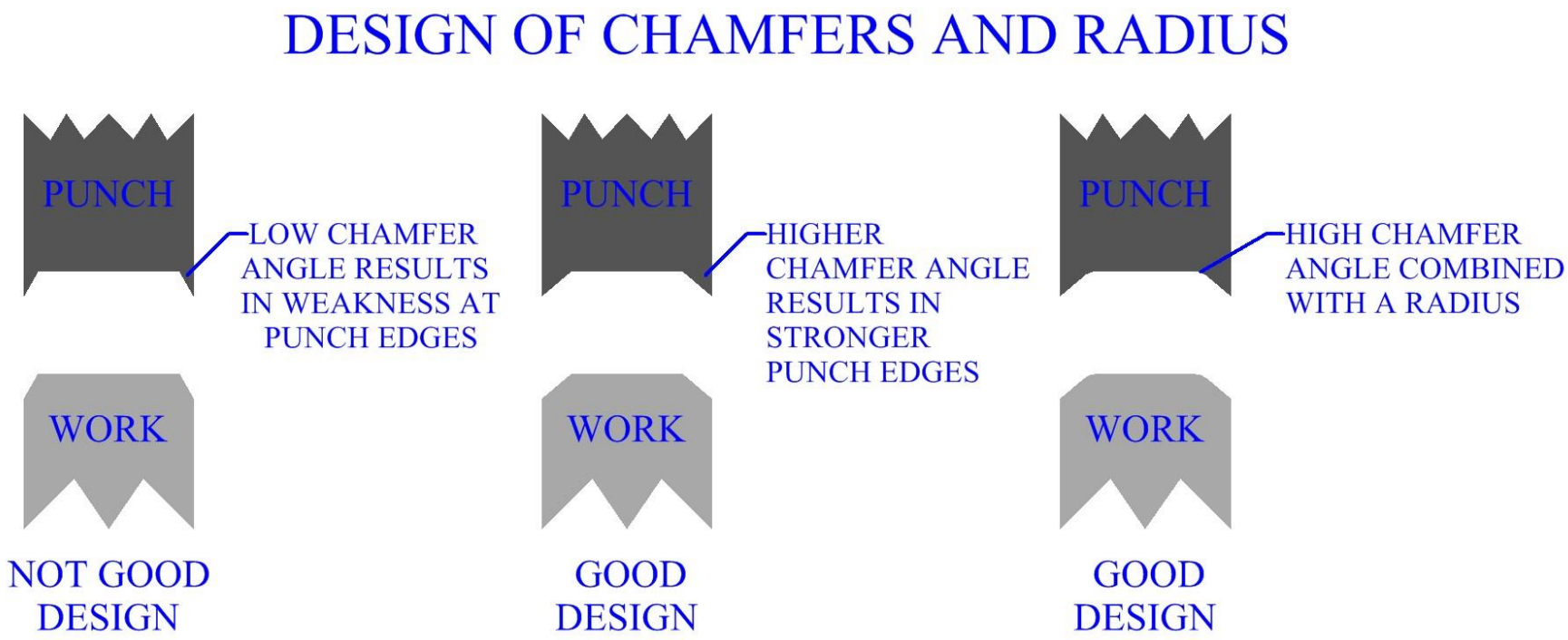
These three cannot be produced; must be machined.



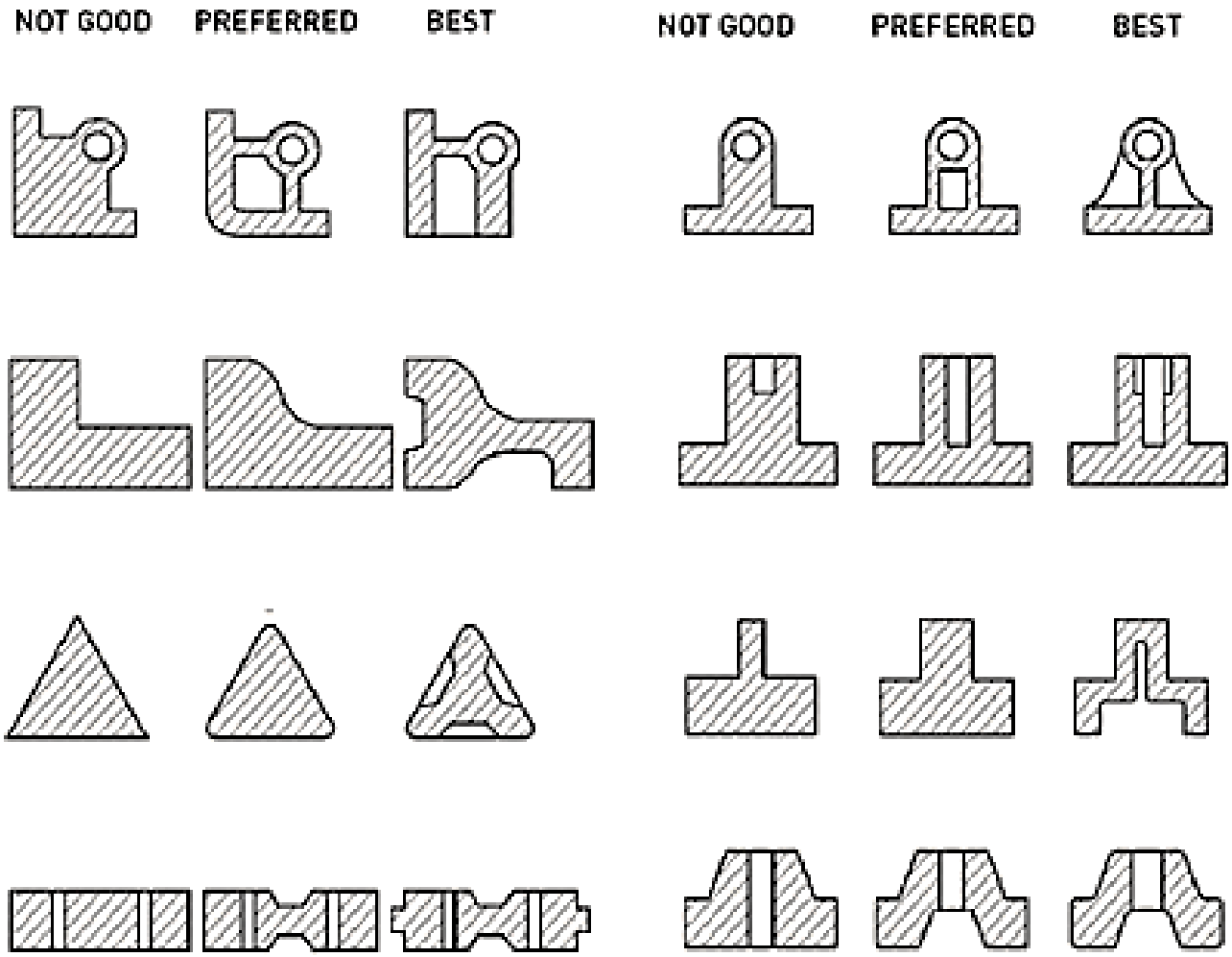
These three can be produced.

Poor and Good Designs of P/M Parts (Cont.)

Design suggestions



Design suggestions (Cont)



Design suggestions (Cont.)

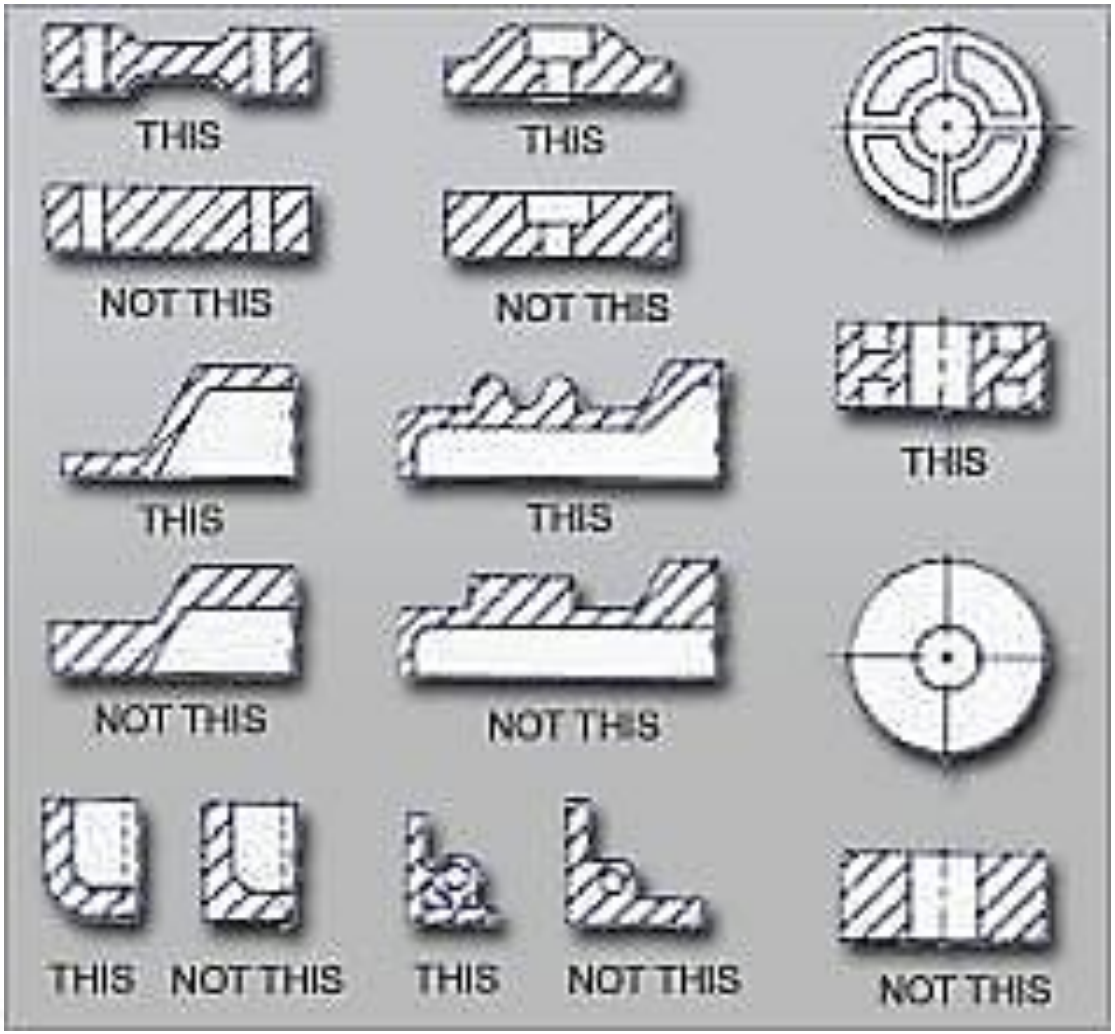
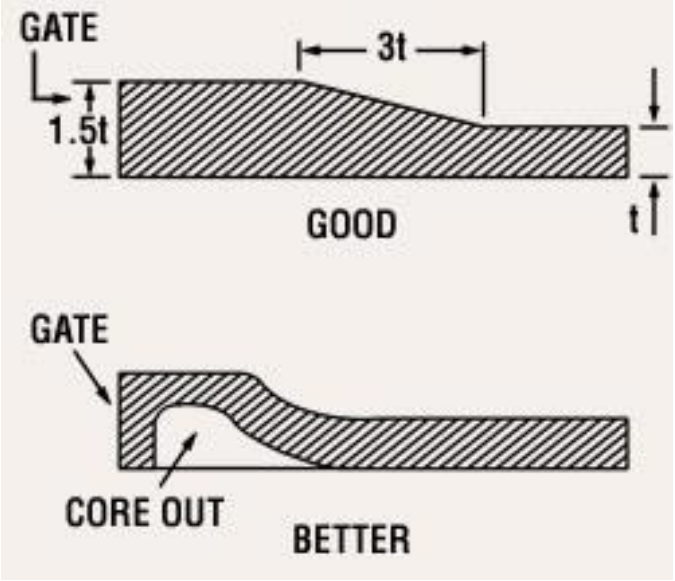
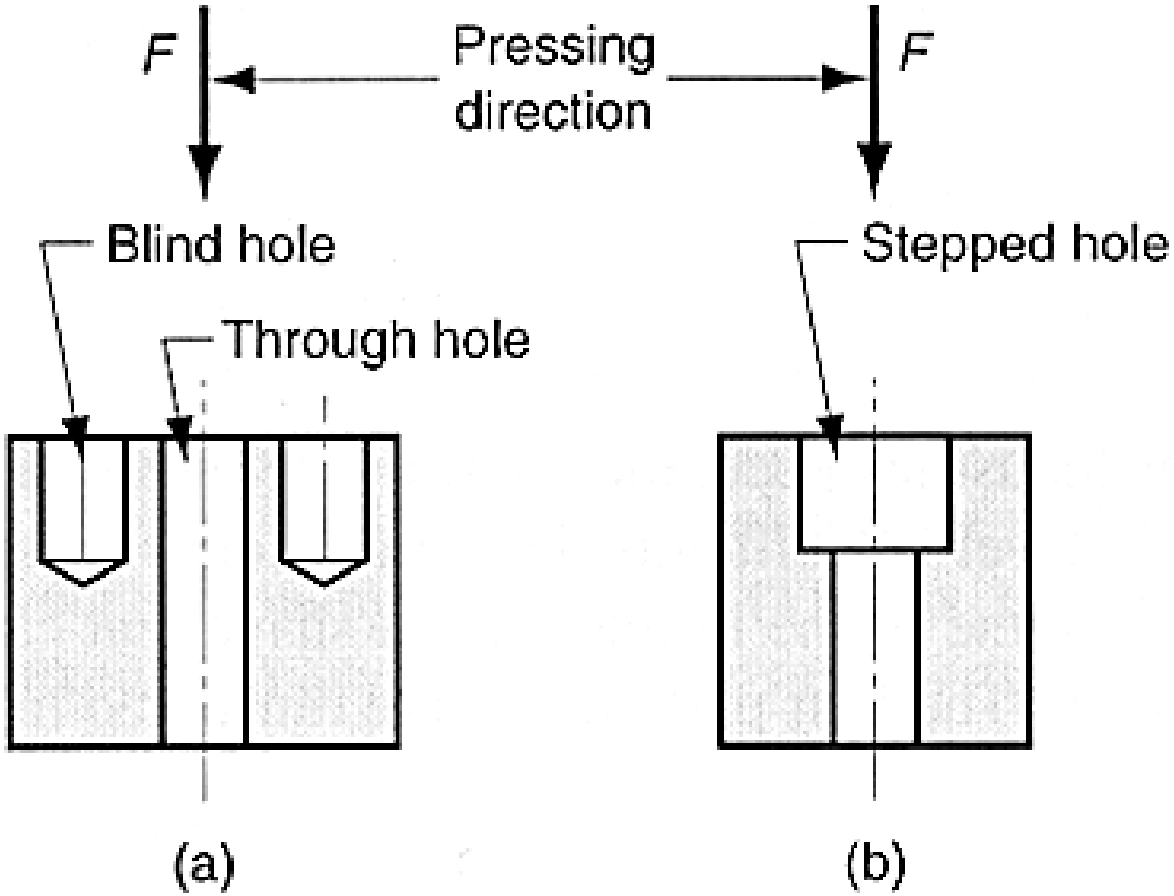


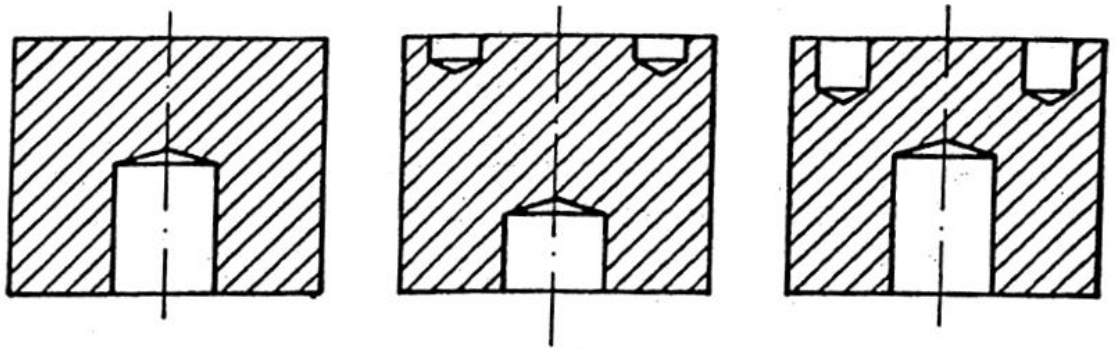
Figure 2



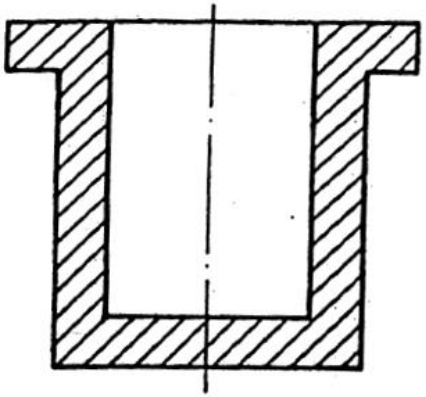
Stepped holes



Blind holes

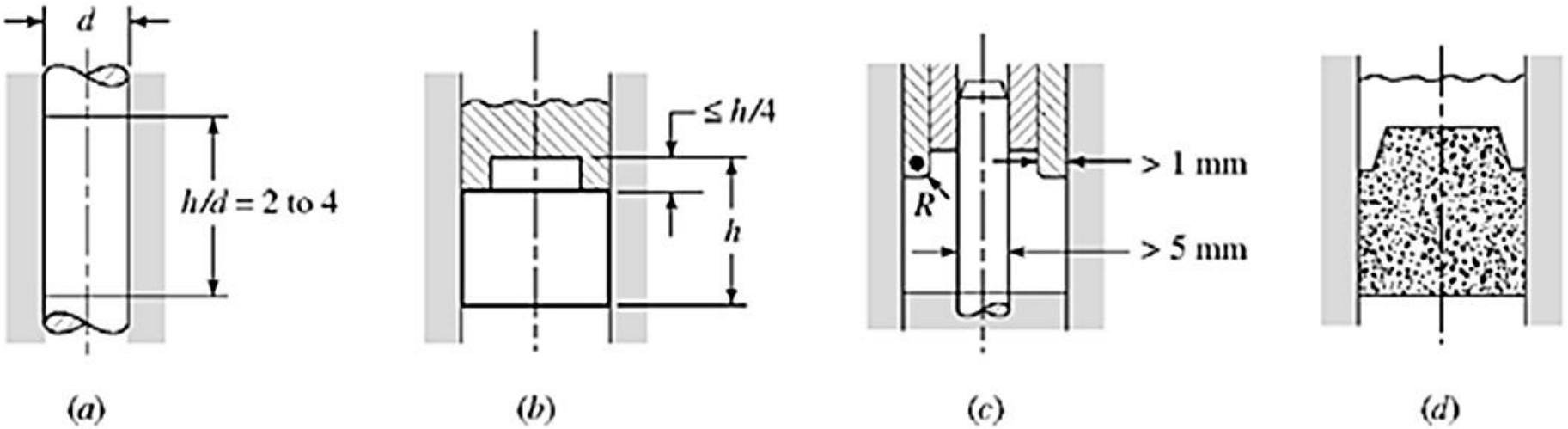


These blind holes are all suitable for production. Blind holes from above should be shallow; blind holes from below may be deep.



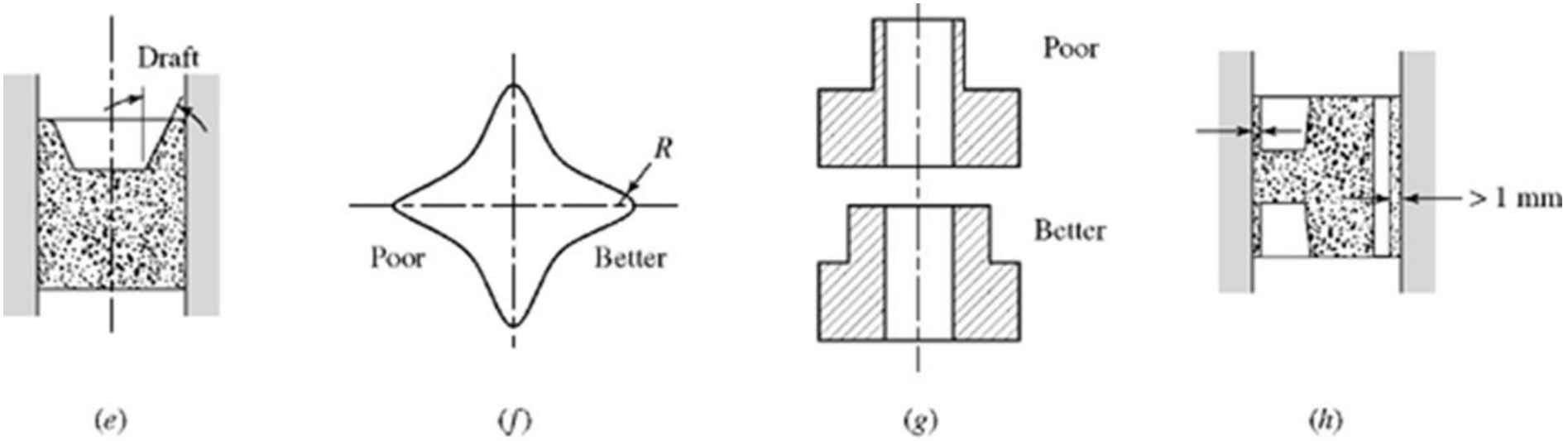
This type of deep blind hole is possible, but tooling is expensive. Powder must be transferred from fill position to ready-for-pressing position before any compacting commences.

Design considerations



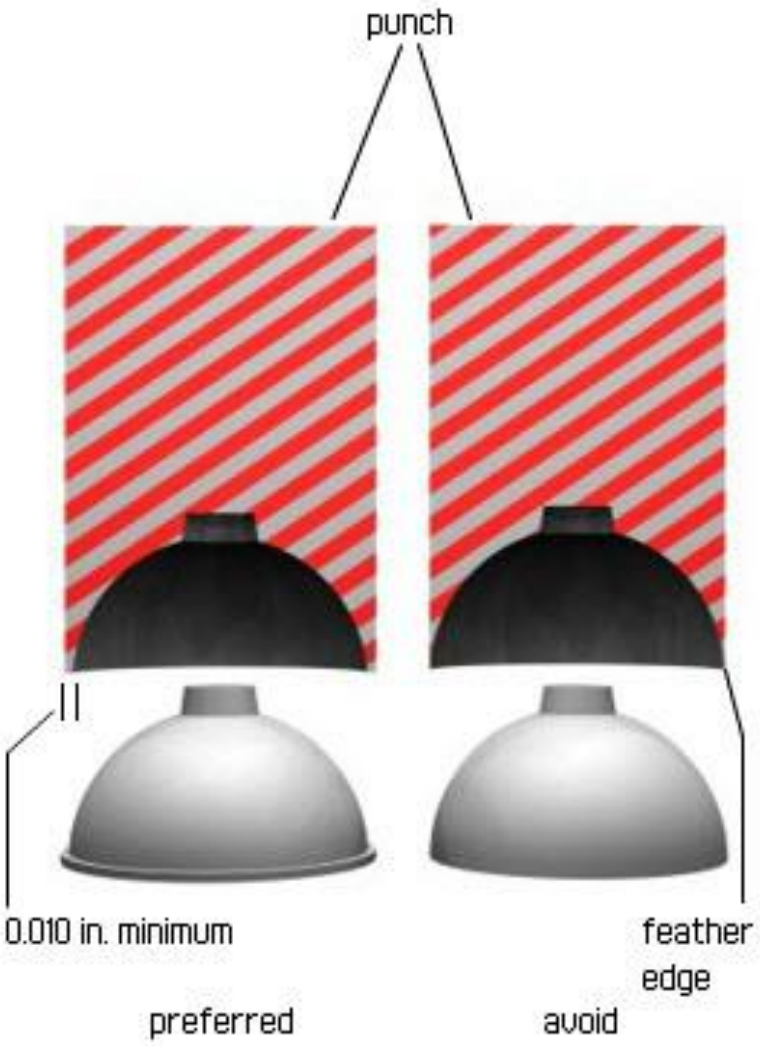
(a) Length to thickness ratio limited to 2-4; (b) Steps limited to avoid density variation; (c) Radii provided to extend die life, sleeves greater than 1 mm, through hole greater than 5 mm; (d) Feather-edged punches with flat face

Design considerations (Cont.)

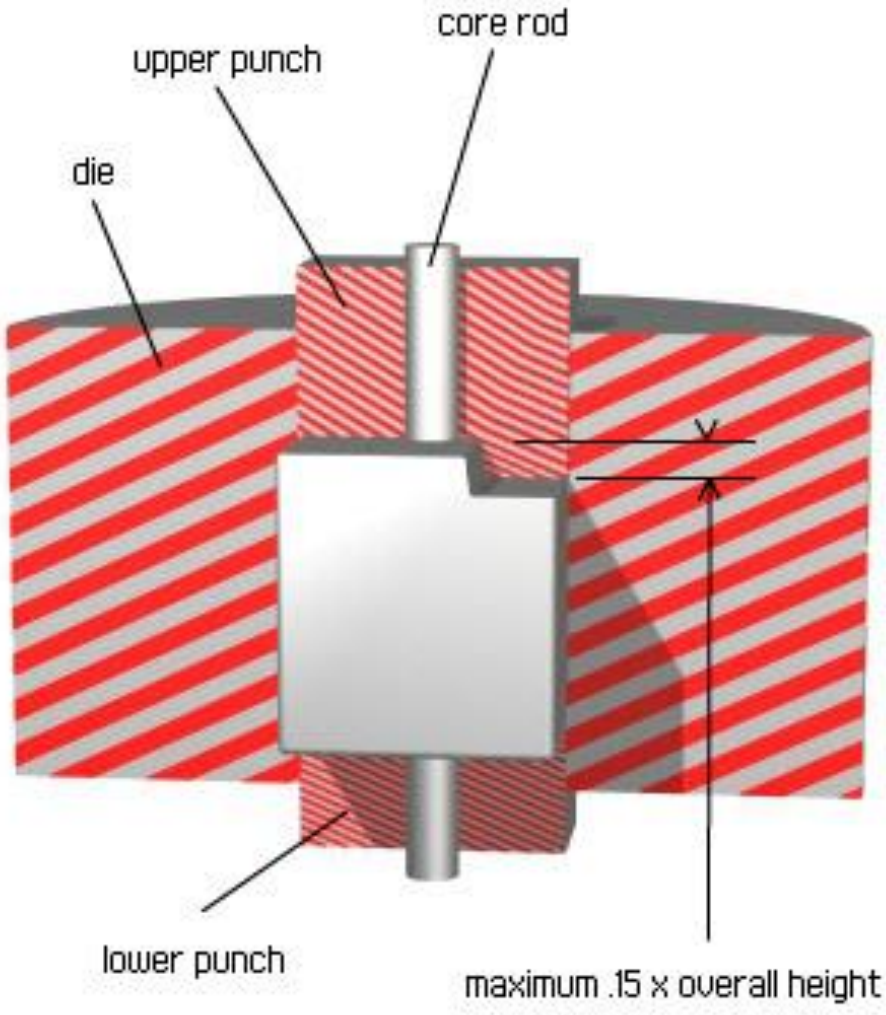


(e) Internal cavity requires a draft; (f) Sharp corner should be avoided; (g) Large wall thickness difference should be avoided; (h) Wall thickness should be larger than 1 mm.

Design considerations (Cont.)



Design considerations (Cont.)



Design considerations (Cont.)

(i) Avoid sharp corners and thus the corners have to be either radiused or chamfered.

(ii) As under-cuts and re-entrant angles cannot be molded into the component (conventional pressing & sintering), these have to be machined subsequently.

(iii) The inability of the powder metallurgy process to introduce cross holes. Such features would have to be machined using a post processing step.

(iv) To prevent excessive wear of the tools chamfers greater than 45 degrees are preferred, but in case of less than 45 degrees lands are required.

(v) Punches less than 1 mm be avoided.

Design considerations (Cont.)

(vi) Large sectional changes should be avoided as far as possible as they may lead to the cracking of the green component at the change in section through transfer of metal powder into the wide section during the compaction processes.

(vii) The practical minimum diameter which can be easily molded is about 2 mm and holes running parallel to the direction of pressing should normally have a length to diameter ratio of 4 : 1.

(viii) Groves are generally molded into the top face of the component and these should not extend to more than 30 % of the total length.

Design considerations (Cont.)

(ix) Tolerances on sintered components can be improved by sizing at extra cost as per design requirements.

- Tolerances after sintering are generally equivalent to those obtained by turning, milling, etc.
- But after sizing these may be considered equivalent to medium grinding or broaching.


Thank You!