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Mid Semester Examination – October – 2017
Solution and Marking scheme

Branch: M.Tech (Manufacturing Process Engineering) Sem.:- I
Subject with Subject Code:- Sheet Metal Engineering [MMF104C]Marks: 20
Date: - 09/10/2017 Time: - 1 Hr.

Q1 a) Explain fine blanking and advantages of fine blanking Marks 4 + 4

Fine blanking is a specialized form of blanking where there is no fracture zone when shearing. This is achieved by compressing the whole part and then an upper and lower punch extract the blank. This allows the process to hold very tight tolerances, and perhaps eliminate secondary operations. Materials that can be fine blanked include aluminium, brass, copper, and carbon, alloy, and stainless steels. Fine blanking presses are similar to other metal stamping presses, but they have a few critical additional parts. A typical compound fine blanking press includes a hardened die punch (male), the hardened blanking die (female), and a guide plate of similar shape/size to the blanking die. The guide plate is the first applied to the material, impinging the material with a sharp protrusion or stinger around the perimeter of the die opening. Next a counter pressure is applied opposite the punch, and finally the die punch forces the material through the die opening. Since the guide plate holds the material so tightly, and since the counter pressure is applied, the material is cut in a manner more like extrusion than typical punching. Mechanical properties of the cut benefit similarly with a hardened layer at the cut edge of the part. Because the material is so tightly held and controlled in this setup, part flatness remains very true, distortion is nearly eliminated, and edge burr is minimal. Clearances between the die and punch are generally around 1% of the cut material thickness, which typically varies between 0.5–13 mm (0.020–0.512 in). Currently parts as thick as 19 mm (0.75 in) can be cut using fine blanking. Tolerances between ±0.0003–0.002 in (0.0076–0.0508 mm) are possible, depending on base material thickness and tensile strength, and part layout. With standard compound fine blanking processes, multiple parts can often be completed in a single operation. Parts can be pierced, partially pierced, offset (up to 75°), embossed, or coined, often in a single operation. Some combinations may require progressive fine blanking operations, in which multiple operations are performed at the same pressing station.

The advantages of fine blanking are:

- excellent dimensional control, accuracy, and repeatability through a production run;
- excellent part flatness is retained;
- straight, superior finished edges to other metal stamping processes;
- little need to machine details;
- multiple features can be added simultaneously in 1 operation;
- more economical for large production runs than traditional operations when additional machining cost and time are factored in (1000–20000 parts minimum, depending on secondary machining operations).

One of the main advantages of fine blanking is that slots or holes can be placed very near to the edges of the part, or near to each other. Also, fine blanking can produce holes that are much smaller (as compared to material thickness) than can be produced by conventional stamping.

The disadvantages are:

- slightly slower than traditional punching operations
- higher equipment costs, due higher tooling cost when compared to traditional punching operations and to higher tonnage requirements for the presses

Q1 b) Explain characteristics of sheet metal. 1 Mark each

Characteristic	Importance
Elongation	Determines the capability of the sheet metal to stretch without necking and failure; high strain-hardening exponent (n) and strain-rate sensitivity exponent (m)desirable.
Yield-point elongation	Observed with mild-steel sheets; also called Lueder's bands and stretcher strains; causes flame like depressions on the sheet surfaces; can be eliminated by temper rolling, but sheet must be formed within a certain time after rolling.
Anisotropy (planar)	Exhibits different behavior in different planar directions; present in cold-rolled sheets because of preferred orientation or mechanical fibering; causes earing in drawing; can be reduced or eliminated by

	annealing but at lowered strength.
Anisotropy (normal)	Determines thinning behavior of sheet metals during stretching; important in deep drawing operations.
Grain size	Determines surface roughness on stretched sheet metal; the coarser the grain, the rougher the appearance (orange peel); also affects material strength.
Residual stresses	Caused by non uniform deformation during forming; causes part distortion when sectioned and can lead to stress-corrosion cracking; reduced or eliminated by stress relieving.
Spring back	Caused by elastic recovery of the plastically deformed sheet after unloading; causes distortion of part and loss of dimensional accuracy; can be controlled by techniques such as over bending and bottoming of the punch.
Wrinkling	Caused by compressive stresses in the plane of the sheet; can be objectionable or can be useful in imparting stiffness to parts; can be controlled by proper tool and die design.
Quality of sheared edges	Depends on process used; edges can be rough, not square, and contain cracks, residual stresses, and a work-hardened layer, which are all detrimental to the formability of the sheet; quality can be improved by control of clearance, tool and die design, fine blanking, shaving, and lubrication.
Surface condition of sheet	Depends on rolling practice; important in sheet forming as it can cause tearing and poor surface quality

Q2 a) Explain process to calculate punching force with example

Marks 2+2

Punching force is the total force required by the machine to punch a particular hole based on the material thickness, type and hole shape. Calculating the punching force is very important for checking whether the machine has enough tonnage to do the job without damaging the machine itself. This is especially true if a large tool is used in thicker material or harder materials such as stainless steel. The most common formula to determine the punching tool is by multiplying the material shear strength with the material thickness and the perimeter of the punch tool.

The general Punching force formula;

Punching force = perimeter X thickness X shear stress

$$F = P * t * \sigma_s$$

If the tool shape is round or circular shape;

$$F = \pi * D * t * \sigma_s$$

Example to calculate punching force for rectangle tool with the dimension of 40 mm x 60mm, the material is 4mm thick Stainless Steel T316

The rectangle perimeter, P = 2 x (40 + 60) = 200mm = 0.2m

The material thickness, t = 4mm = 0.004m

The shear strength of Stainless steel T316 = 482.63 Mpa = 4.921487 x 10^7 Kg/m^2

The Punching Force, F = 0.2 x 0.004 x (4.921487 x 10^7) = 39370 Kg = **39.37 Ton**

Q2 b) Compare process of blanking with piercing

Marks 2+2

Blanking	Piercing
Punching or blanking is a process in which the punch removes a portion of material from the larger piece or a strip of sheet metal. If the small removed piece is the useful part and the rest is scrap, the operation is called blanking	It is a process by which a hole is cut (or torn) in metal. It is different from punching in that piercing does not generate a slug. Instead, the metal is pushed back to form a jagged flange on the back side of the hole.
The piece cut out is called as blank and may	A pierced hole looks somewhat like a bullet

be further processed. Blanks are often cut out of a sheet or strip	hole in a sheet of metal
Blanking wastes certain amount of material. When designing a sheet metal blanking process the geometry of blanks should be nestled as efficiently as possible to minimize the material waste.	Size of the component is generally larger in piercing than blanking.

Q2 c) Write basic applications of piercing and punching

Marks 2+2

Applications of punching

- Joining of sheet metal using riveting and fasteners
- To manufacture washers
- To manufacture perforated sheets etc

Applications of piercing

- To prepare shiver
- To prepare flanges
- To prepare scrubbers etc

Q2 d) Explain qualities of sheet metal required for blanking operation

Marks 4

- Low shear strength
- Higher ductility
- Optimum tensile strength
- Low modulus of rupture
- Optimum thickness
- Should be soft