

Test: Broach Engineering



1. Design – Basics

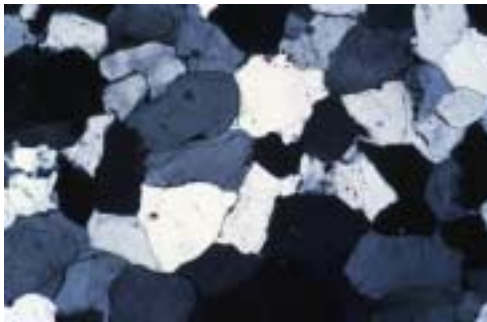
- 1.1 What is the datum? Explain the design, manufacturing, inspection and working datums. Show the examples of the above-listed datums on a drawing of a broach tool. What is the symbol for a datum target?
- 1.2 Draw simple sketches explaining the meaning of: circularity, cylindricity, perpendicularity, position, concentricity, symmetry, and runout. Show geometric characteristic symbols to be used on drawings (ASME Y14.5M-1994) for the listed features.
- 1.3 What is the difference between tolerance and allowance?
- 1.4 Draw simple sketches explaining typical fits between a shaft and a hole: Clearance Fit, Transition Fit, and Interference Fit.
- 1.5 What are the two most common parameters to indicate surface finish on a drawing?
- 1.6 Describe the degrees of freedom of a workpiece located in space?



2. Metal Cutting and Tool Design – General

- 2.1 Explain why studying the types of chips produced is important in understanding cutting operations.
- 2.2 Why is it not always advisable to increase the cutting speed in order to increase the production rate?
- 2.3 What are the possible reasons and consequences of tool chipping?
- 2.4 What are the effects of performing a cutting operation with a dull tool? Give a definition of a dull tool?
- 2.5 When is the tool sharpness more important
 - when cutting feed (rise per tooth) is small
 - when cutting feed is high
 - when cutting speed is high
 - when cutting speed is low
- 2.6 What are the major parameters of the cutting regime: in turning; in milling; in grinding; in broaching; in gear shaving.

- 2.7 What is the geometry of the cutting tool? Give the definitions and explain the significance of the rake, flank (relief), approach and inclination angles?
- 2.8 What is relationship between (abrasive) grit size and surface finish of part in grinding?
- 2.9 Why is aluminum oxide used more frequently than silicon carbide as an abrasive?
- 2.10 Why is CBN superior to silicon carbide and aluminum oxide as an abrasive in some applications? Give examples.
- 2.11 What materials commonly are used as bonding agents in grinding wheels?
- 2.12 Why is the grade of a bond in a grinding wheel important?
- 2.13 How does grade differ from structure?
- 2.14 What is accomplished in dressing a grinding wheel?
- 2.15 An abrasive wheel has the following mark on its side:
51-A-80-D-10-S-210
What are abrasive type, grain size, grade, structure, and bond type of this wheel? Is it suitable for finish grinding of a broach tool made of CPM M4S HSS?
- 2.16 Describe the differences between physical vapor deposition (PVD) and chemical vapor deposition (CVD) process in the coating of cutting tools?
- 2.17 Why does machining with a TiN-coated tool consume less power than uncoated HSS?
- 2.18 How is machinability defined in broaching?
- 2.19 What is the chief function of the cutting fluids?
- 2.20 What are the four basic types of the cutting fluids
- 2.21 What are EP (extreme pressure) additives in the cutting fluids? Give examples of common EPs.
- 2.22 Is the control of cutting fluid temperature important? In what way?



Non of above

3. Material Science – General

- 3.1 Metals consist of
Metallic molecules
Molecules and
atoms
Atoms arranged in
certain order

- 3.2 What are the three most common crystal structures found in metals?
- 3.3 What are the standard units of reporting or measuring stress in the English system?
lbin
psi
in/s²

lbf/in

mechanical stress is a non-dimensional unit

In the metric system?

Pa

Nm

Ns⁻¹

Kgf

- 3.4 What are some important properties that relate to
a) elastic response of materials?
b) plastic response of materials?
Explain the answers using a stress-strain diagram.
- 3.5 For common carbon steel, what is higher yield strength or ultimate stress?
Ultimate stress
Yield strength
They are equal for most of metallic materials
- 3.6 What is the toughness of a material?
- 3.7 What is strain hardening or work hardening? How might this phenomenon be measured or reported? How might it be used in manufacturing?
- 3.8 What are some of the various material characteristics or responses that have been associated with the term HARDNESS?
- 3.9 Both the Brinell and Rockwell hardness tests are penetration tests. What would you cite as the major difference between two methods?
- 3.10 Under what conditions might one want to use a microhardness test?
- 3.11 What is meant by the term *fracture*? What is the difference in the appearance of ductile and brittle fracture?
- 3.12 What is the carbon content in a 1020 steel
20% 2% 0.20% 10%



4. Quality Assurance, Testing and Inspection – General

- 4.1 Describe the terms sample size, random sampling, population, and lot size?
- 4.2 What is the normal error distribution?
- 4.3 What is a least-square analysis?
- 4.4 What is the correlation coefficient? What does it mean when the correlation coefficient is 1.0?
- 4.5 How is Student's *t*-distribution used?

- 4.6 How can statistical analysis be used to determine the number of measurements needed for a required level of confidence?
- 4.7 Define standard deviation. Why is it important?
- 4.8 When the most precise measurement is desired, how would you select the degree of discrimination of a measuring tool with respect to the size to be measured?
- 4.9 Explain the difference between attributes and variable inspection.



5. Broach Tool Design

5.1 Materials aspect

- 5.1.1 What are the basic advantages of HSS compare to high-carbon tool steels?
- 5.1.2 Make a list of alloying elements used in high speed steels. Explain why they are so effective in cutting tools. Explain why HSS is a composed material.
- 5.1.3 What is the major goal of the processing heat treatment? Cite some of specific objectives that may be sought?
- 5.1.4 What some of the possible objectives of annealing operations for HSS bars to be used to produce broaches?
- 5.1.5 What is the use of continuous-cooling-transformation (C-C-T) diagram in heat treatment? What is the cooling rate?
- 5.1.6 What should be a prevailing phase in a broach tool material:
 - Ferrite
 - Martensite
 - Tempered mirtensite
 - Bainite
 - Pearlite
- 5.1.7 Why are high speed steels usually tempered (two or three times) before being put into use? What properties increase during tempering? Which ones decrease?
- 5.1.8 Why is retain austenite an undesirable structure in heat treated HSS?
- 5.1.9 Why is the fine grain size often desired in a convention broach tool material and in CPM HSS?
- 5.1.10 What is hot (red) hardness?
- 5.1.11 Define metallurgical burn occurred in grinding? What is its structure and how it may affect tool performance?
- 5.1.12 What are the common wear mechanisms in broaching? How hardness and composition of the work material affect the wear and wear pattern (appearance of wear) of a broach?
- 5.1.13 What is the tool life of a broach? Explain how the elements of the broaching regime affect this life.



5.2 Design aspect

- 5.2.1 Describe the factors that contribute to broaching force and explain why they do so. Draw the force diagram for conventional and helical broaches. Explain how the design components of a broach affect these components.
- 5.2.2 What should be the minimum number of teeth in contact with the workpiece?
- 5.2.3 What are the consideration in the calculating and selecting the pitch?
- 5.2.4 What are the major considerations in assigning the number of:
- roughing teeth
 - semi-finishing teeth
- 5.2.5 How the lead and the number of starts selected for a helical broaches?
- 5.2.6 Attached is the drawing of a 98 helical gear tooth “spiralglide” pull broach body. Using this drawing answer the following questions:
- 5.2.6.1 How many starts does this broach body’s gullet have?
- 5.2.6.2 What is the shape and size of a single “tooth” produced if only this body was used for broaching?
- 5.2.6.3 What is the design set of datums used?
- 5.2.6.4 How is the surface finish assigned for different surfaces?
- 5.2.6.5 What is the rake (hook) angle?
- 5.2.6.6 What is the flank (relief) angle for the cutting edges?
- 5.2.6.7 How is the relief of the sides of each tooth achieved? What is the actual difference between profiles of two adjacent teeth (select #69 and #70)? Draw a simple sketch to illustrate your answer.
- 5.2.6.8 What is the broach coating (if any) assigned by the drawing?
- 5.2.7 Attached is a 98 helical gear tooth “spiralglide” pull broach side shaving shell. Using this drawing, answer the following questions:
- 5.2.7.1 What is the set of the design datums selected?
- 5.2.7.2 Show how the final profile is generated by teeth #1-#19 successively. Pay particular attention to the generation of corner radii.
- 5.2.7.3 What is the lead of this shell’s gullet? What is the lead of the teeth?
- 5.2.7.4 What is the side relief angle on tooth #8?
- 5.2.7.5 Explain what does it mean “GRIND SQUARE” note on the drawing? What is the proper way to specify this requirement?
- 5.2.7.6 Explain what does it mean “GRIND THESE SURFACES SQUARE AND IN LINE WITH EACH OTHER” ? What is the proper way to specify these requirements?

5.2.7.7 If the corresponding broach tool body is ideal, what would be the maximum azimuthal/circumferential/tangential) and diametral play between this shell and the body?



5.3 Basics of gearing

- 5.3.1 Why is the involute form used for gear teeth?
- 5.3.2 What is the diametral pitch of a gear?
- 5.3.3 On a sketch of internal ring gear, indicate the pitch circle, addendum circle, dedendum circle, and the circular pitch. Which of the design elements are related to DOP?
- 5.3.4 What are the advantages of helical gears?

What is the principal disadvantage of helical gears?

- 5.3.5 What factors usually are checked in inspecting gears?
- 5.3.6 How is the lead related to helix angle in a helical gear? Define the lead of a helical gear in your own terms.
- 5.3.7 How is the base circle diameter related to pressure angle (in your answer assume that all other factors remain the same).



http://www.zeiss.com/imt/Customer_Solutions/applications/reverse_engineering.htm
Reverse Engineering: the neat way from
model to data

http://www.matter.org.uk/steelmatter/metallurgy/7_1_2.html
TTT CCT diagrams