Rotary Bit Cutting Structures, an Explanation with Teeth

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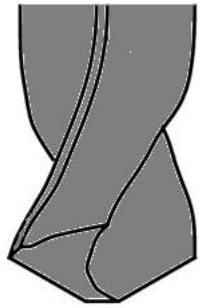
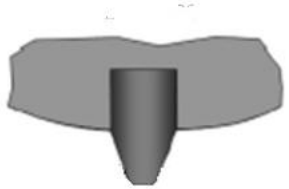
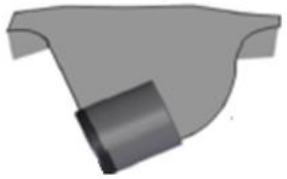
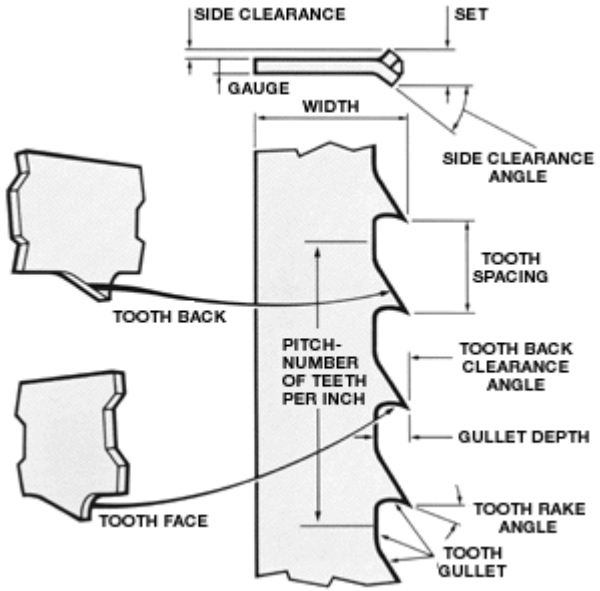
Mechanics of material removal

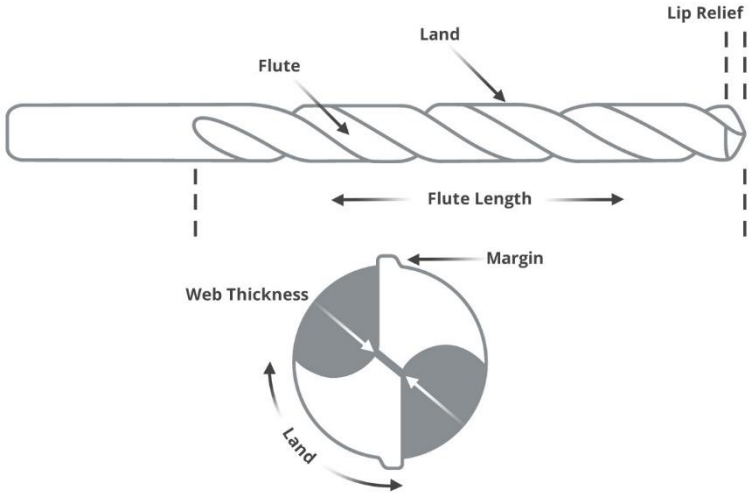
- For a cutting tool to perform work properly it must do 3 things
  - Penetrate the material
  - Create cuttings from the material
  - Evacuate the cuttings
- The cutting tool feature that performs these 3 tasks is called the Cutting Structure

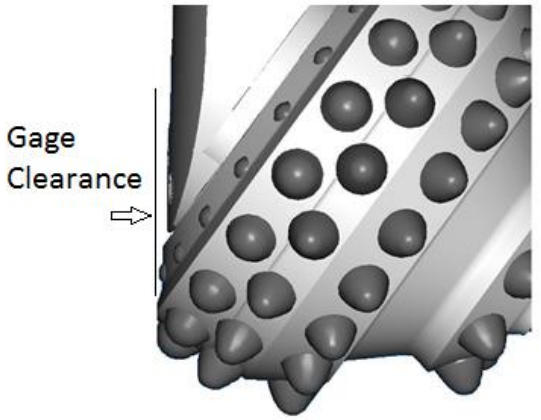






Cutting Structure Geometry

- Penetrate the material: Point Contact
- Create cuttings from the material: Tooth Shape
- Remove the cuttings: Gullet, Flute, Bit clearance
- Tool body clearance: Set, Margin or Gage Clearance

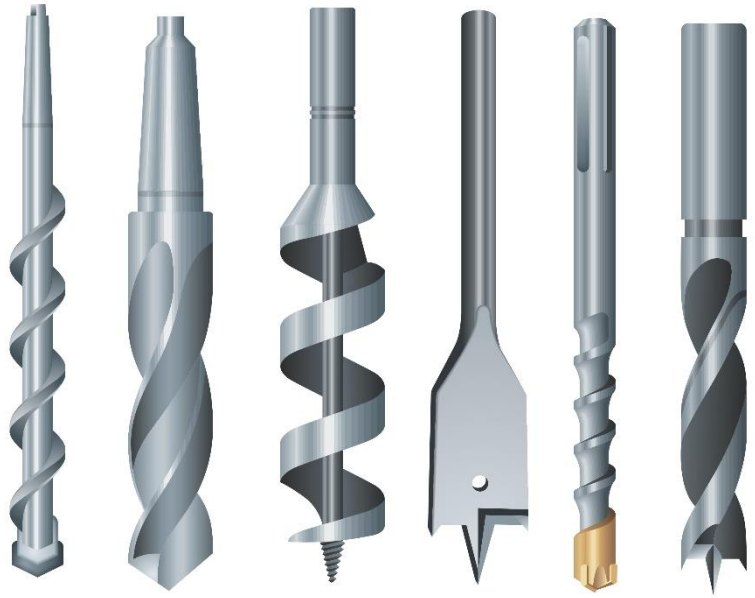






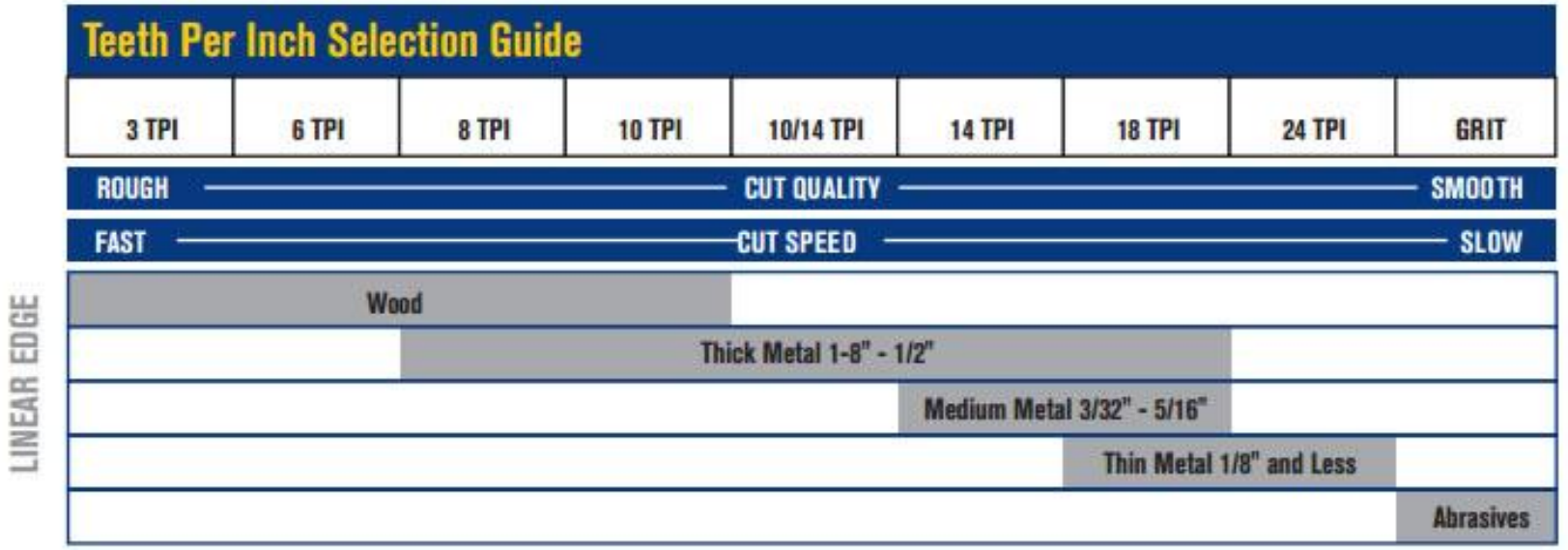
Mechanics of material removal

- The Base material, quantity, spacing, shape, length, rake angle and gullet of a tools tooth dictate How and Where a tool is to be used
  - Material best suited for the tool
  - Penetration Rate, Feed pressure or Weight on Bit



Linear Cutting Structure - Sawing

- Defined by TPI or Teeth Per Inch
  - Softer material – Longer teeth and fewer number of teeth
  - Harder material – Shorter teeth and higher number of teeth



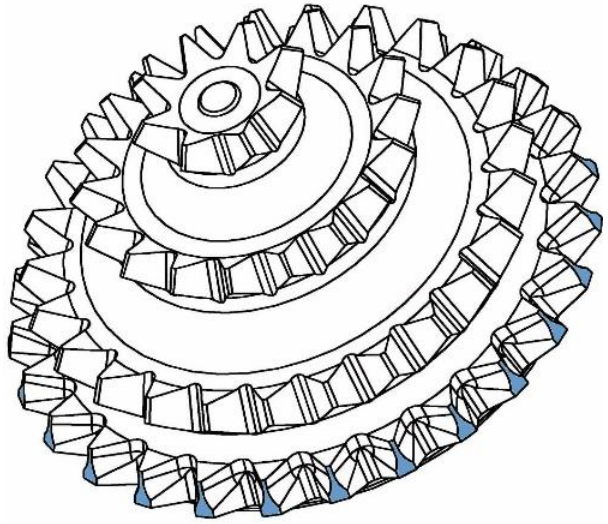
Rotary Bit Cutting Structure

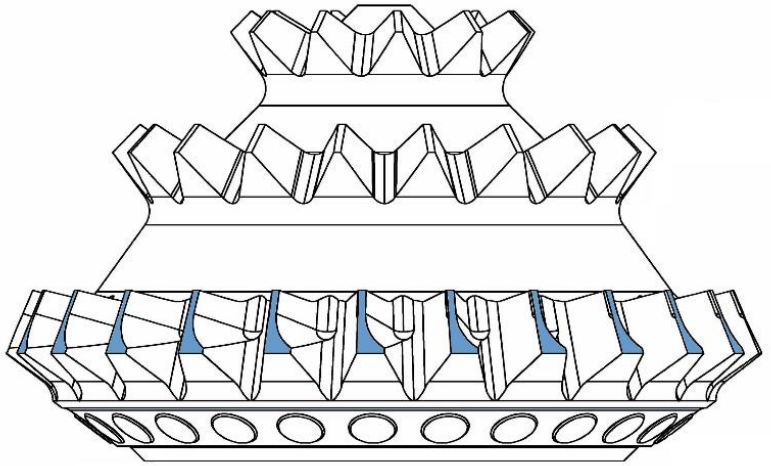
- Defined by an IADC Code
  - Softer material - Longer teeth and fewer number of teeth
    - Higher RPM's Lower Weight on Bit
  - Harder material – Shorter teeth and higher number of teeth
    - Lower RPM's Higher Weight on Bit

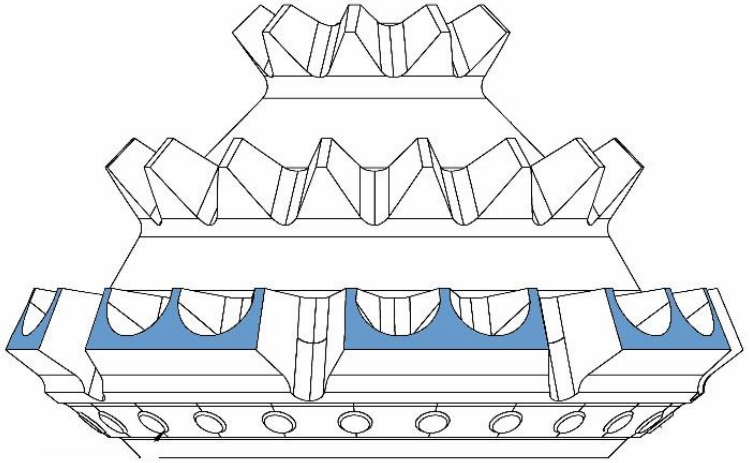
IADC 1-X-X | IADC 2-X-X | IADC 3-X-X | IADC 4-X-X | IADC 5-X-X | IADC 6-X-X | IADC 7-X-X | IADC 8-X-X

Rotary Bit Cutting Structure Shapes

- Milled Tooth (Aka: Tooth Bit, Steel Tooth Bit or Soft Bit)
  - Shape is milled out of the Bit Cone or as a Casting
  - Hardened tooth with Tungsten Carbide overlay
  - Gage row teeth will have different shapes for wear resistance to help maintain bore diameter.





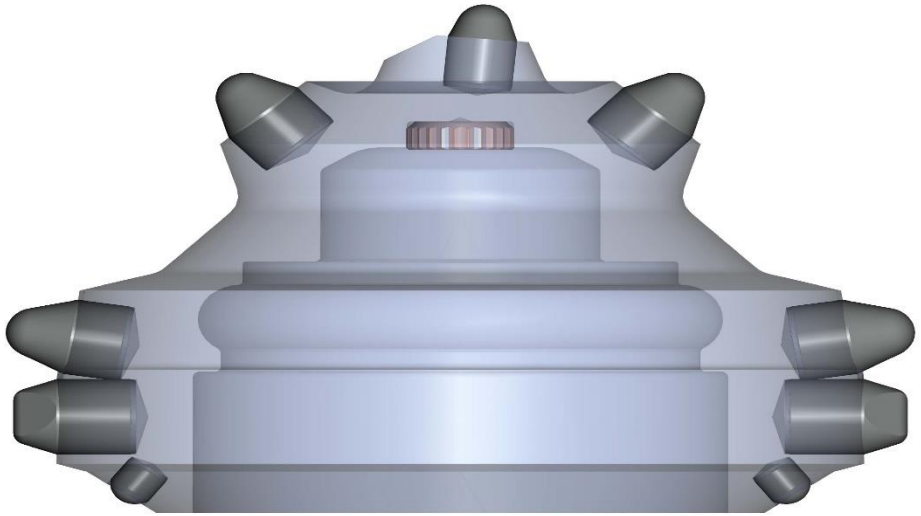


Rotary Bit Cutting Structure Shapes

- Tungsten Carbide (Aka: TCI Bit, Button Bit or Hard Bit)
  - Tungsten Carbide Inserts
  - Pressed into the bit cone
  - Soft Formations

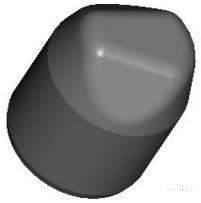
Chisel

Conical

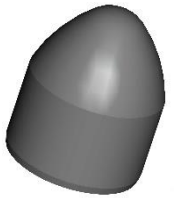


  - Hard Formations

Round Top



Wedge Crested



Ogive

Rotary Bit selection for optimal performance

- What are your ground conditions
  - Ground hardness or UCS
    - Select cutting structure based on IADC
      - Recommended Weight on Bit (WOB)
      - Recommended RPM
  - Broken Ground
    - Using a harder bit than recommended helps the cutting structure hold up better

Rotary Bit selection for optimal performance

- Do you know your actual downhole WOB (feed pressure)?
- What impacts downhole WOB?
    - Drill rig efficiency
    - Drill string friction
        - Bore length
        - Clay content
    - Drill string coiling or snaking
        - Worn or undersized drill string
        - Long bore lengths
- How do you overcome these inefficiencies to get to the recommended WOB?
    - Increase WOB if possible (see above)
    - Decrease number of cutter contact points by going to a softer bit

Summary

- The mechanical removal of material in Rotary Drilling requires 3 things
  - Penetration of the material
  - Creation of cuttings
  - Removal of cuttings
- The number of teeth or points of contact of a tool dictates
  - Material that the cutter can be used in
  - Optimal feed pressure “Weight on Bit”
  - Optimal RPM
- Increase WOB by increasing feed pressure or decreasing number of contact points
- Formation changes in a bore will require adjustments in WOB and or RPM to maintain optimal performance in Bit life and Rate of Penetration.
- Using the lowest RPM as feasible helps prolong bearing life.

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