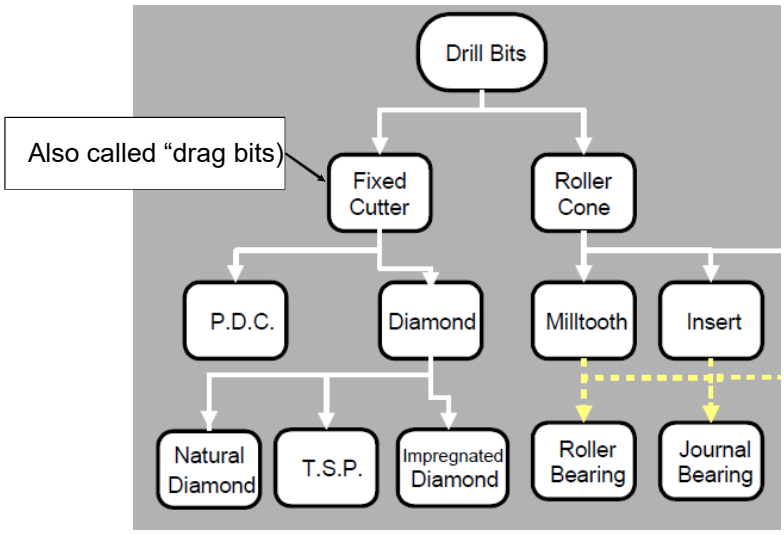
Drilling Bits I

Outline

- Bit classification
- Rock failure mechanisms and drilling mechanisms
- Roller cone bits
- IADC Classification for Roller Cone Bits
- PDC bits
- Natural diamond bits
- IADC bit wear
- Bits Strength and weakness

Drill bit classification



Rock Failure Mechanism

- Basic mechanisms of rock removal:
  1. Wedging
  2. Scraping and grinding
  3. Erosion by fluid jet action
  4. Crushing
  5. Torsion or Twisting

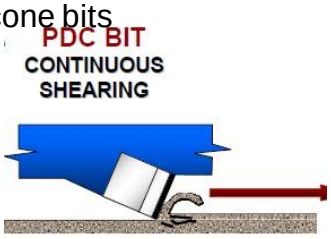
One mechanism will be more dominant than the other for a specific type of bits

We will talk about drag bits and roller cones

Failure mechanisms

Shear Failure

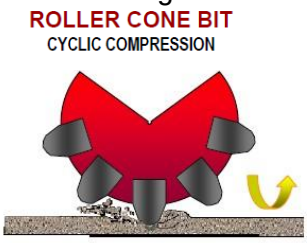
- PDC cutters are used to shear the rock with continuous scraping motion
- Shear failure will also occur when using aggressive roller cone bits



Compressive Failure

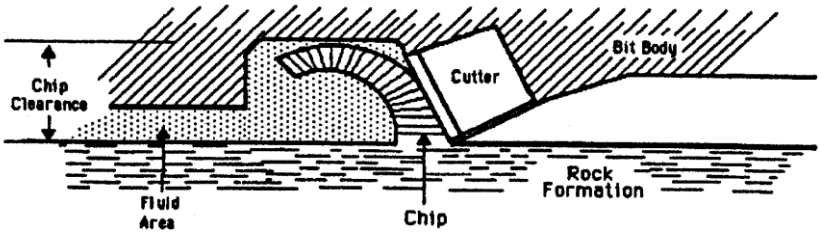
- Roller cones are designed to crush the rock

- Compressive failure might occur when using a dull PDC



Drag Bits

Drag bits drill by physically "plowing" or "machining" cuttings from the bottom of the hole.

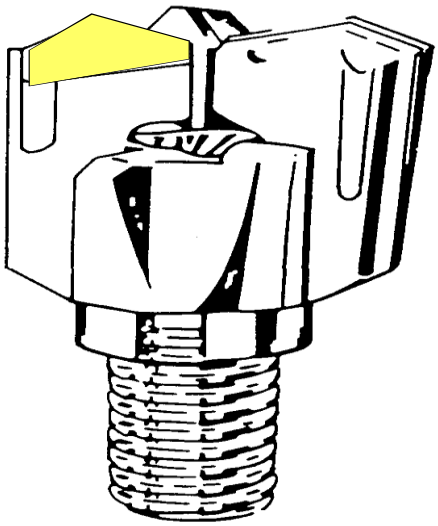


Drag Bits

Cutter may be made from:

- Steel
- Tungsten carbide
- Natural diamonds
- Polycrystalline diamond Compact(PDC)

Fishtail type drag bit



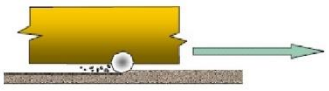
Compressive and shear drilling mechanism

Compressive and Shear Failure

- Soft/medium mill tooth bits
- Soft/medium insert bits
- PDC bits in hard

Compressive and shear drilling mechanism

- Shear/Compressive Failure



Diamond Bit
CONTIIJUOUS
CRUSHING & ABRASION

Roller cone bits

Two types of rolling cutter bits

- Steel Tooth (milled tooth)
- Carbide Tooth (tungsten carbide insert)

Advantages

- For any type of formation there is a suitable design of rock bit
- Can handle changes in formation
- Acceptable life and drilling rate
- Reasonable cost

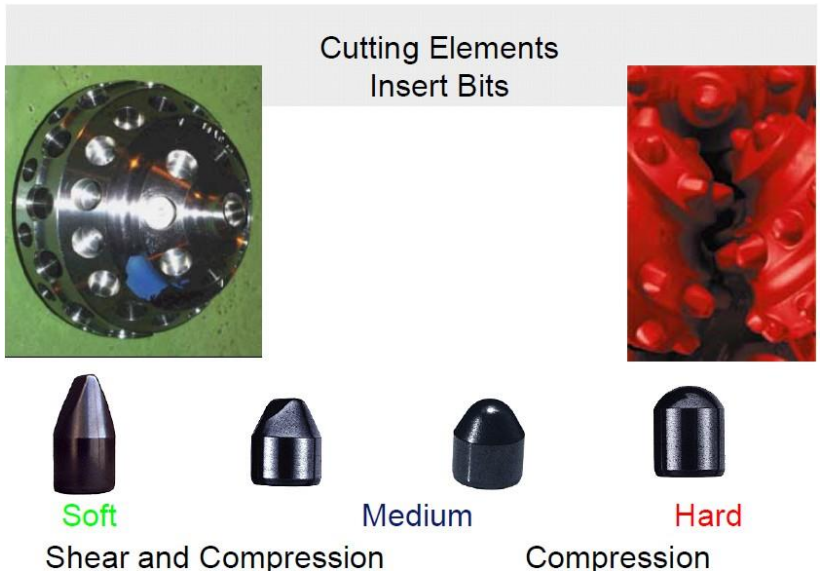
Roller cone bits

- ***Milled Tooth Bit (Steel Tooth)***
  - **Long** teeth for **soft** formations
  - **Shorter** teeth for **harder** formations
  - Self-sharpening teeth by using hard facing on one side
  - High drilling rates - especially in softer rocks

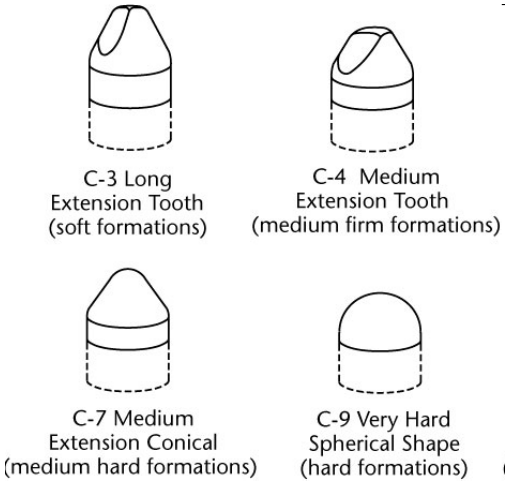
Roller cone bits

- ***Tungsten Carbide Insert Bits (TSI)***
  - Long life cutting structure in hard rocks
  - Hemispherical inserts for very hard rocks
  - Larger and more pointed inserts for softer rock
  - Can handle high bit weights and high RPM

  - (Tungsten carbide is a very hard, brittle



Tungsten Carbide Inserts



C-3 Long Extension Tooth (soft formations)

C-4 Medium Extension Tooth (medium firm formations)

C-7 Medium Extension Conical (medium hard formations)

C-9 Very Hard Spherical Shape (hard formations)

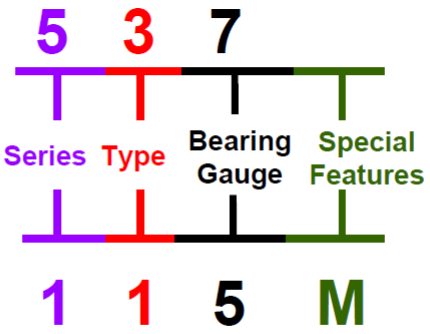
IADC Classification for Roller Cone Bits

Provides a Method of Categorizing Roller Cone Rock Bits

- 4-Character Design/Application Code
- First 3 Characters are NUMERIC
- 4th Character is ALPHABETIC

135M or 447X or 637Y

Reading the code



Sequence

135M or 447X or 637Y

- Numeric Characters are defined:
  - Series *1st*
  - Type *2nd*
  - Bearing & Gage *3rd*
- Alphabetic Character defined:
  - Features Available *4th*

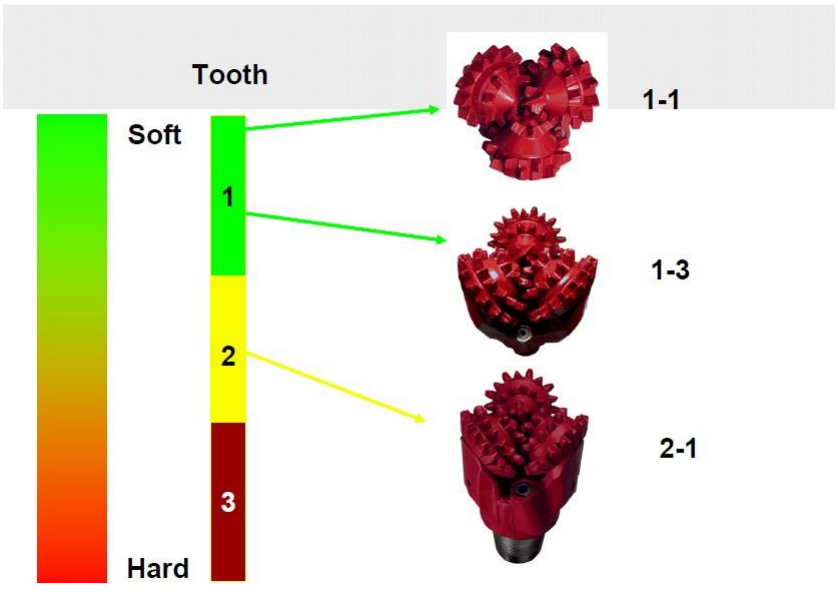
Series

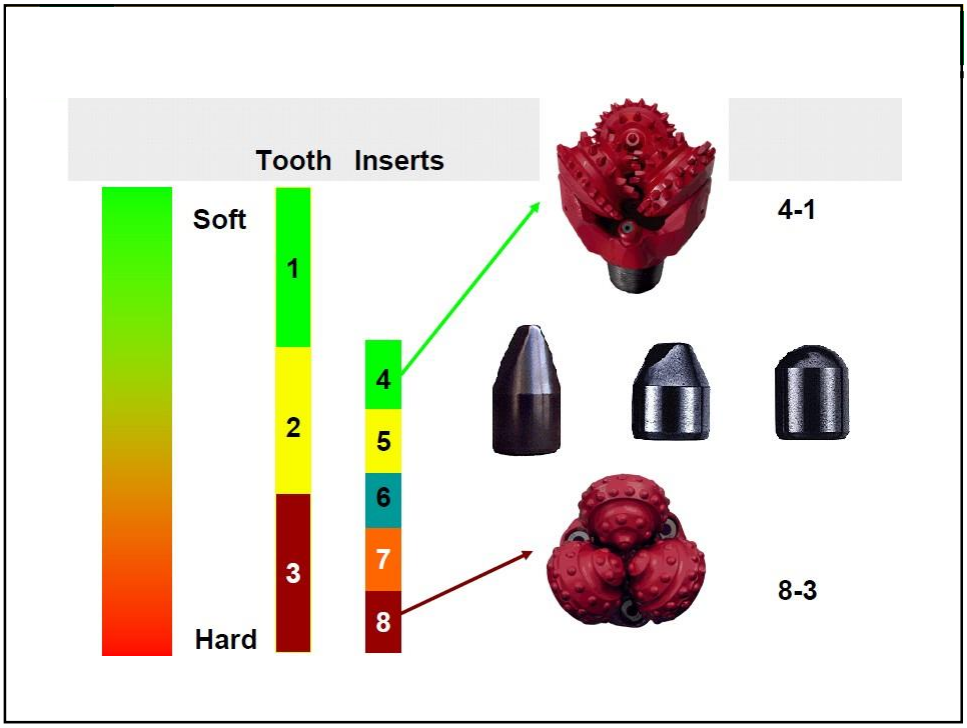
135M or 447X or 637Y

FIRST CHARACTER

- General Formation Characteristics
- Eight (8) Series or Categories
- Series 1 to 3 Milled Tooth Bits
- Series 4 to 8 Tungsten Carbide Insert Bits

The higher the series number, the harder/more abrasive the rock





Define Hardness

Hardness	UCS (psi)	Examples
Ultra Soft	< 1,000	gumbo, clay
Very Soft	1,000 - 4,000	unconsolidated sands, chalk, salt, claystone
Soft	4,000 - 8,000	coal, siltstone, schist, sands
Medium	8,000 - 17,000	sandstone, slate, shale, limestone, dolomite
Hard	17,000 - 27,000	quartzite, basalt, gabbro, limestone, dolomite
Very Hard	> 27,000	marble, granite, gneiss

UCS = Uniaxial Unconfined Compressive Strength

Type

135M or 447X or 637Y

SECOND CHARACTER

- Degree of formation Hardness
- Each Series divided into 3 or 4 'Types'
- Type 1 Softest Formation in a Series

Increasing Rock Hardness

- Type 4 Hardest Formation in a Series

Bearing & Gage

135M or 447X or 637Y

THIRD CHARACTER

- Bearing Design and Gage Protection
- Seven (7) Categories
  - 1. Non-Sealed (Open) Roller Bearing
  - 2. Roller Bearing Air Cooled
  - 3. Non-Sealed (Open) Roller Bearing Gage Protected
  - 4. Sealed Roller Bearing
  - 5. Sealed Roller Bearing Gage Protected
  - 6. Sealed Friction Bearing
  - 7. Sealed Friction Bearing Gage Protected

What are Bearings?

Bearings are what make the cones on a Tricone spin.

There are four common types of bearings:

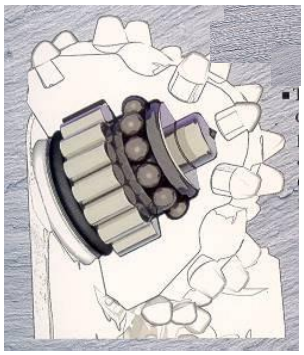
1- Standard open bearing roller bit

2- Air-cooled roller bearings

3- sealed roller bearings

4- sealed journal (friction) bearings

Roller Cone with sealed roller Bearings



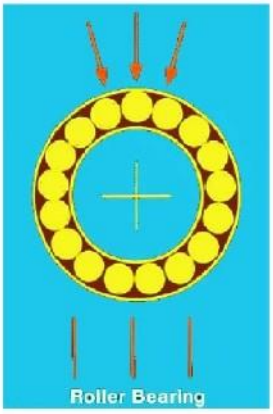
Milled Tooth Bit (Steel Tooth) with sealed roller bearings

Roller cone bearings

Friction / Journal

Roller

Roller cone bearings



Usually sealed, but may be unsealed

Features Available

135M or 447X or 637Y

FOURTH CHARACTER

- Features Available (Optional)
- Sixteen (16) Alphabetic Characters
- Most Significant Feature Listed

(i.e. only one alphabetic character should be selected)

IADC Features Available

- A - Air Application
- B - Special Bearing/Seal
- C - Center Jet
- D - Deviation Control
- E - Extended Nozzles
- G - Gage/Body Protection
- H - Horizontal Application
- J - Jet Deflection
- L - Lug Pads
- M - Motor Application
- S - Standard Milled Tooth
- T - Two-Cone Bit
- W - Enhanced Cutting structure
- X - Chisel Tooth Insert
- Y - Conical Tooth Insert
- Z - Other Shape Inserts

135M or 447X or 637Y