# NEW GRADE OF SLEEVE MATERIAL WITH IMPROVED WEAR RESISTANCE FOR FINISHING STANDS

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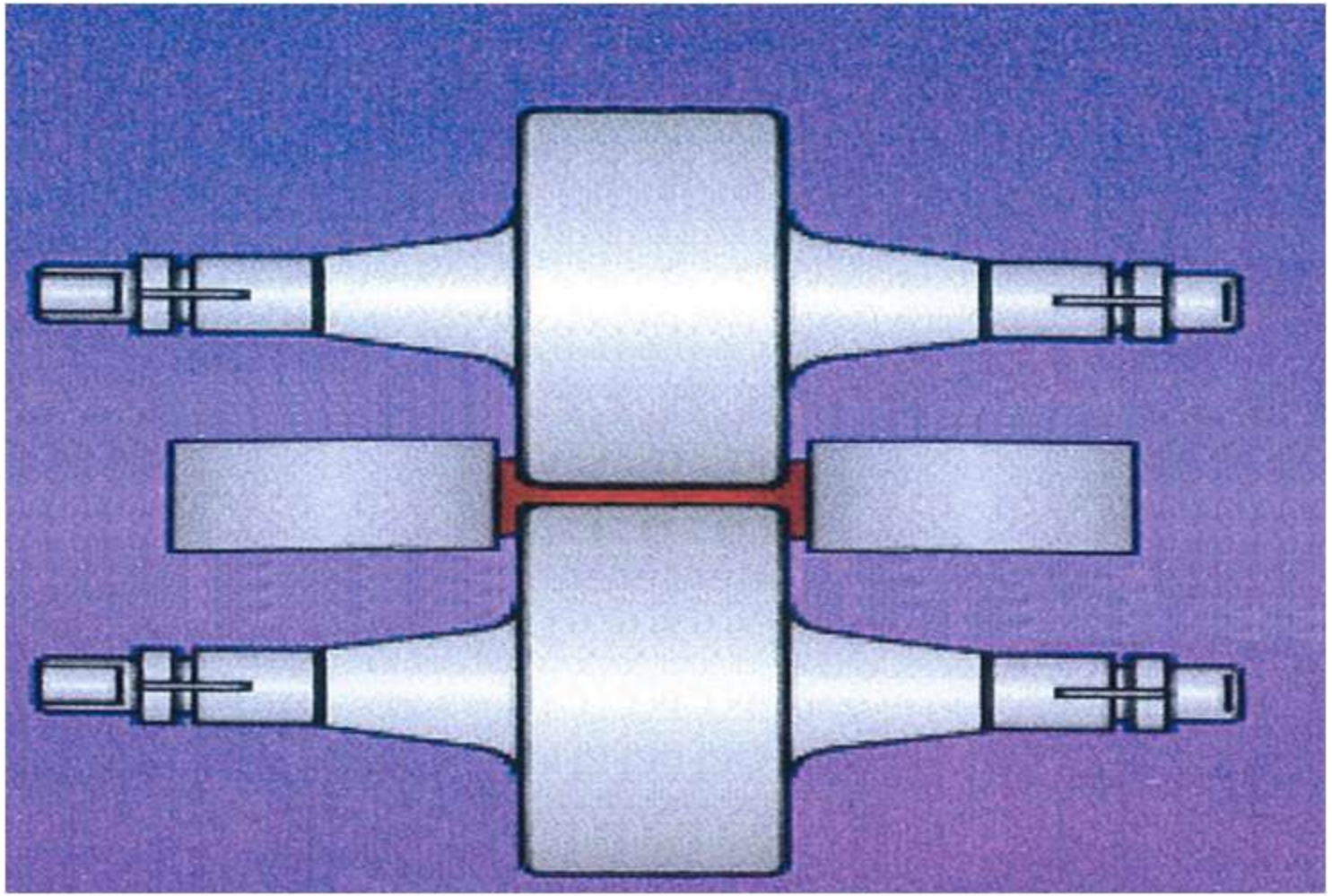
# TOPICS COVERED

- Principle Understanding of types of rolls
- Process of manufacture of sleeves
- Methodology of developing the new grade
- Differences between new grade and conventional sleeve material
- Field test results

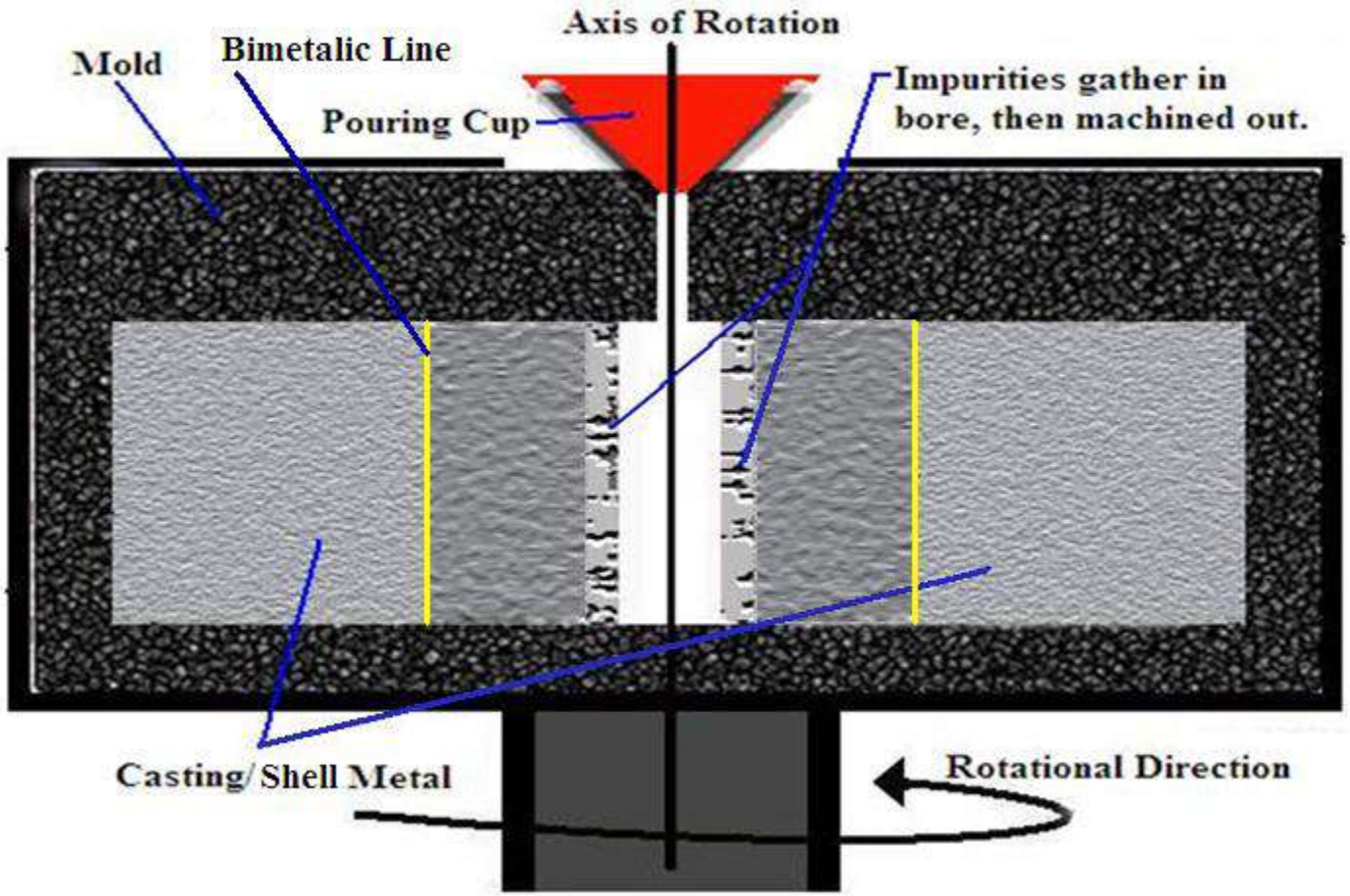
# PRINCIPLE UNDERSTANDING
## BEAM MILL-UNIVERSAL STAND



# PRINCIPLE UNDERSTANDING
# DIFFERENT ROLL DESIGNS FOR BEAM MILLS

- **Single Poured solid (Monobloc) rolls (Traditionally used)**
- **Two Piece Construction consisting of Forged steel arbor with a shrink fitted sleeve**
- **Sleeves double Poured with Harder outer shell and Softer inner core**

# PRINCIPLE OF UNDERSTANDING
## SCHEMATIC OF VERTICAL CENTRIFUGAL CASTING PROCESS



# PRINCIPLE UNDERSTANDING ADVANTAGES OF CENTRIFUGAL CASTING

- Directional solidification ( OD to ID)
- Impurities are forced out inside bore & machined out
- Finer Grain Structure
- Casting Bimetal rolls with softer core

# PRINCIPLE UNDERSTANDING

## MANUFACTURING PROCESS FLOW DIAGRAM

- Raw Material
- Melting Furnace
- Casting
- Cool Down
- Rough Machine
- Heat Treat
- Inspection Hardness/Micro
- Finish Machine
- Final Inspection

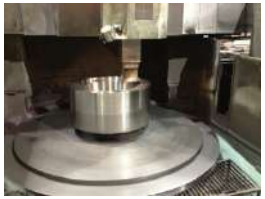

Rail

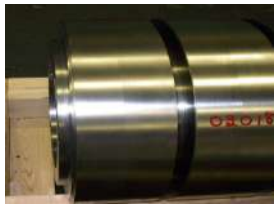

Pig Iron


Our own Roll Scrap



Alloy Additions





# PRINCIPLE UNDERSTANDING THAT SUPPORT NEW MATERIAL

## CONVENTIONAL HORIZONTAL ROLL MATERIALS

| Grade | Typical Hardness Range, Shore C scale |
|---|---|
| Adamite | 55-63 |
| Nodular Iron | 55-78 |
| High Chrome Steel | 66-73 |
| HSS | 75-85 |

# METHODOLOGY: RECOGNIZING SHORT COMINGS

- Customer experienced high wear rate at the later finishing stands using Adamite or Nodular Iron sleeve
- Traditional Adamite grade hardness (abrasive wear resistance) limited to 65-67 shore max.
- Traditional Nodular Iron grade hardness is limited to 70-72 shore max.
- Adamite & NI perform well during initial campaign but tend wear faster during later part of campaign.

# METHODOLOGY: MICRO CONSTITUENTS THAT AFFECT THE SLEEVE PERFORMANCE

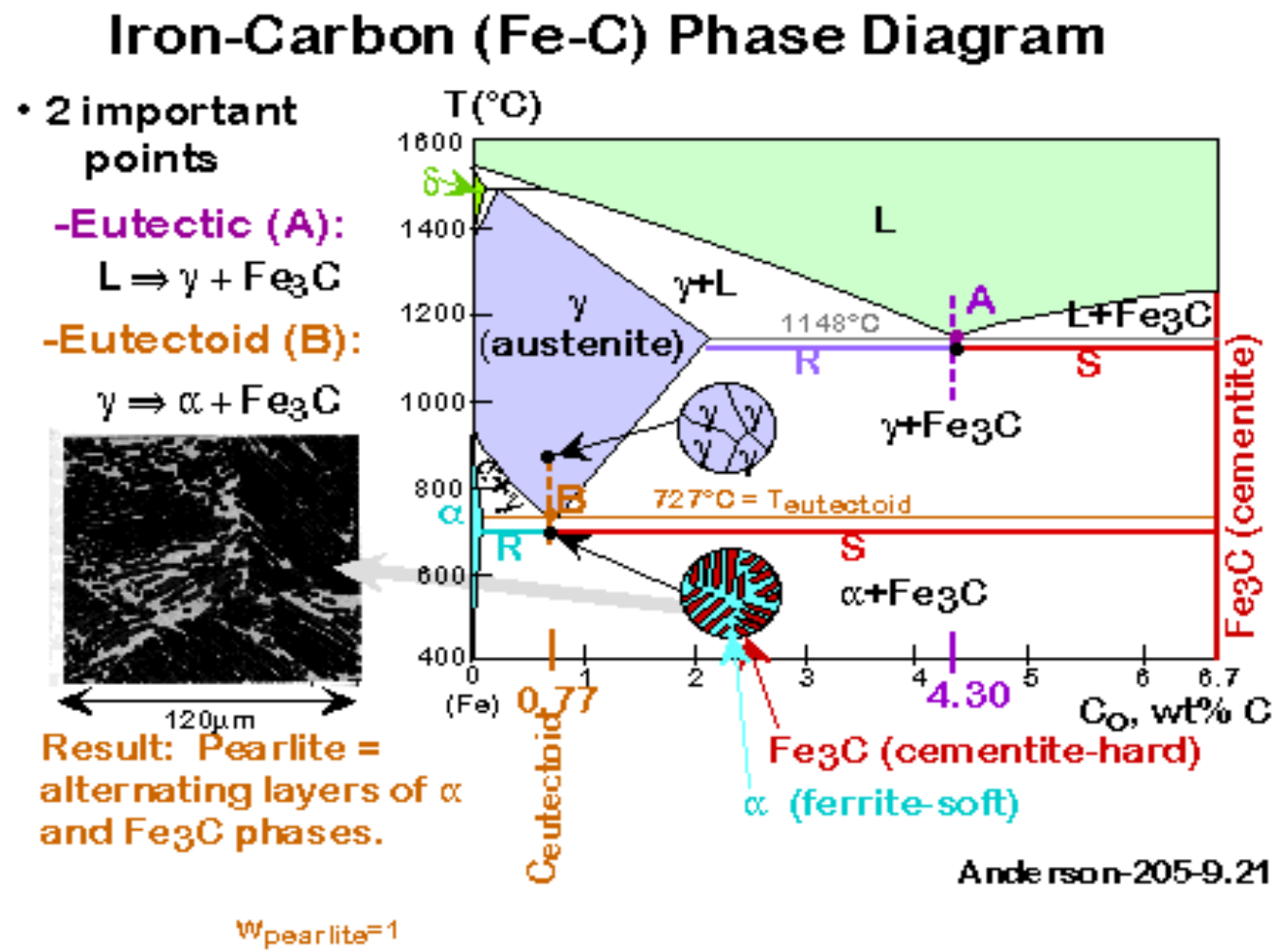
- **PERCENTAGE CARBIDES**
  **(Eutectic Carbides & Secondary Carbides)**

- **TYPE OF CARBIDES**
  **(Iron Carbides, Chrome Carbides, Moly Carbides)**

- **TYPE OF MATRIX**
  **(Pearlite, Bainite/Acicular)**

- **GRAPHITE**
  **(Morphology of Graphite)**

# IRON- CARBON PHASE DIAGRAM



# METHODOLOGY: UNDERSTANDING THE CAUSES OF SHORTCOMINGS

**Adamite Grade:**

**Carbon Content: 1.5 to 2.2 %**

**Amount of Primary/Eutectic Carbides form during solidification is Restricted to about 20 %**

**Nodular Iron Grade:**

**Carbon Content: 3.0 to 4.0 %**

**Nodular Irons have higher percentage of Eutectic carbides ( 25 to 33 %). They have softer matrix ( Pearlite or upper Bainite)**

# METHODOLOGY: ESTABLISHING THE OBJECTIVES FOR THE NEW GRADE

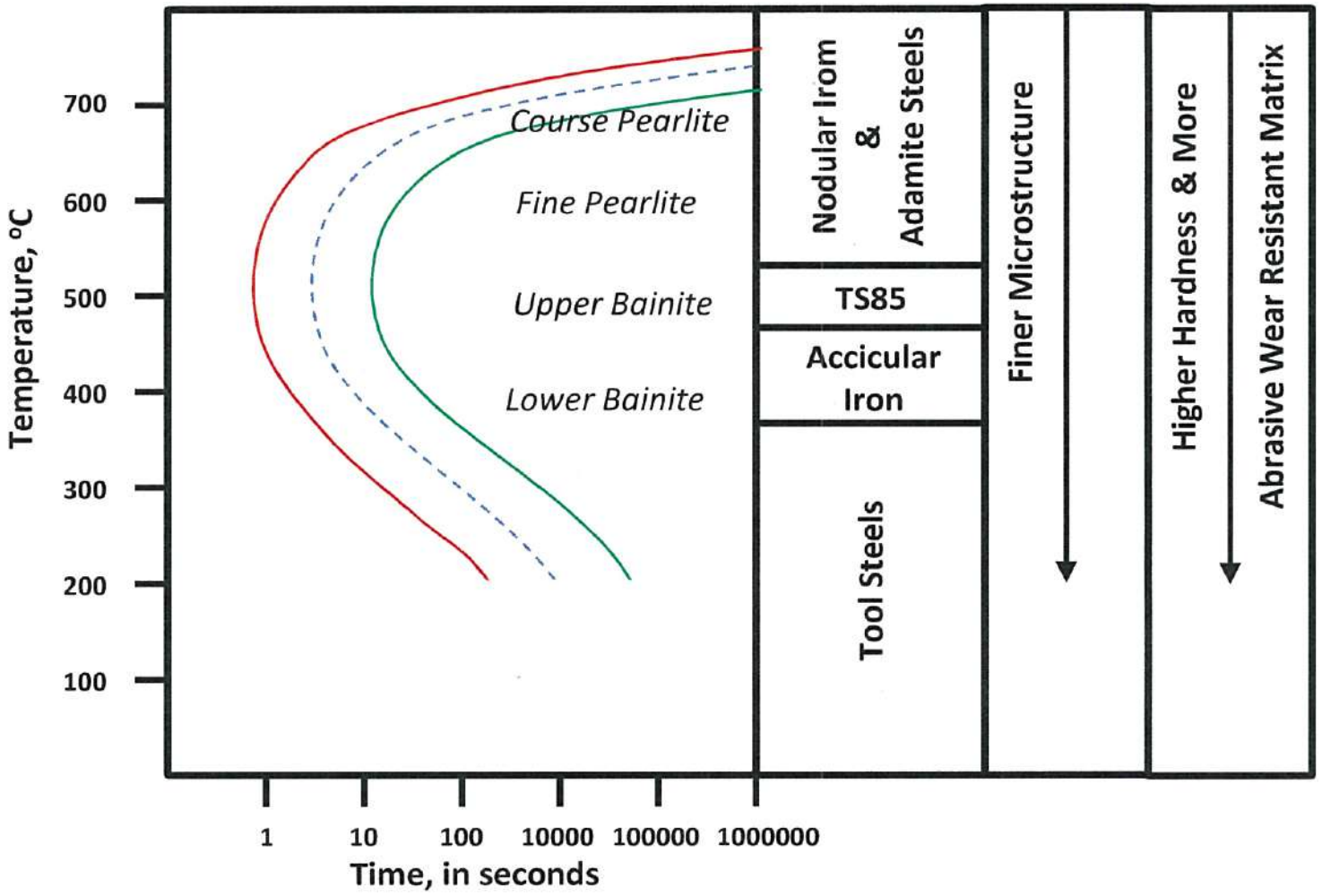
**The Composition and Processing are Selected to provide:**

- **Optimum Amount of Eutectic Carbides**
  - **Special Secondary Carbides**
    - **Harder and Tougher Matrix**

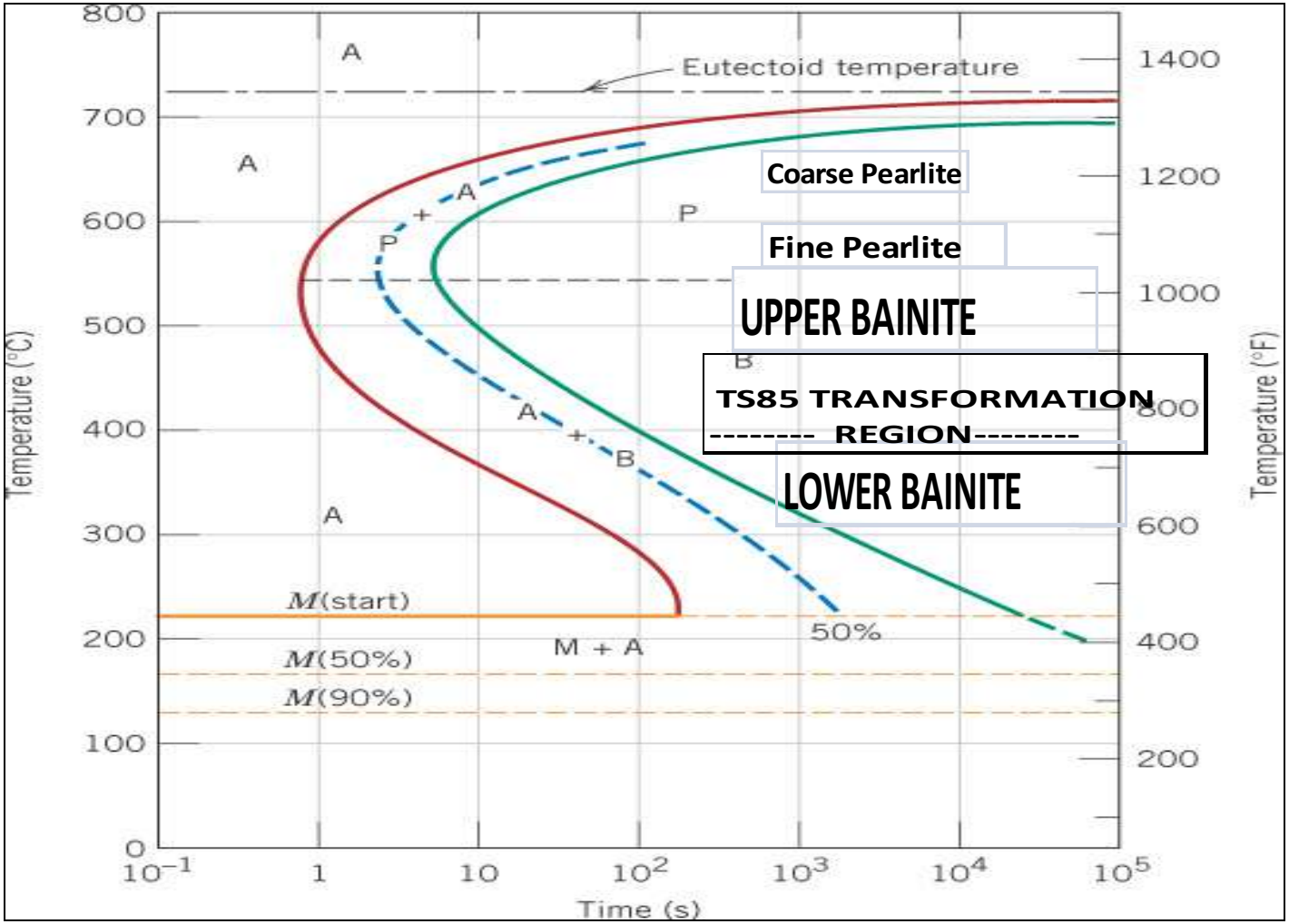
# DIFFERENCES IN CHEMICAL COMPOSITION
## ADAMITE, NODULAR IRON & NEW GRADE

| Grade | C | Si | Mn | Cr | Ni | Mo | Others |
|---|---|---|---|---|---|---|---|
| Adamite | 1.50-2.30 | 0.50- 0.90 | 0.5-1.00 | 1.00 -4.30 | 1.00- 1.50 | 0.15- 0.50 | --- |
| Nodular Iron | 3.00- 3.40 | 1.30-2.10 | 0.30-0.70 | 0.15-0.90 | 1.90-2.50 | 0.15-0.50 | --- |
| New Grade TS85 | 1.90- 3.30 | 0.50-1.50 | 0.30-1.00 | 0.50-2.00 | 2.00-5.00 | 0.15- 1.00 | Nb, V,W upto 2.00 |

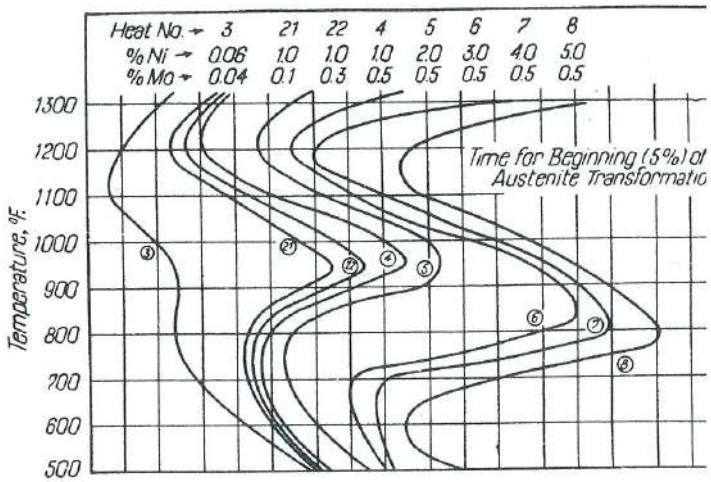
# DIFFERENCES: MATRIX TRANSFORMATION SCHEMATIC TTT DIAGRAM

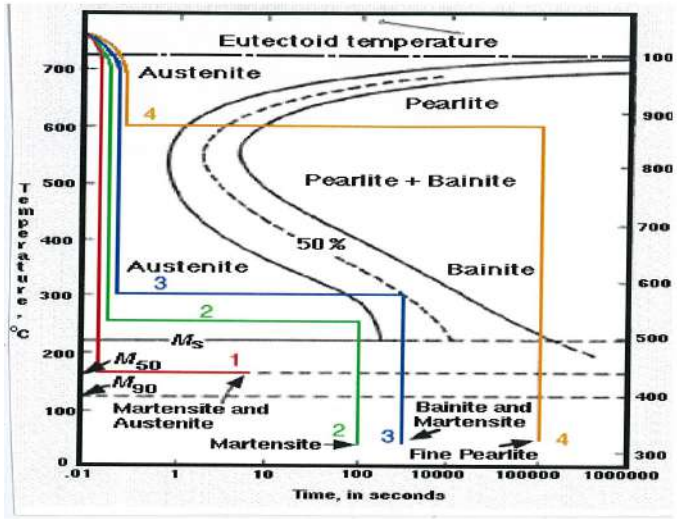


# DIFFERENCES: TS85 MATRIX TRANSFORMATION REGION



# CONTROL OF COMPOSITON AND COOLING TO ACHIEVE THE DESIRED TRANSFORMATION

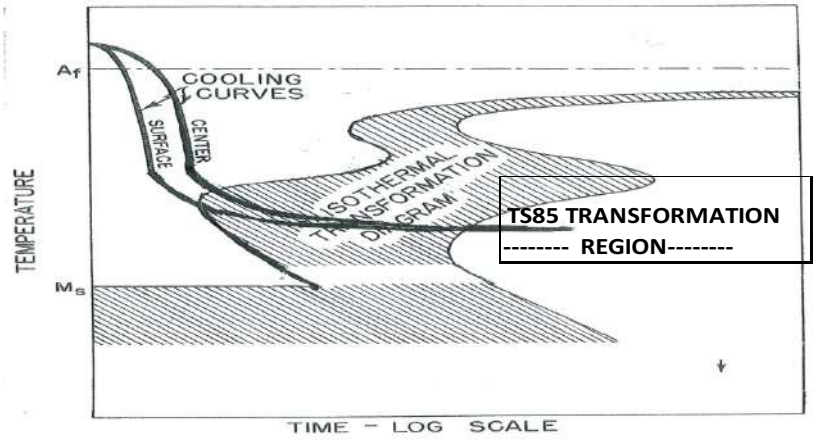



**2nd curve left (#21) 1% Ni, 0.1 Mo**

**Right extreme curve (#8) 5 % Ni, 0.5 Mo**

TTT diagram with 2.5 C, 2% Si

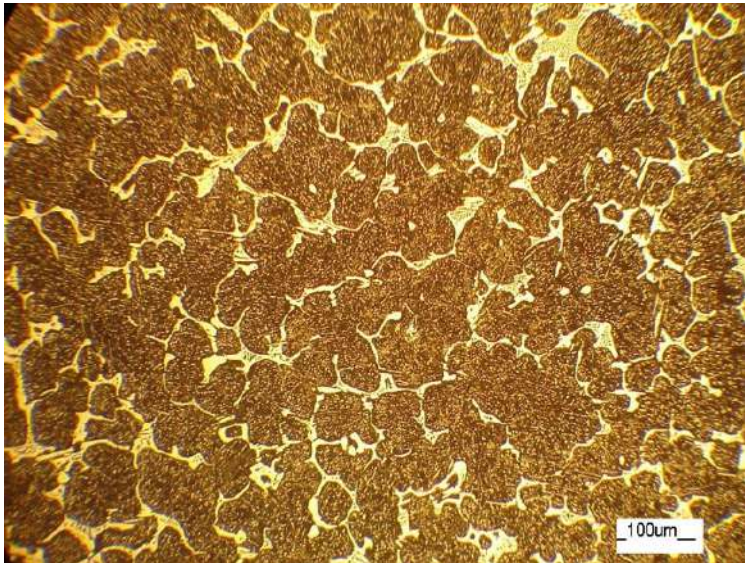


# DIFFERENCES: SPECIAL CARBIDES

## MICRO HARDNESS & CRYSTAL STRUCTURE OF VARIOUS CARBIDES

| Carbide | Micro Hardness (Vickers Scale) | Crystal structure |
|---|---|---|
| Fe(3)C | 800- 1090 | Orthorhombic |
| (Fe Cr)3 C | 850- 1370 | Orthorhombic |
| Mo(2)C | 1500-1650 | Hexagonal |
| NbC | 2400 | Cubic |
| Cr(3) C(2) | 1300 | Orthorhombic |
| VC | 2400- 2600 | Hexagonal |

# DIFFERENCES: CARBIDE CONTENT
## MICROSTRUCTURE OF ADAMITE & NEW GRADE




**Microstructure of Adamite**

**100 X 2% Nital AS100***

**Est. % of Primary/Eutectic carbides = 18 %**


**Microstructure of TS85***

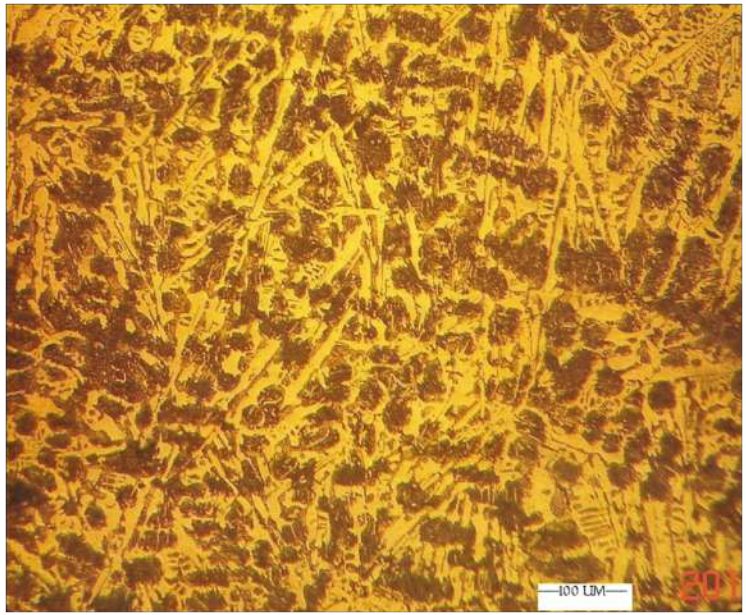
**100 X 2% Nital**

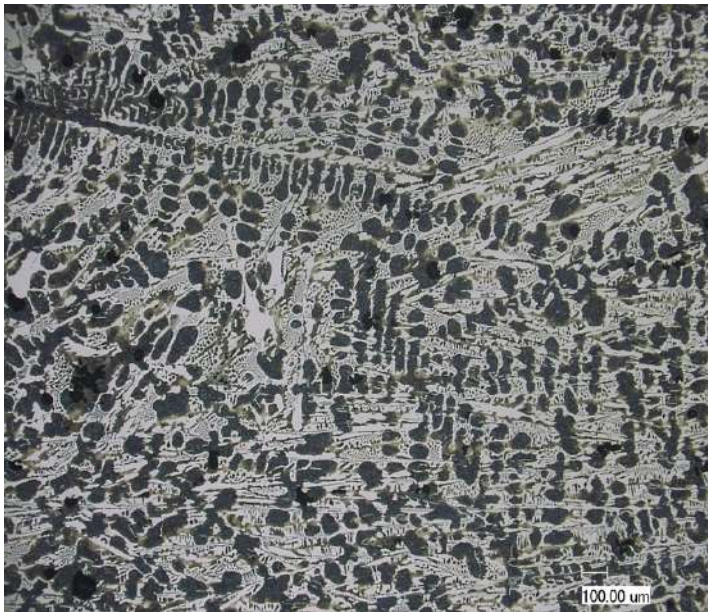
**Est. % of Primary/Eutectic carbides = 33 %**

***AS100 is MCC International trade name for Adamite**

**TS85 is MCC International trade name for new grade**

# DIFFERENCES: CARBIDE CONTENT
# MICROSTRUCTURE OF NODULAR IRON & TS85




**Microstructure of Nodular Iron Roll NI70***

**% of Primary/Eutectic carbide= 24 %**

**(100 x 2% nital etch)**

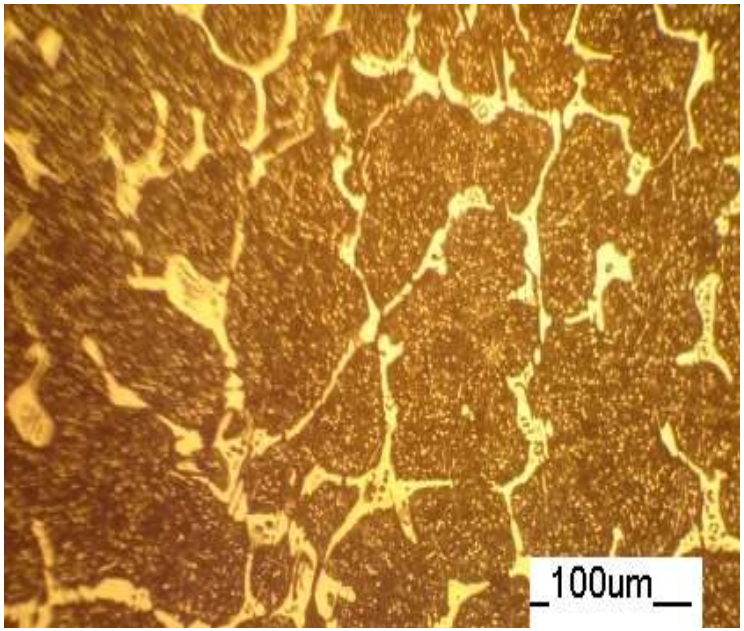
**Microstructure of TS85 Roll**

**% of Primary/Eutectic carbide= 33 %**

**(100 x 2% nital etch)**

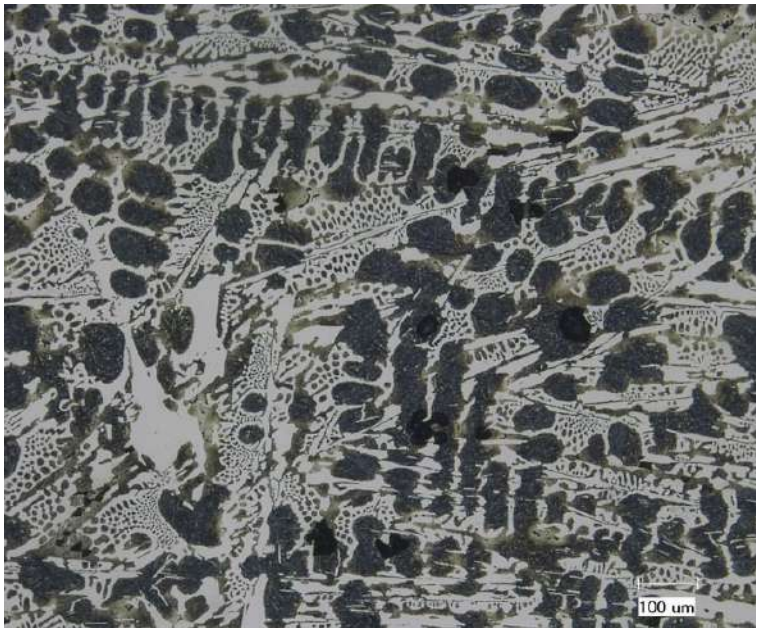
***NI70 is MCC International trade name for Nodular Iron ( 70 Sh.)**

# DIFFERENCES: MICROSTRUCTURAL DIFFERENCES OF ADAMITE & TS85*




**Microstructure of Adamite**

**200 x** **2 % Nital etch**

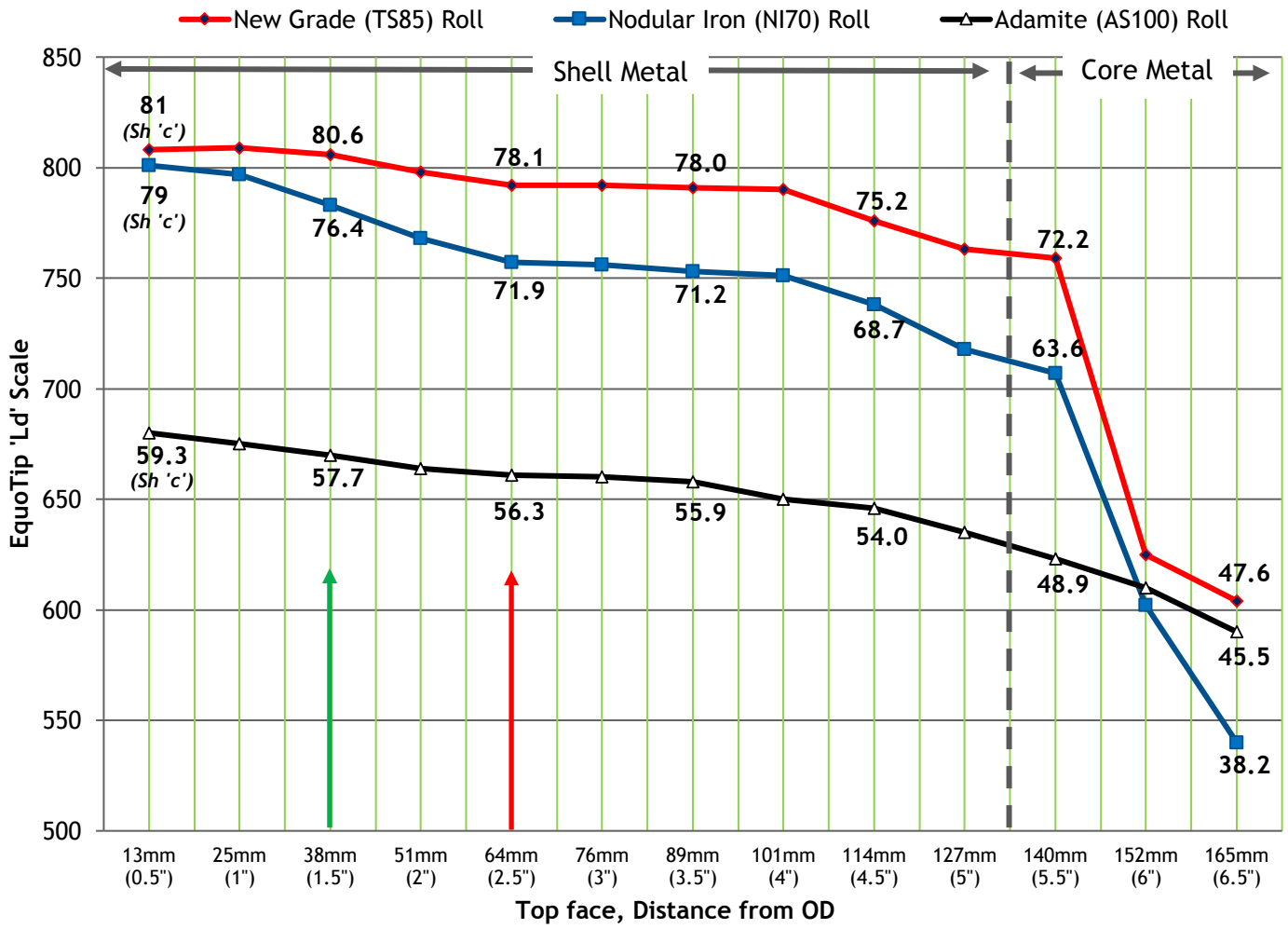



**Microstructure of TS85**

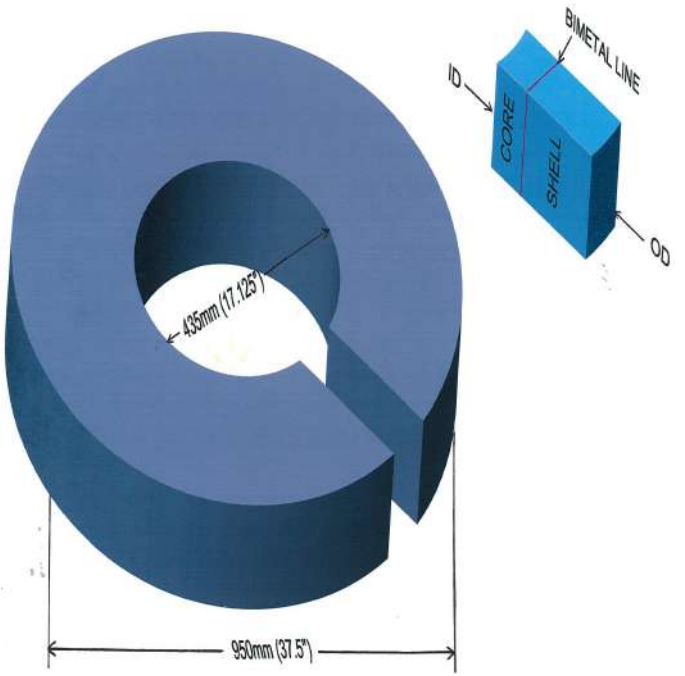
**200 x** **2 % Nital etch**

**TS85 is MCC International trade name for new grade**

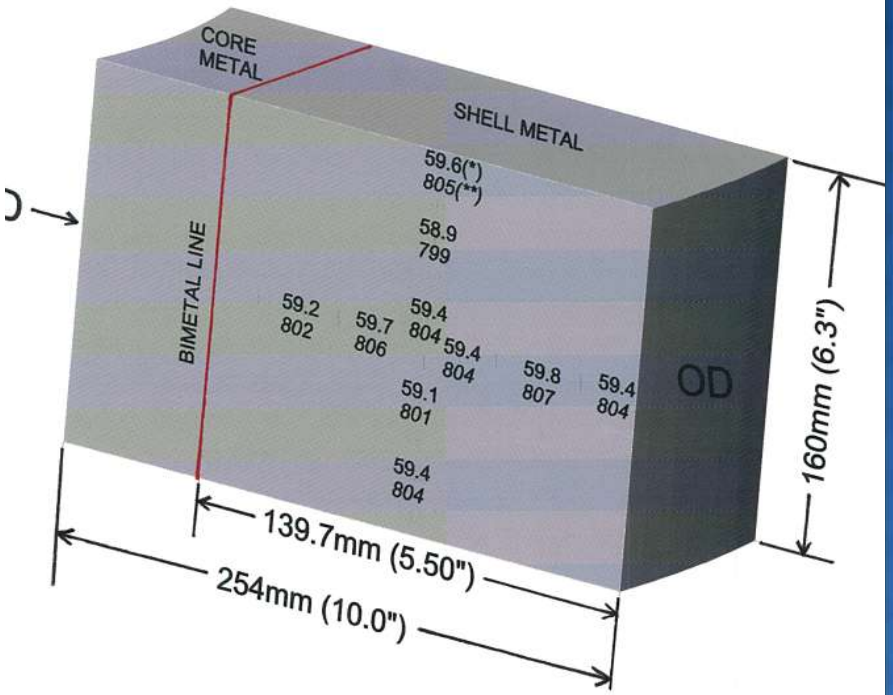
# DIFFERENCES: HARDNESS DATA ADAMITE,NI & TS
## COMPARISON OF HARDNESS PROFILE ON THE FACE



# SCHEMATIC OF SAMPLE FOR MICRO AND HARDNESS




Schematic of sample cut from the roll for hardness & micro.

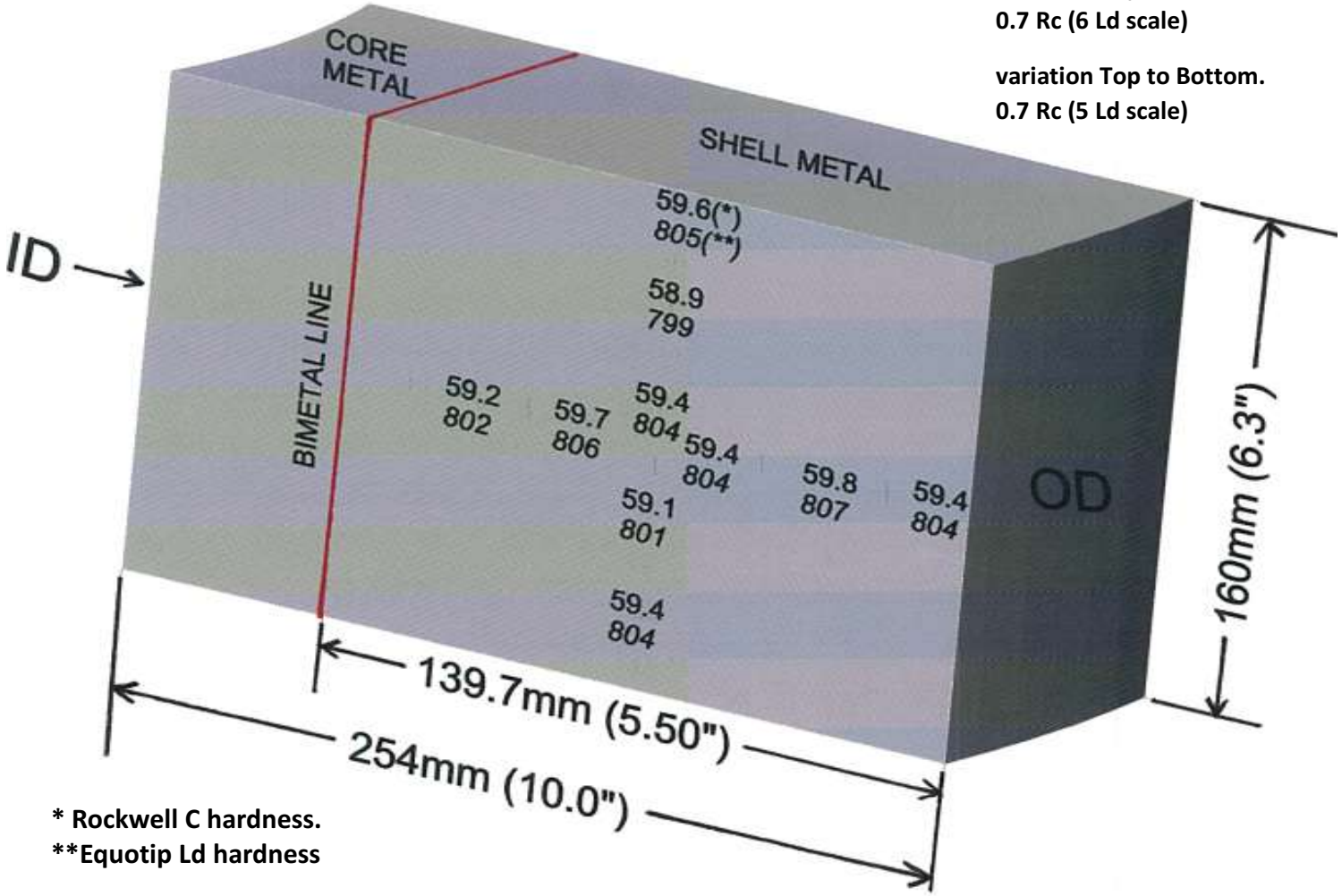



Hardness reading from Top face to bottom face & thru' the wall thickness.

# DIFFERENCES: HARDNESS DATA THRU' THE SECTION THICKNESS

**variation Top to Bottom.**
**0.7 Rc (6 Ld scale)**

**variation Top to Bottom.**
**0.7 Rc (5 Ld scale)**




*** Rockwell C hardness.**
****Equotip Ld hardness**

# RESULT: SUCCESSFUL APPLICATION FILED TESTING _PROCESSING W6X6 BEAM

**Stands 7-12 with a W6x6 in them**

# RESULT: MINIMUM WEAR ON SLEEVE SURFACE. TS85 ROLL WEB AT 500 TONS, JUST STARTING TO WEAR, BUT STILL HAS LATHE MACHINING MARKS.

# RESULTS: MINIMUM DEGRADATION AFTER 1000 TONS. TS85 SLEEVE WEB STILL LOOKS GOOD. THE SCALE WILL BREAK AFTER THE STRAIGHTENER

# RESULTS: FINISHER ROLL AFTER 1123 TONS. TS85 SLEEVE CHANGED ONLY BECAUSE IT HAD A GUIDE MARK IN THE CENTER OF THE PASS.

# RESULTS: NO MARKINGS ON THE FLANGE SURFACE. W6 X6 FLANGE SURFACE AFTER PROCESSING 1000 TONS

**Surface looks very good except for light scale & water marks**

# RESULTS: COMPARISON OF DRESSING REQUIRED. AVERAGE ROLLING CAMPAIGN & AMOUNT OF DRESSING FOR ADAMITE, NODULAR IRON & TS85

| Sleeve material | Average tons/ rolling | Amount of dressing for clean up |
|---|---|---|
| Adamite* | 425 | 15-20mm |
| Nodular Iron ** | 1000 | 8 mm |
| New grade ( TS85) | 1150 | 4-5 mm |

* MCC AS100 Grade.
* *MCC NI70 Grade.

# RESULTS: FLANGE DIMENSIONAL CONSISTANCY. LASER BAR GAGE SHOWS HOW CONSISTENT ARE THE FLANGE WIDTH

# RESULTS: SUCCESSFUL APPLICATION
# BEAM COMING OUT FINISHING STAND

# SUMMARY

- An overview of Vertical Centrifugal Casting is provided.
- Limitation of Conventional Sleeve ( roll) material is explained ( Carbide content, matrix)
- The chemistry range and the final microstructure of the new Grade (TS85) is provided
- The hardness profile for the new Grade is compared with Traditional Adamite and Nodular Iron grades
- The field test results of the sleeve performance is provided.

# CONCLUSIONS

- The test results show when rolling w6 x6 beam using the new material grade (TS85*), required 70% less dressing compared to conventional Adamite Sleeve and 50% less compared to Nodular Iron grade.

- By replacing conventional sleeves ( Adamite/ Nodular iron) with TS85 customer achieved the following:

1. LESS ROLL DRESSING BETWEEN CAMPAIGN
2. REDUCED THE NUMBER OF ROLL CHANGES
3. MINIMIZED ROLL ADJUSTMENTS DUE TO MORE CONSISTANT BAR
4. IMPROVED PRODUCTIVITY

* TS85 is MCC International trade name for the new grade.

# FINAL REMARK

- Hardness is only one part of equation for improved performance(optimum micro-structure provides significant improvement in fire cracking and fatigue resistance)
- Changing the sleeve at the same interval or taking same amount of dressing defeats the purpose of new and improved roll materials
- Keeping good data on rolling campaign (tonnage, dressing) is the key for increased Mill Productivity.

- **THANK YOU ALL**

# SEM PICTURE SHOWING THE SPECIAL SECONDARY CARBIDES IN THE MICRO