

Progress in Carbide Rolls and Technical Services

MMC RYOTEC Corporation

A Group Company of  MITSUBISHI MATERIALS



EF-517E-2310

Attendee :

Joji “George” Yoshida

Sales Representative

Sales Div., Wear Resistant Tools

Gr.

Jun Hashimoto

Roll Design Engineer

Wear Resistant Tools Div.

1. Introduction
2. Carbide rolls and Steel Industry
3. Advantages of Carbide
4. Things to consider when using carbide
5. Ring Slip and Clamping System
6. Future Initiatives (Developments)
7. Conclusion
8. Q&A

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Introducing Carbide Rolls

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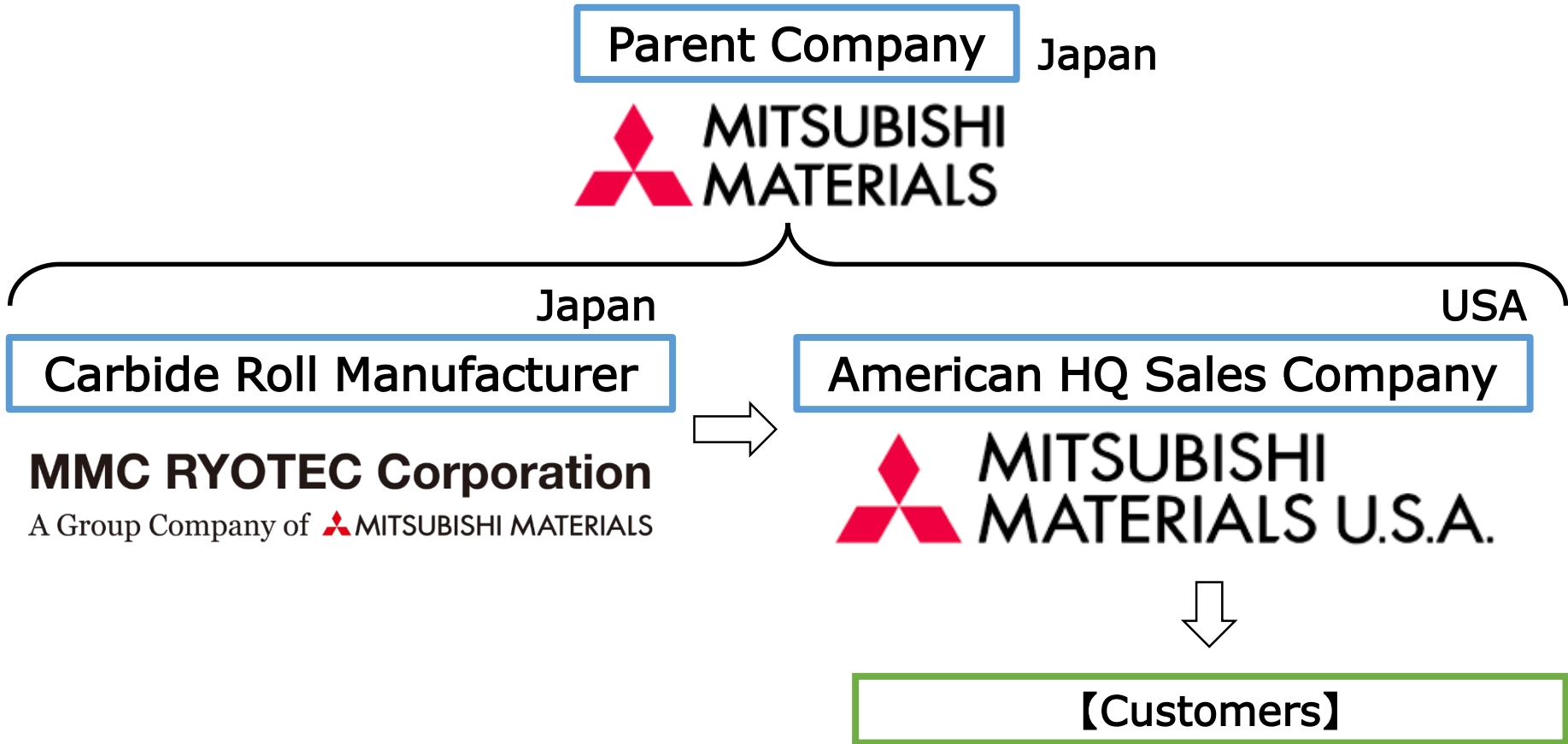
- MMC RYOTEC Corp. has been supplying ring rolls, 3-rolls and composite rolls made with our **original tungsten carbide grade**.



- We share the intensive technology with Mitsubishi Materials, who have their **own production system from development and manufacturing of raw material powder to carbide rolls**.

Introducing Carbide Rolls

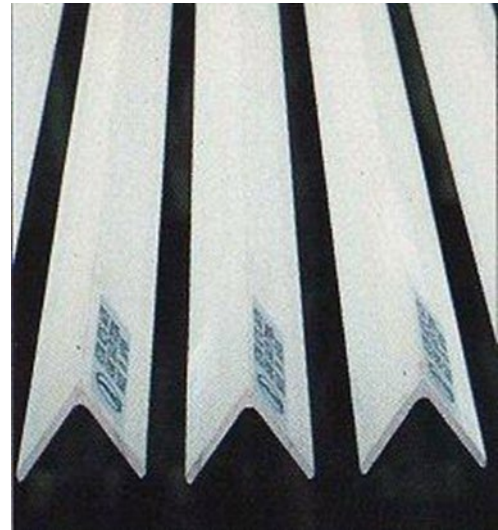
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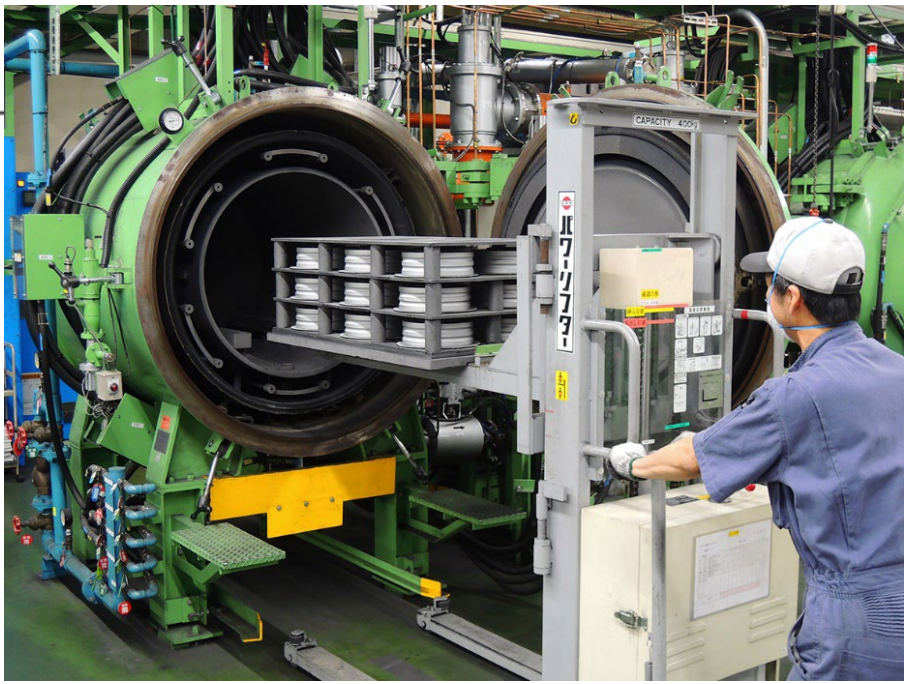
Connection with steel industry

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- Our carbide rolls are mainly used for manufacturing **wire rod, rebar** and **angle steel (structural steel)** products.



- We have been supplying carbide rolls for more than **50 years** to steel mills worldwide.

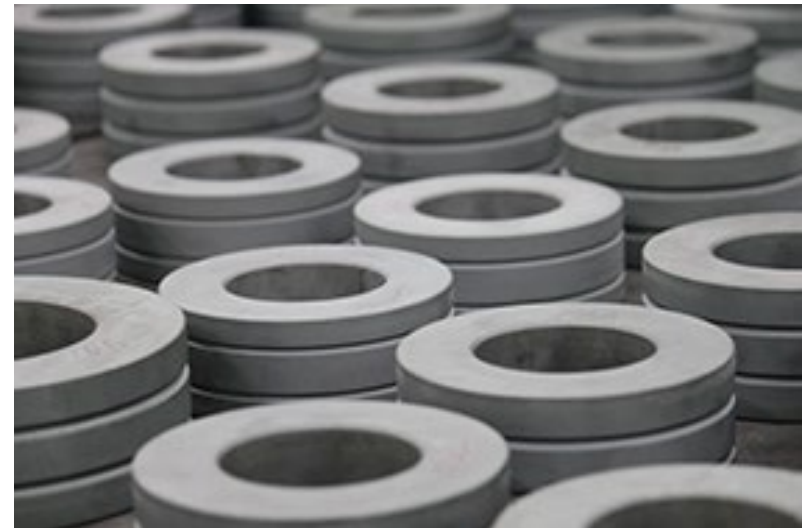


Supply Record

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Supplied from **early 1970s**...

- Leading supplier in Japan.
- A lot of supply records not only in Asia but also in Europe and America.
- Our strong products: Composite rolls **more than 5,000 sets** supplied.



Supply Record

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We do business with more than 10 countries around the world.

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World's steel industry is actively working towards decarbonization due to ...

- **Concern of Climate change**
- **Global trend of SDGs**

Tungsten carbide rolls are effective against major problems in steel rolling such as wear and cracks, and **eventually reduces the use of steel raw materials**, rather than purchasing ductile cast iron rolls several times.

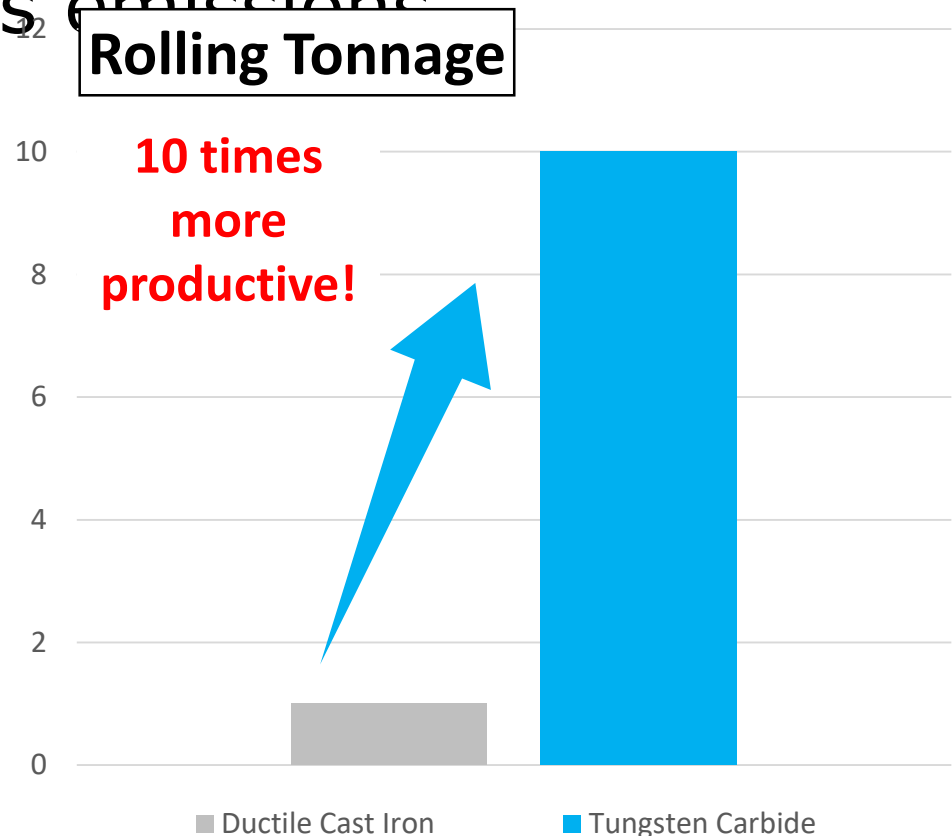


MMCR can help curb these environmental problems from these points of view.

Improving energy efficiency

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- Tungsten carbide roll may also contribute to optimize steel mill's production processes to reduce energy consumption and greenhouse gas emissions.
- Compared to ductile cast iron rolls, the total **rolling tonnage is 10 times better** maximum. Able to reduce redress amount and times.



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Positioning of Carbide Rolls

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The main features of tungsten carbide are...

- **High hardness** : Harder than high speed steel and ductile cast iron used for rolls.
- **Wear resistance** : Maintains high durability.
- **Corrosion resistance** : Strong against chemical corrosion.



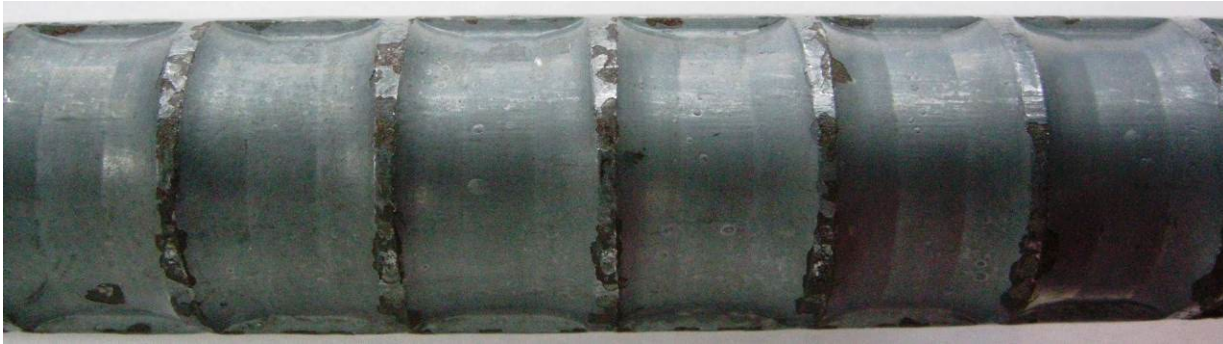
- What kind of advantages does carbide have for hot rolling?

Good balance and high performance of hardness and toughness.

Positioning of Carbide Rolls

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Dramatically improves the appearance of rebar.



Finishing with carbide rolls

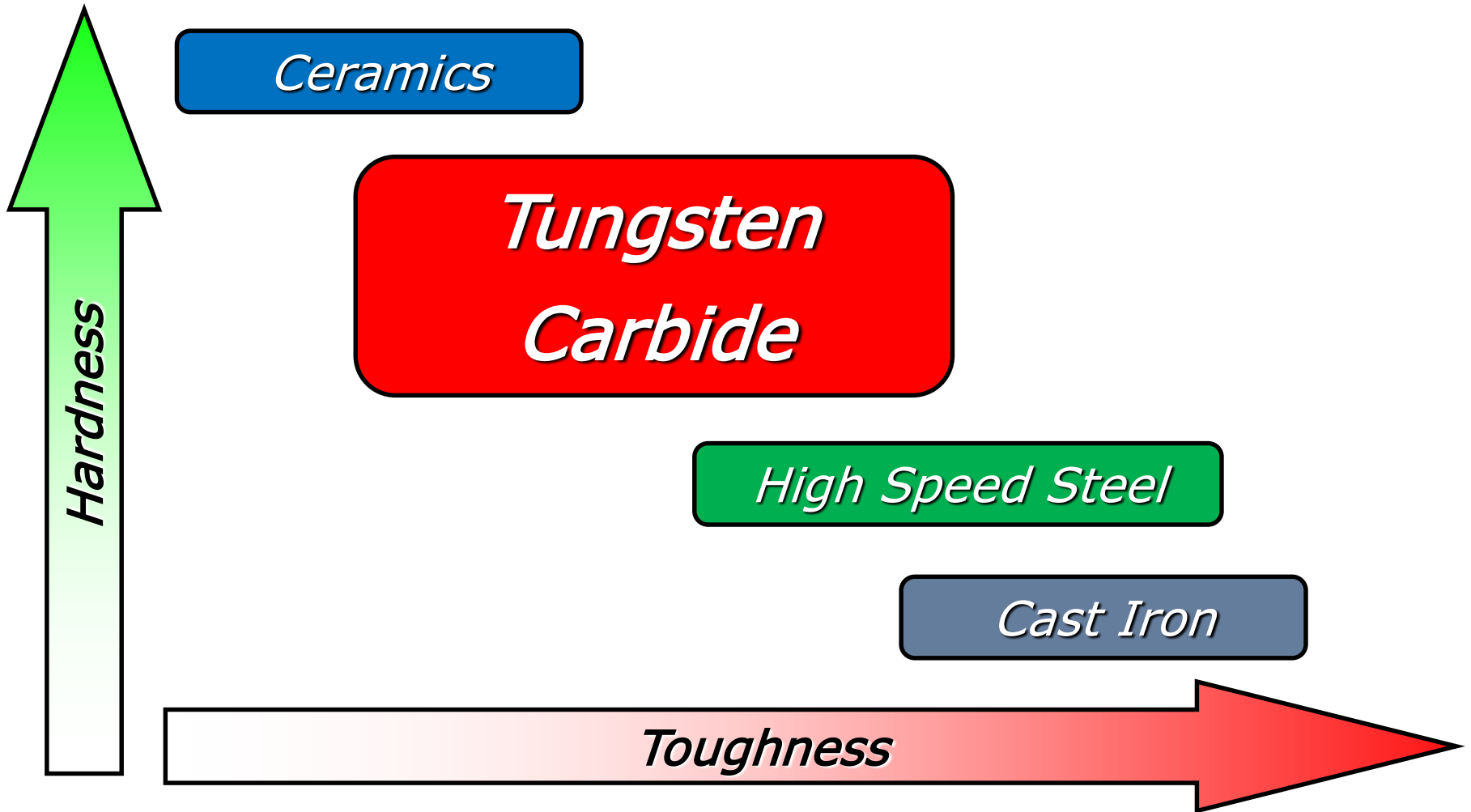


Finishing with cast iron roll

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Positioning of Carbide

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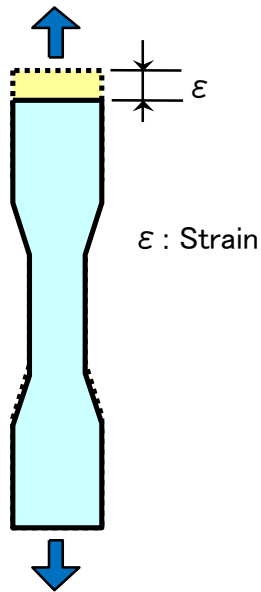
Carbide has excellent **wear resistance** among roll materials.

Positioning of Carbide

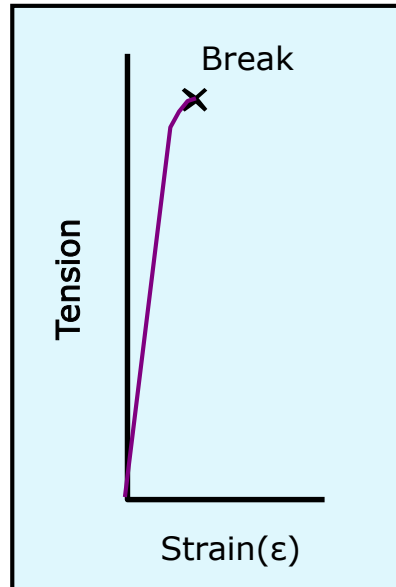
Tungsten Carbide is **very hard material**
but its **weakness is brittleness.**

【Difference of Fracture between Carbide and Steel】

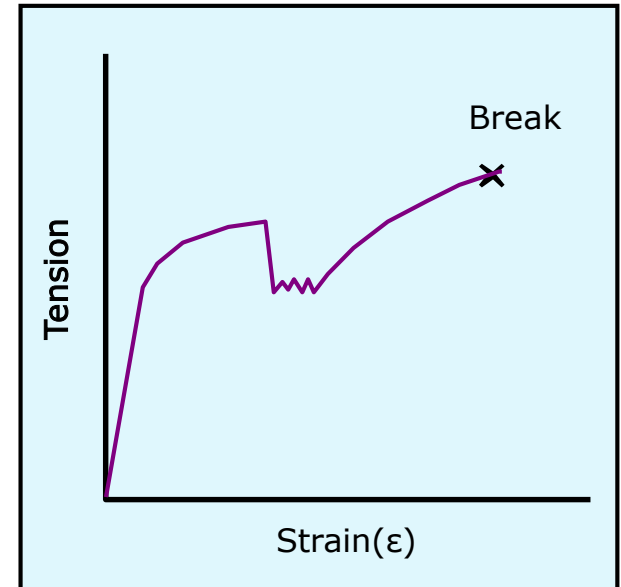
Tensile Force



Carbide



Steel



Tungsten Carbide : Not easy to deform but suddenly fractures.

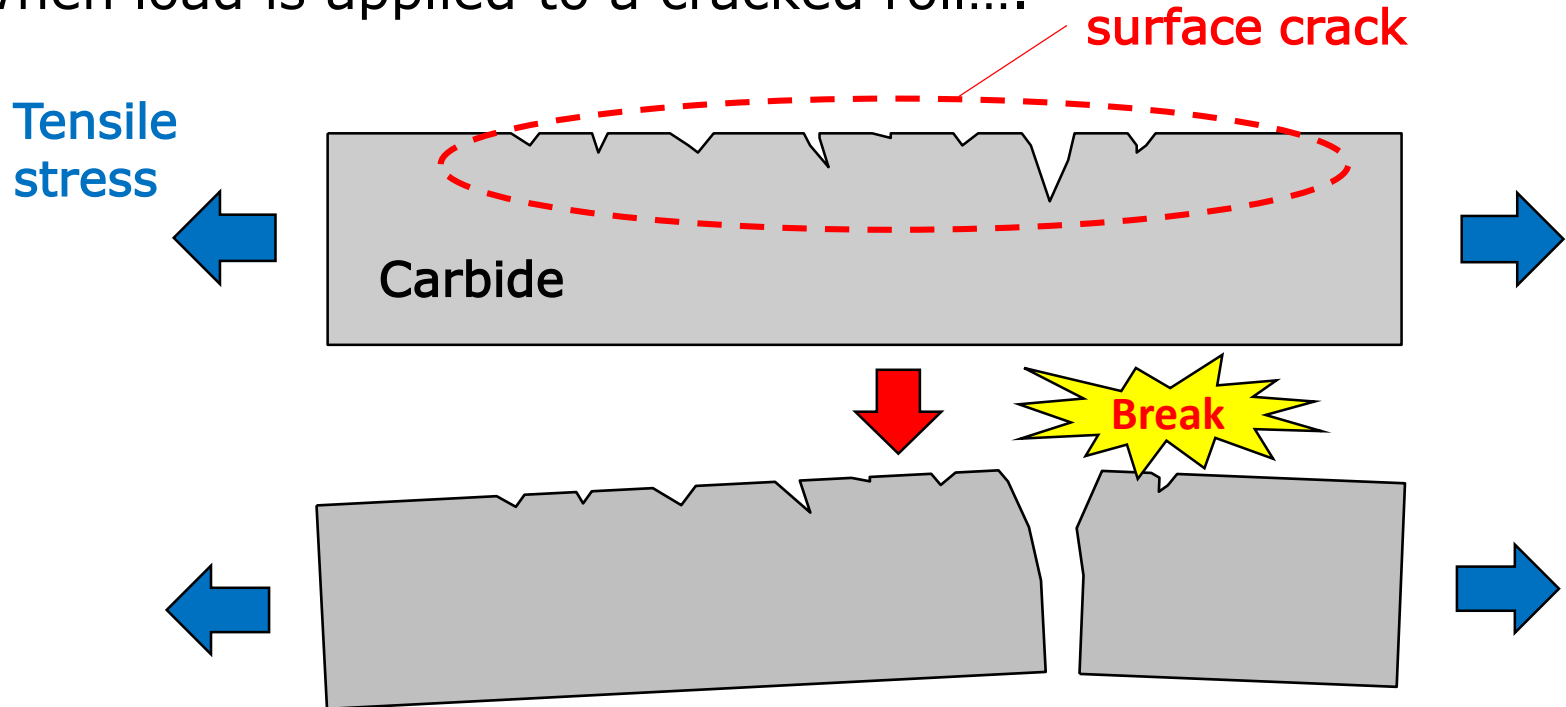
Steel : Fractures after gradually deforming, but able to estimate the fracture.

Positioning of Carbide Rolls

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Progress of Crack Caused by Tensile Stress

- When load is applied to a cracked roll....

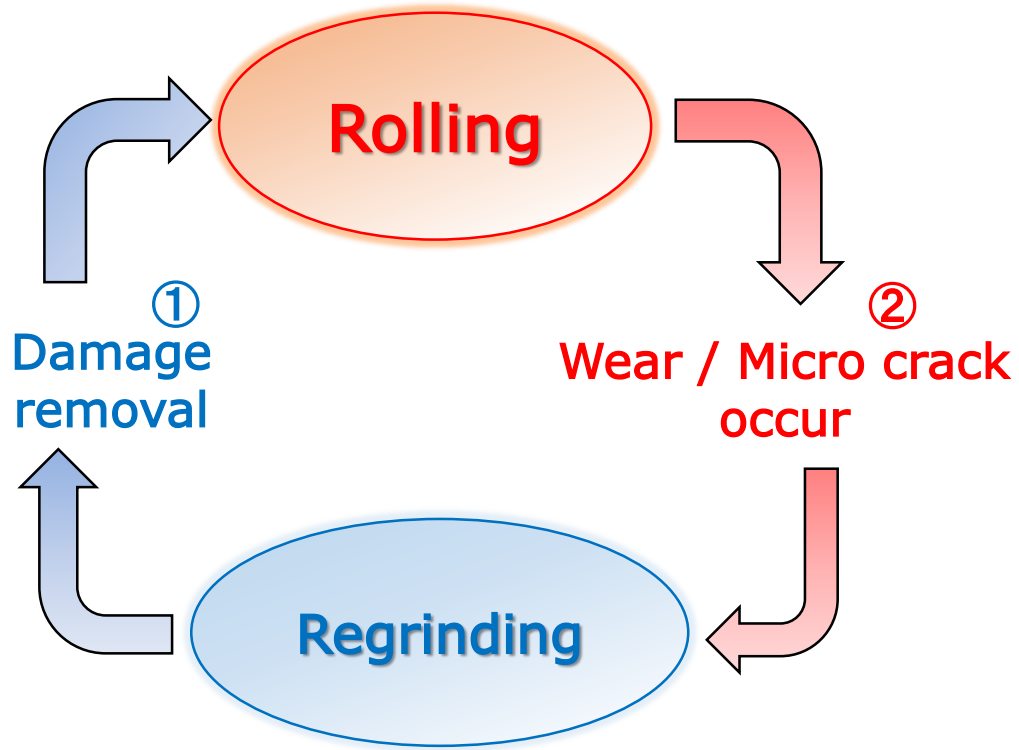


...Cracks progress rapidly and fracture.

Better use of Carbide Rolls . . . 1. Suppress the occurrence of crack.
2. Avoid excessive load.

Damage to Carbide Rolls

Rolling / Regrinding Cycle



⊖Lack of regrinding volume



Damage remains
 ↓
 Growth of micro crack.
 ↓
 Crack occurs.

⊖Bad Rolling condition









Excessive load
 ↓
 Abnormal damage

Optimal volume of regrinding
 Optimal condition of rolling → Exhibiting performance of carbide rolls

Example of Rolling Damage

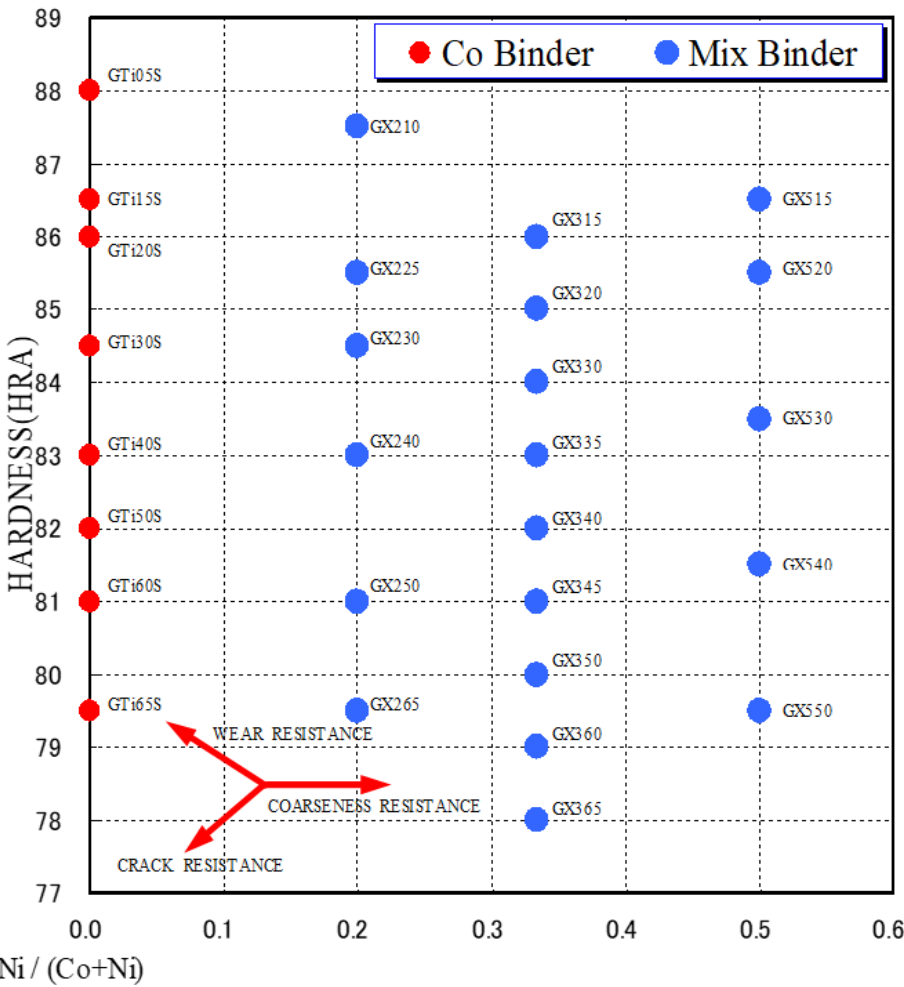
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Normal	Excessive Rolling	Welding	Heat Shock	Corrosion	Crack remaining
					
<p>No crack. No discoloration. Good surface</p>	<p>Rough surface & Grain falling off.</p>	<p>Welding of workpieces.</p>	<p>Temper Color by Heat Shock.</p>	<p>Many crater holes by corrosion</p>	<p>Good Surface but occur cracks by lacking volume of regrinding.</p>

Advantage of Our Carbide

Grade

Our Materials for Hot Rolling



◇ We have around 30 types of Carbide Grades.

- Wear Resistance (Hardness)
- Crack Resistance (Toughness)
- Coarseness Resistance



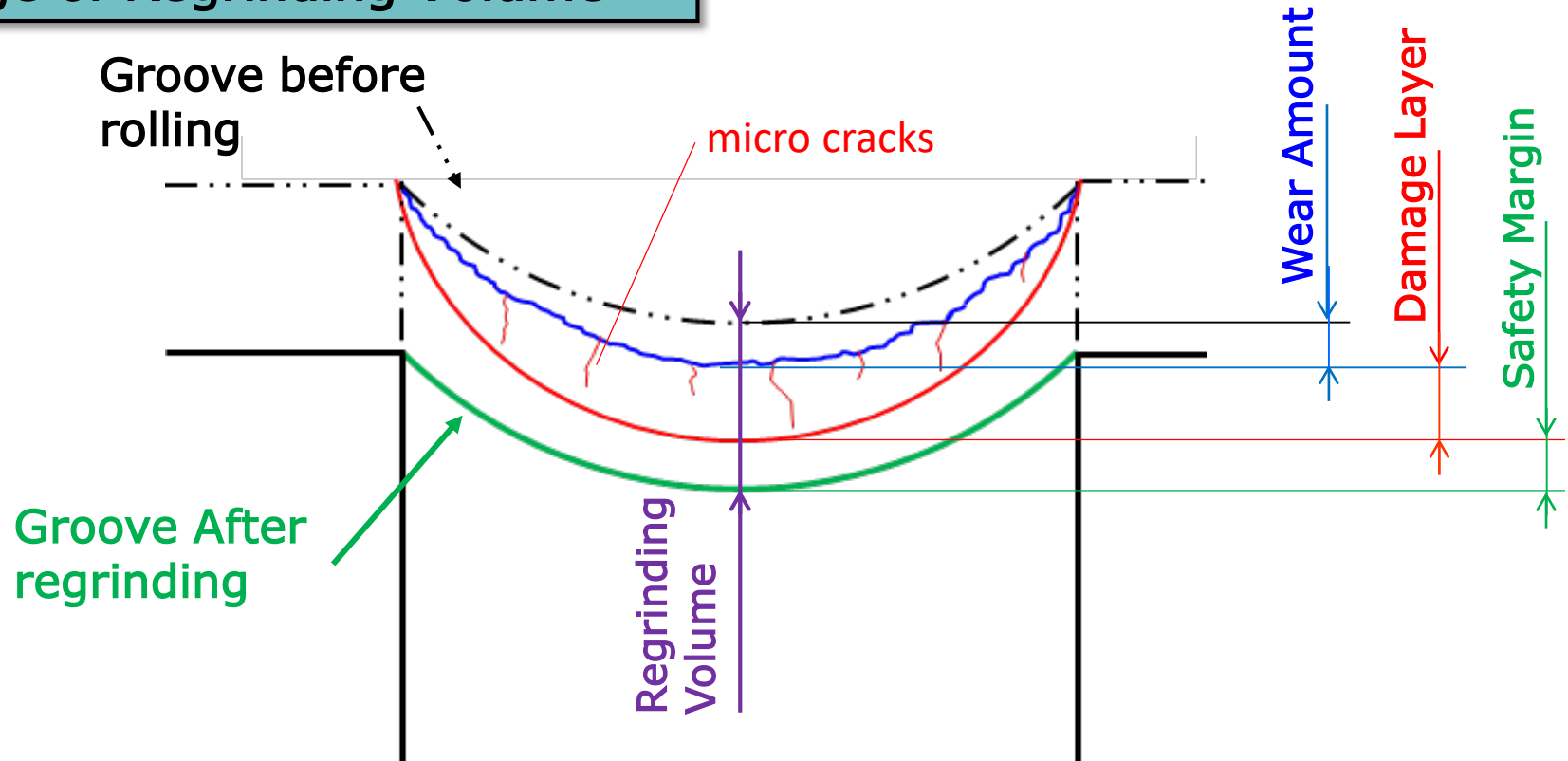
◇ We can supply the best grades for your rolling conditions.

- Product Size
- Rolling Mill No. (Stand)
- . . . etc

= We can suppress damage by using a suitable grade.

Considering Regrinding Volume

Image of Regrinding Volume



Regrinding Volume = **Wear Amount** + **Damage Layer** + **Safety Margin**

⇒ It is especially important to detect the **Damage Layer** accurately.

Damage Layer Detection

Our Measurement Method

【⊖ Eddy Current Flaw



Detecting cracks
by changes in eddy currents.

【⊖ Crack Depth

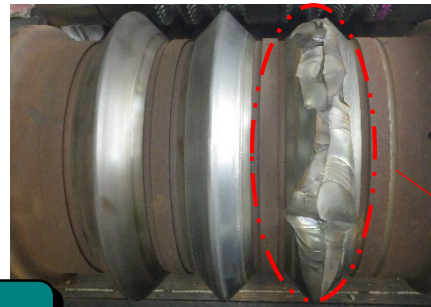


Measuring crack depth
by potential difference

Damage layers can be detected and measured
by using these
measurement methods.

Cooling Water

Importance of Cooling Water



Example of
Cooling Water
Trouble

Breaking

1. Improvement of Rough Surface

By pouring enough cooling water, able to have stable roll surface.

- ★ Improved Roll Life
- ★ Reduction of Regrinding Volume

2. Suppression of Cracks

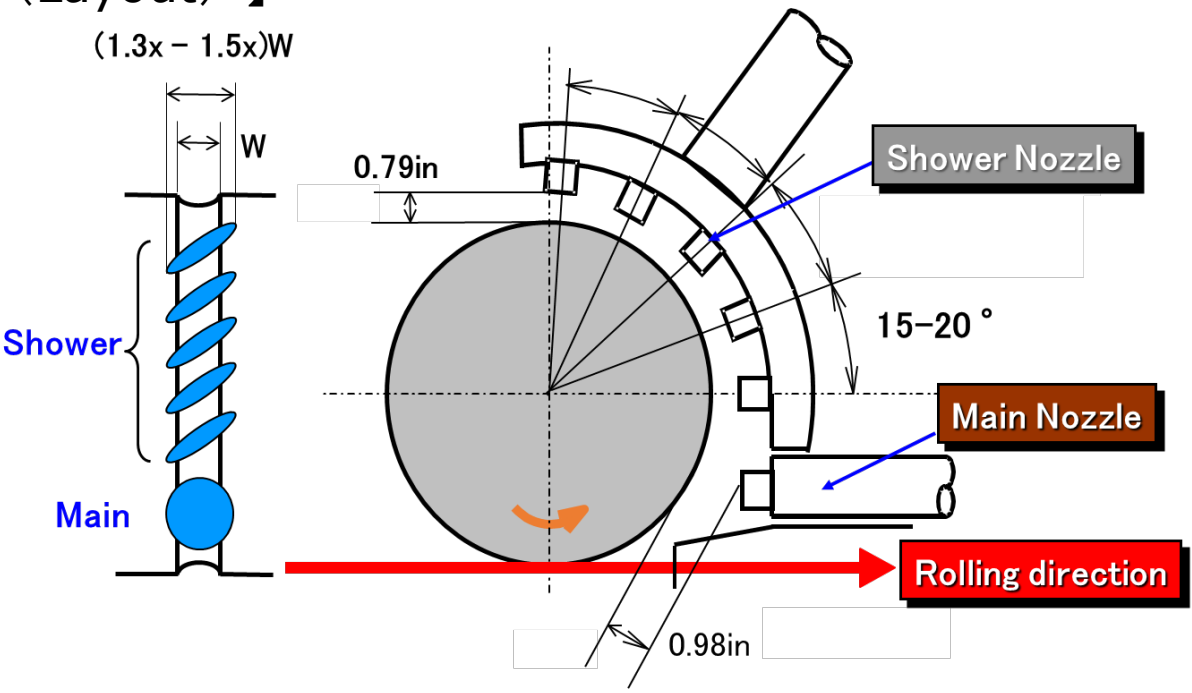
Cracks are easy to expand when they occur, and break up in the worst case. By pouring enough cooling water, it is able to suppress cracks.

Recommendation of cooling water

We have experience in many field surveys regarding cooling water

※ Over 50 surveys in 30 companies.

【Example of Recommended Condition (Layout)】



【Survey Situation】



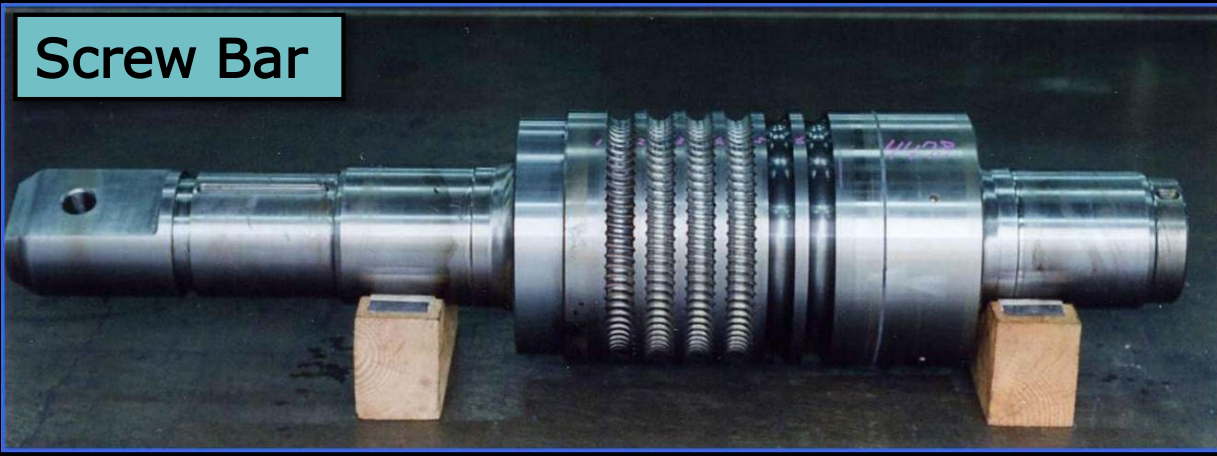
We can recommend and suggest based on our knowledge.
 ⇒ Water amount, pressure, quality, etc.

Success Stories of Carbide

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【Changing to Carbide Rolls in Screw

Screw Bar



[Specification]

- Size/Stand : D38-#12
- Diameter : $\phi 18.7$ in
- Rolling Speed : 4.92yd/s

[Performance]

<Before>

- Grade : High speed steel
- Rolling Amount :
295.3ton/Groove



<After>

- Grade : GX365
- Rolling Amount :
2,953ton/Groove



⇒ The tool life of groove is 10 times longer than HSS

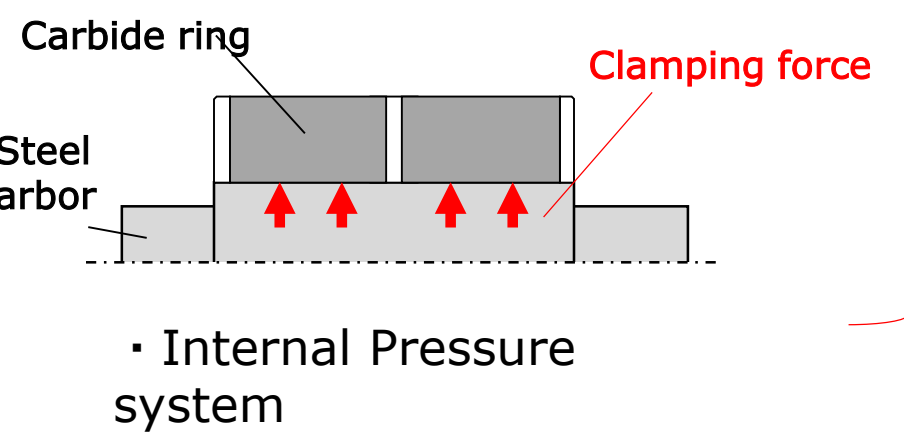
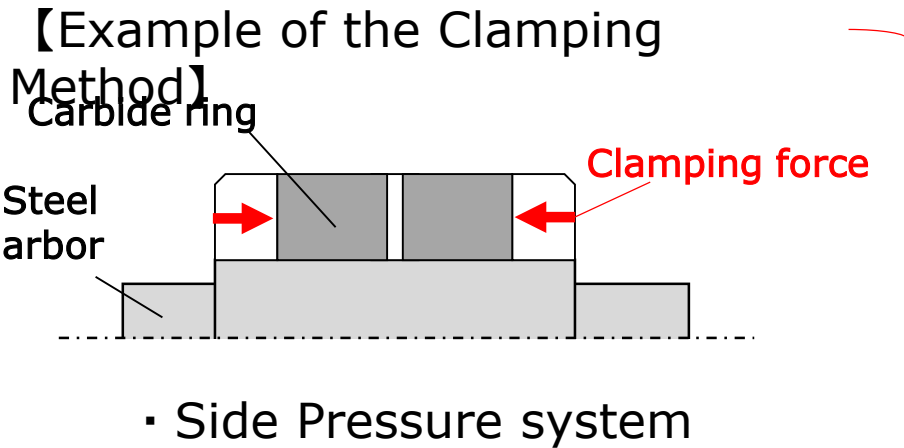
& The shape of the screw notch is stable. (Improves product

quality)

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Ring Slip in Carbide Rolls

Carbide Composite Roll ⇒ Carbide Ring is clamping to the steel arbor



If the **clamping force is weak**, the **ring will slip** and rotate.

- 【Example of Damage by **Ring Slip**】
- Runout of groove occurs ⇒ **Low rolling accuracy.**
 - **Damage to the arbor** by friction.

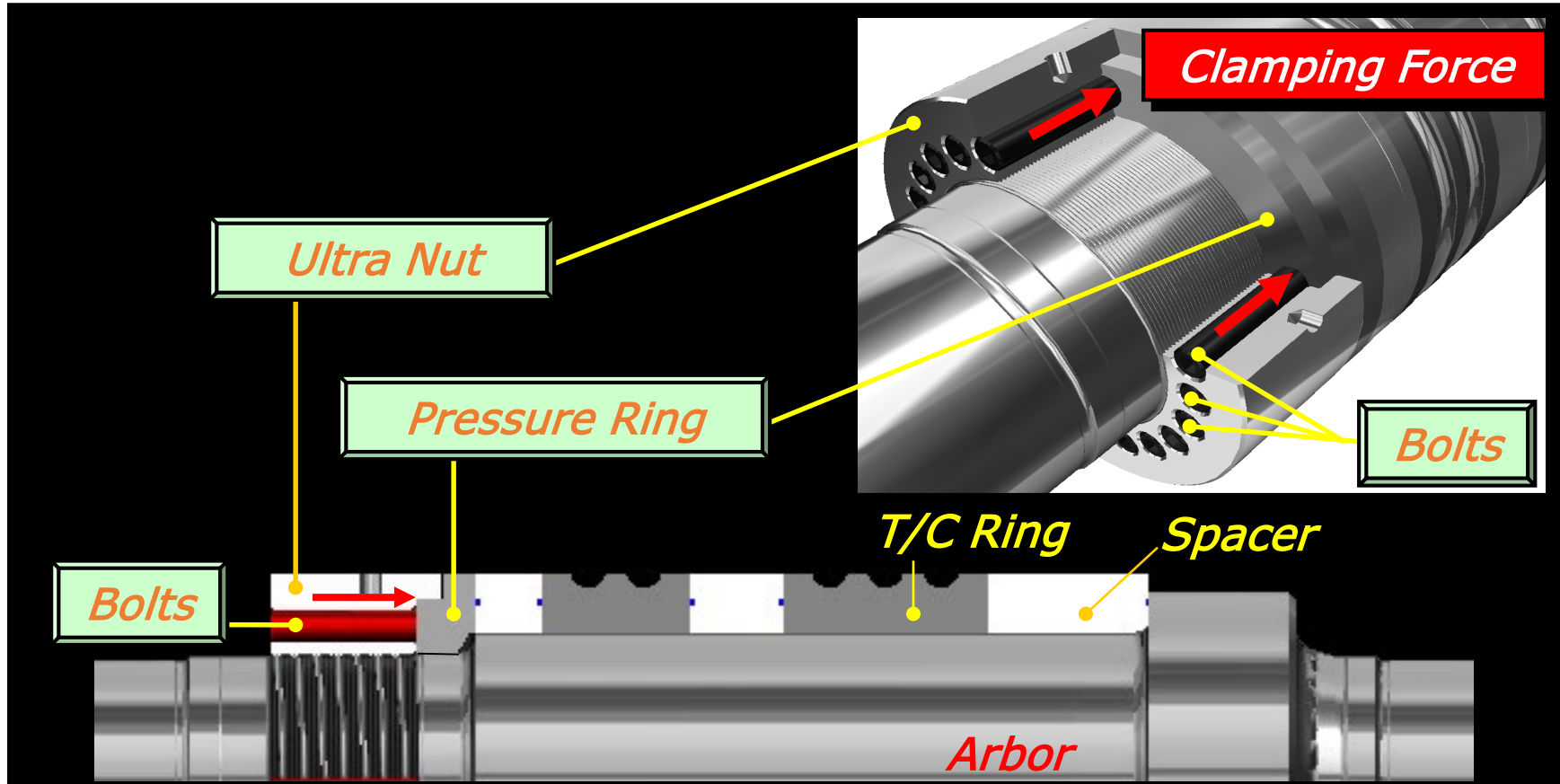


▪ Image of Arbor Damage

ULTRA LOCK Clamping System

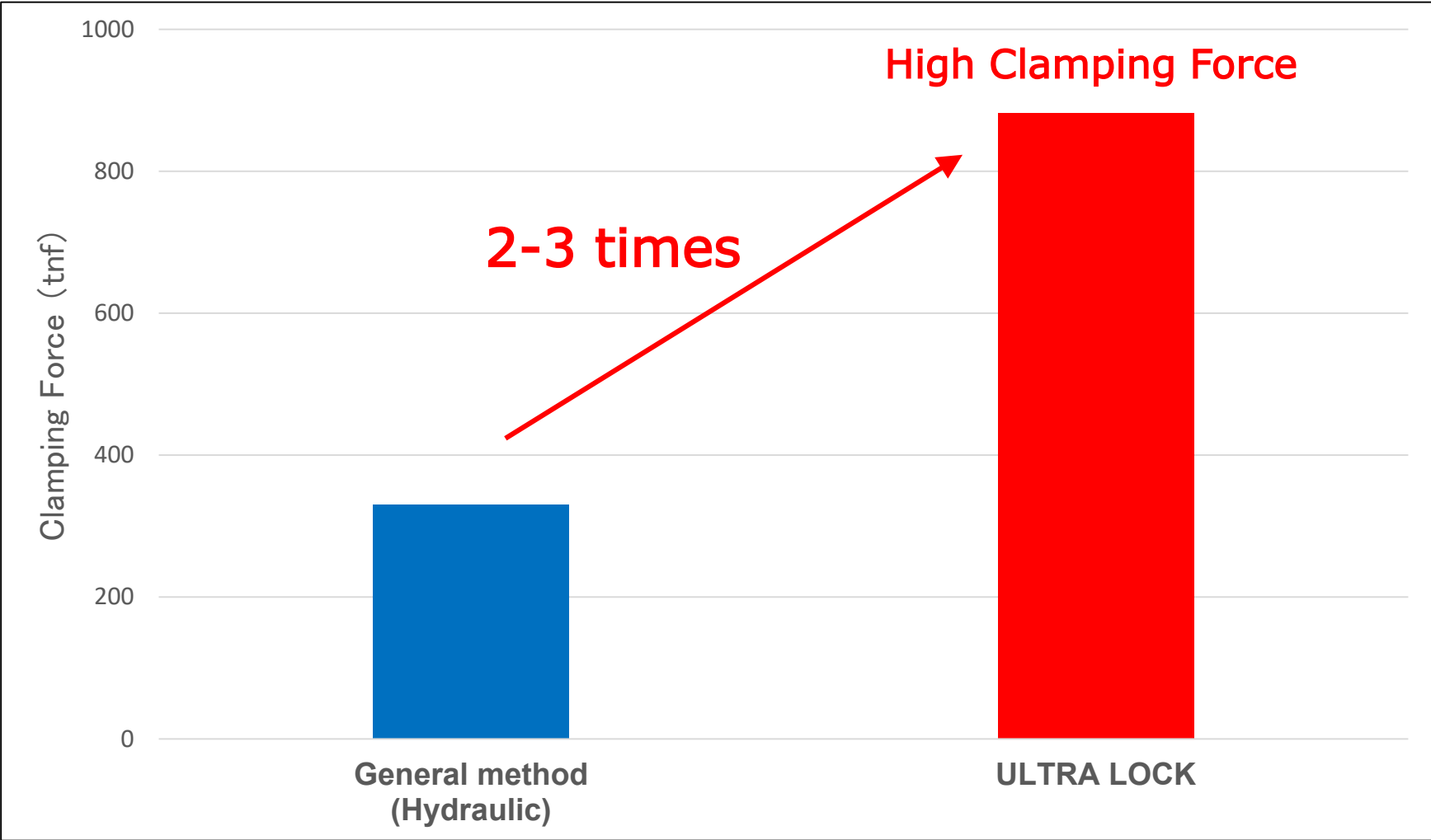
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ULTRA LOCK Clamping System



High Clamping Force by Tightening Bolts

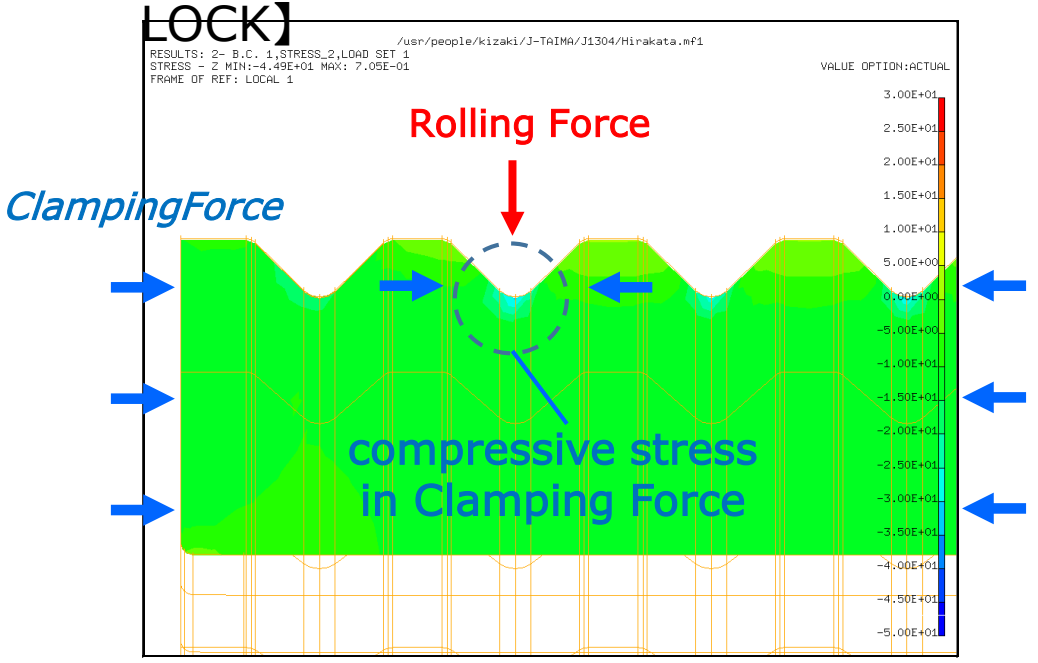
Clamping Force



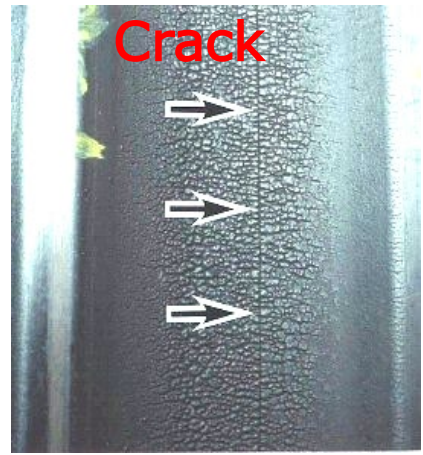
Additional Benefits

= Suppress circumferential cracks of grooves

【Stress Analysis of ULTRA LOCK】



Compressive stress caused by strong side pressure.
⇒ Suppress crack in groove.



【General Method】



【ULTRA LOCK】

Strength and Achievement

⇒Our Carbide Roll can be used in **wide range of user/size/stand.**

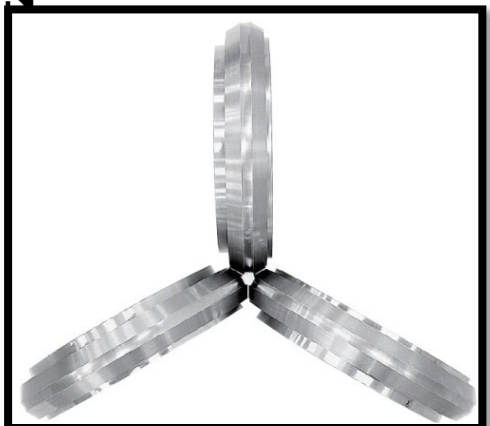
【Achievement#1 : Intermediate Mill #11std】



【Achievement#2 : Large Angle Bar】



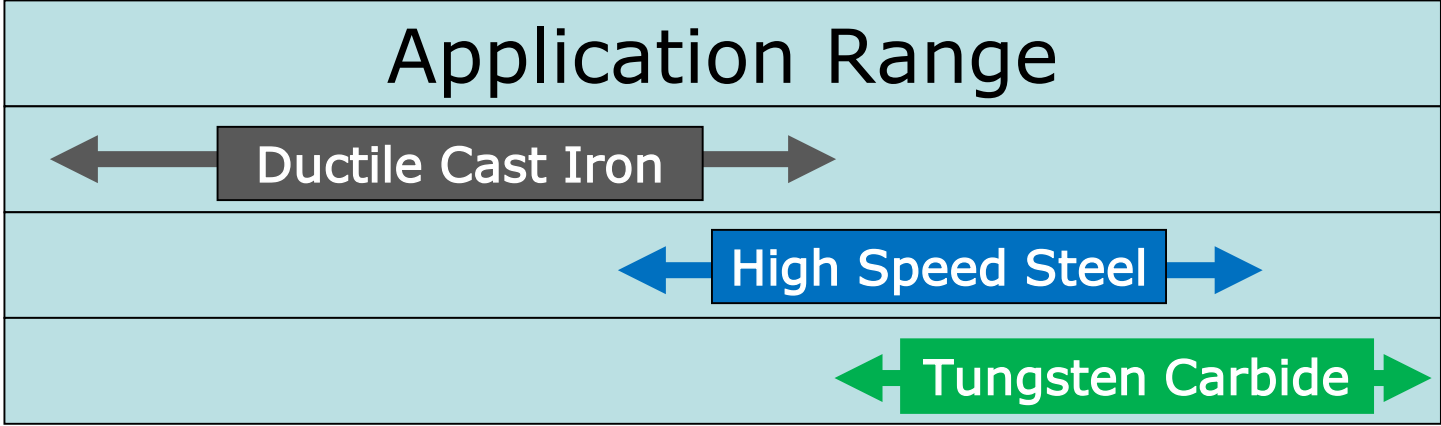
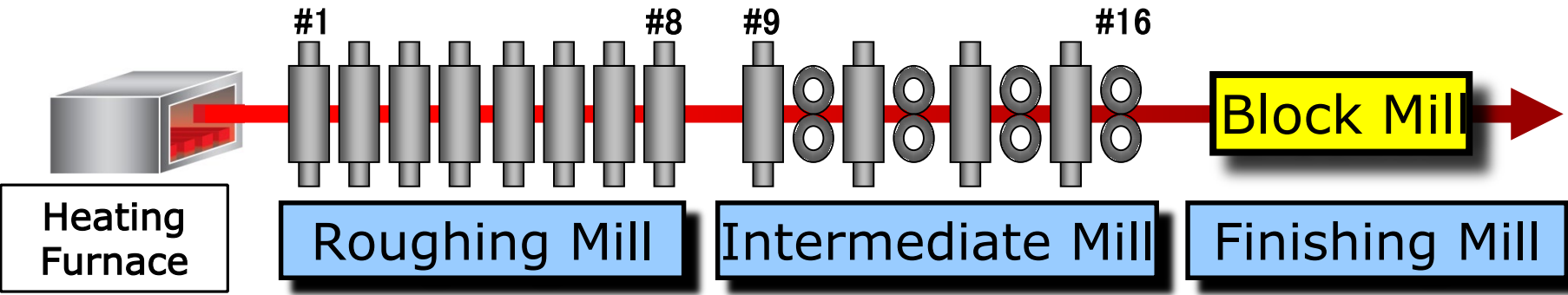
【Achievement#3 : RSB Roll】



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Application of Carbide Rolls

General Mill line (Wire rod)



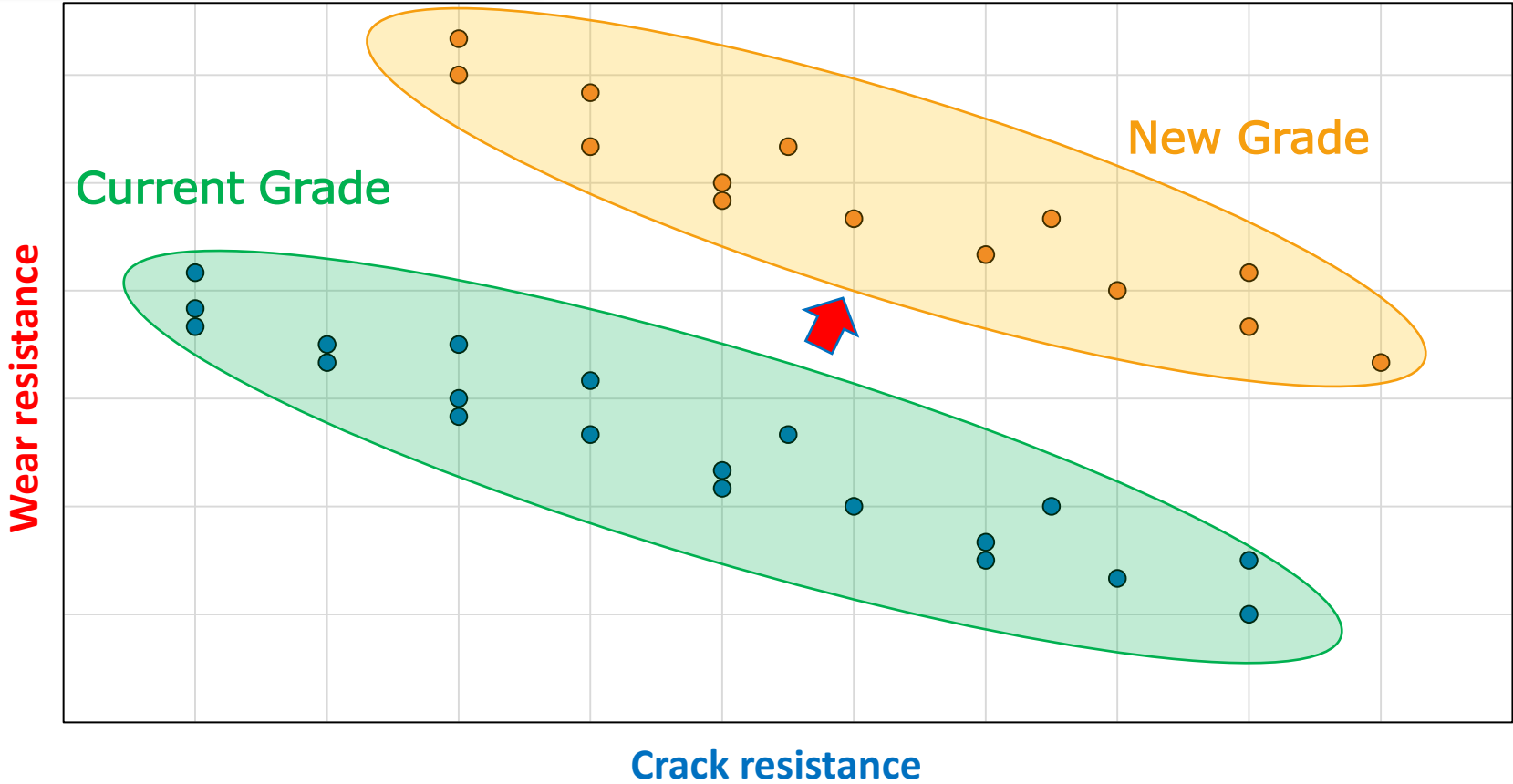
Slow Rolling Speed Fast



High Rolling Load, Heat Effect Low

Performance of New Grade

Performance Image



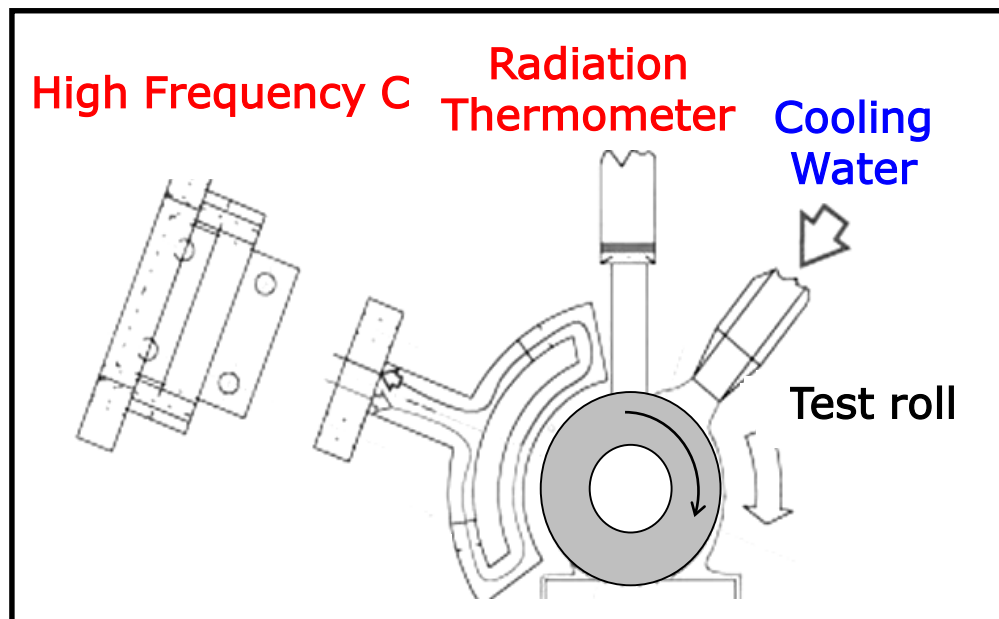
- ⊖ Improve high temperature hardness.
- ⊖ Suppress the progress of cracks.

Wear Resistance & Crack Resistance

Test of New Grade

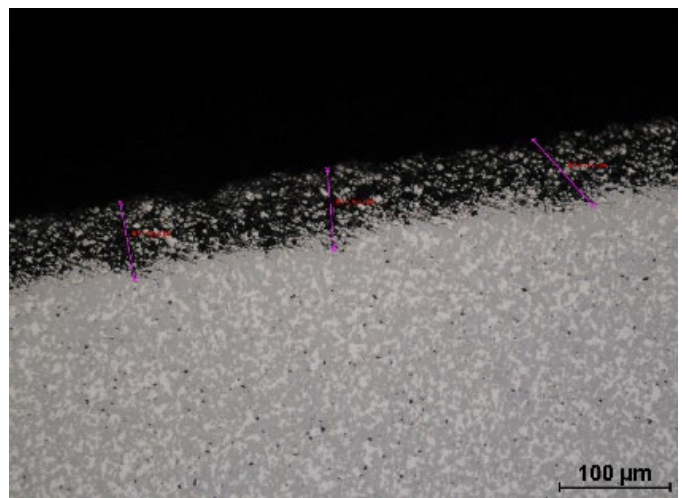
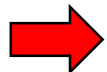
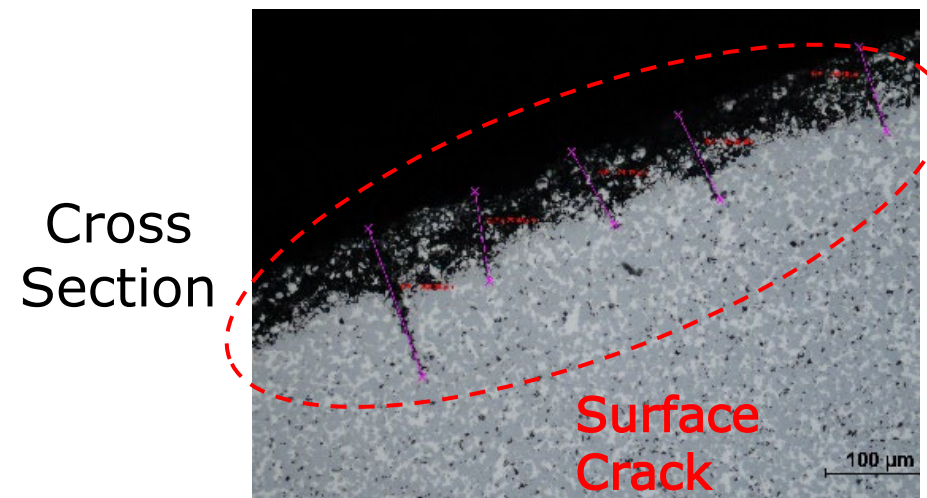
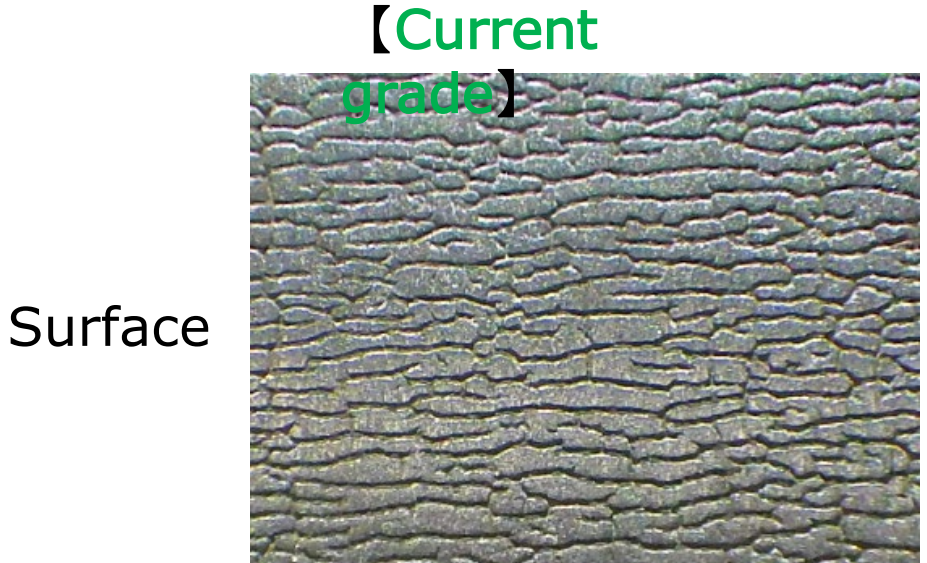
Reproducing **Heating** & **Cooling** cycle in hot rolling.
 ⇒ It can evaluate thermal crack resistance.

- Thermal Crack Test



※ Test Piece : $\phi 1.57\text{in} \times 1.18\text{in}$ /
 Test Condition : $1,112^{\circ}\text{F}$, 4rpm, 3,000cycles

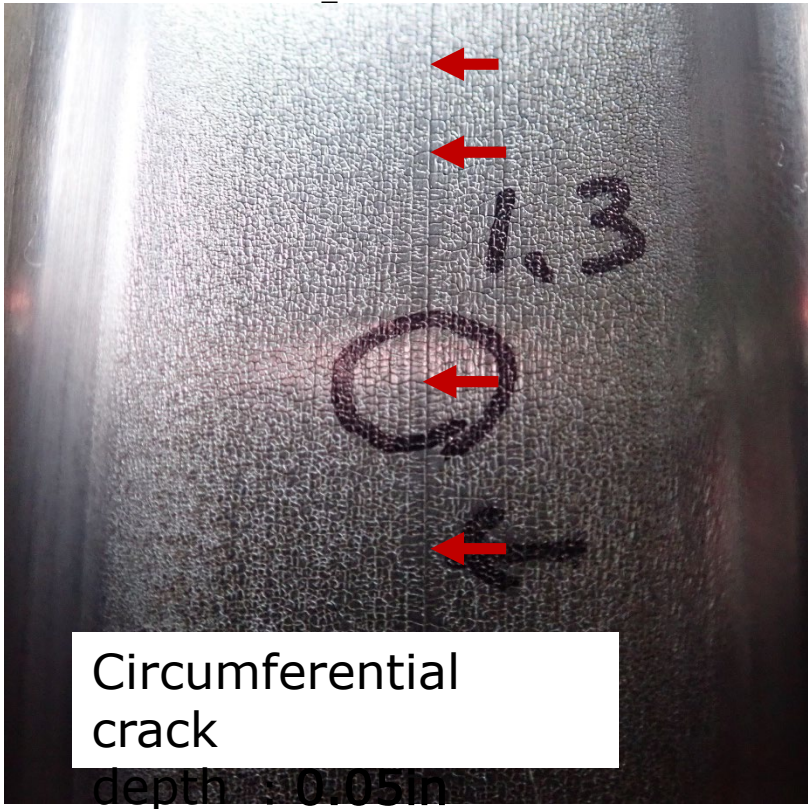
Results of the Test



Comparison by Field Test

【Current

【New grade】



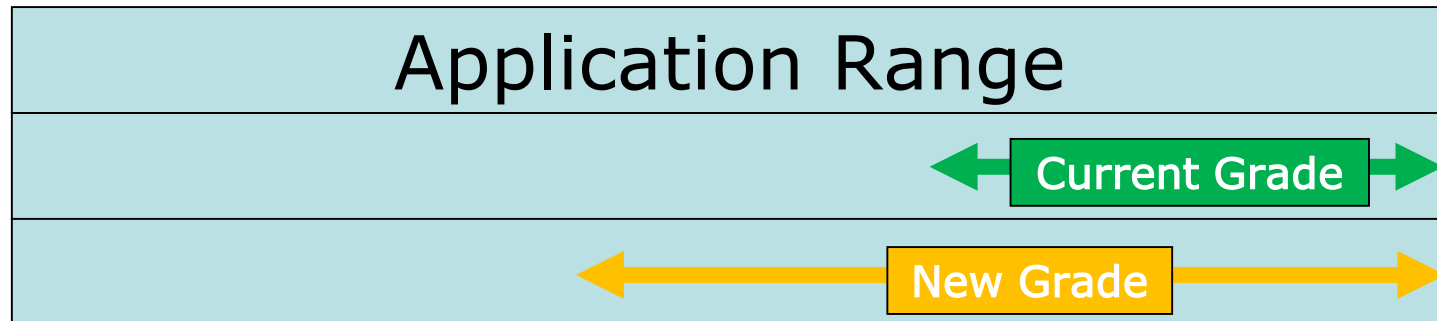
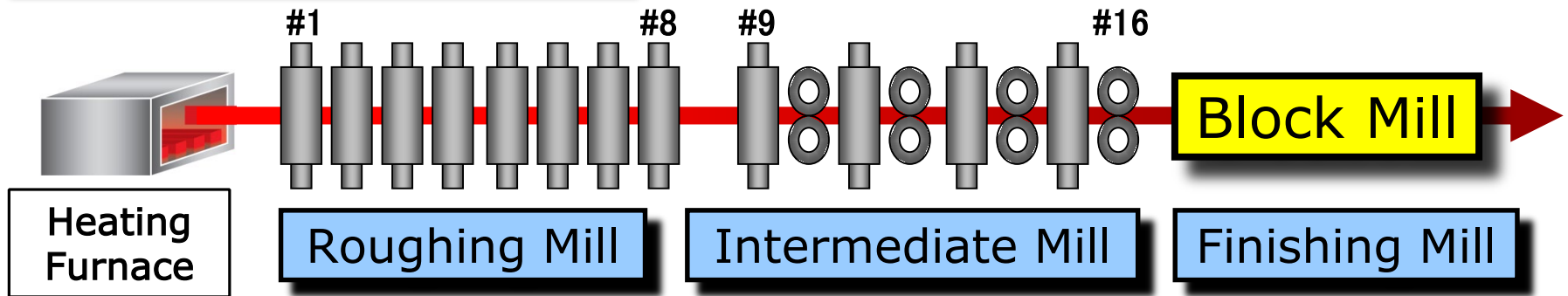
Rolling Tonnage : 4,015 ton/groove
 Wear Depth : 0.012~0.016in
 Surface Roughness : Not Bad
 Crack or Not : Exist

Rolling Tonnage : 4015 ton/groove
 Wear Depth : 0.006~0.008in
 Surface Roughness : Better
 Crack or Not : No

Prospects for the Future

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General Mill line (Wire rod)



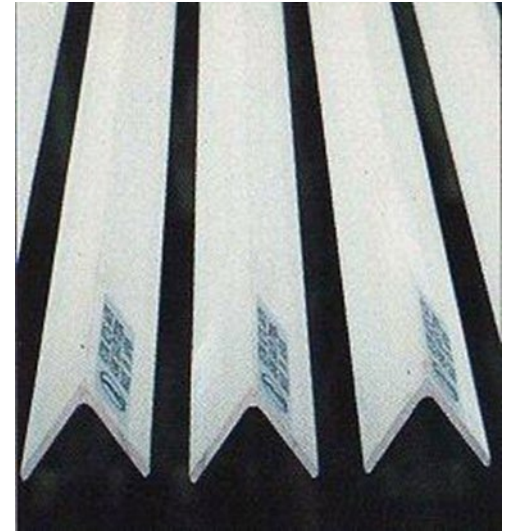
“Resistance of **New Grade**” & “Clamping Force of **ULTRA LOCK**”
⇒ We will expand carbide roll to high load stands (Intermediate Mill) .

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Conclusion

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Our tungsten carbide **ring rolls**, **three-rolls**, and **composite rolls** are used for rolling **wire rods** and **rebars** all over the world.



Conclusion

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Tungsten carbide is a very characteristic material.

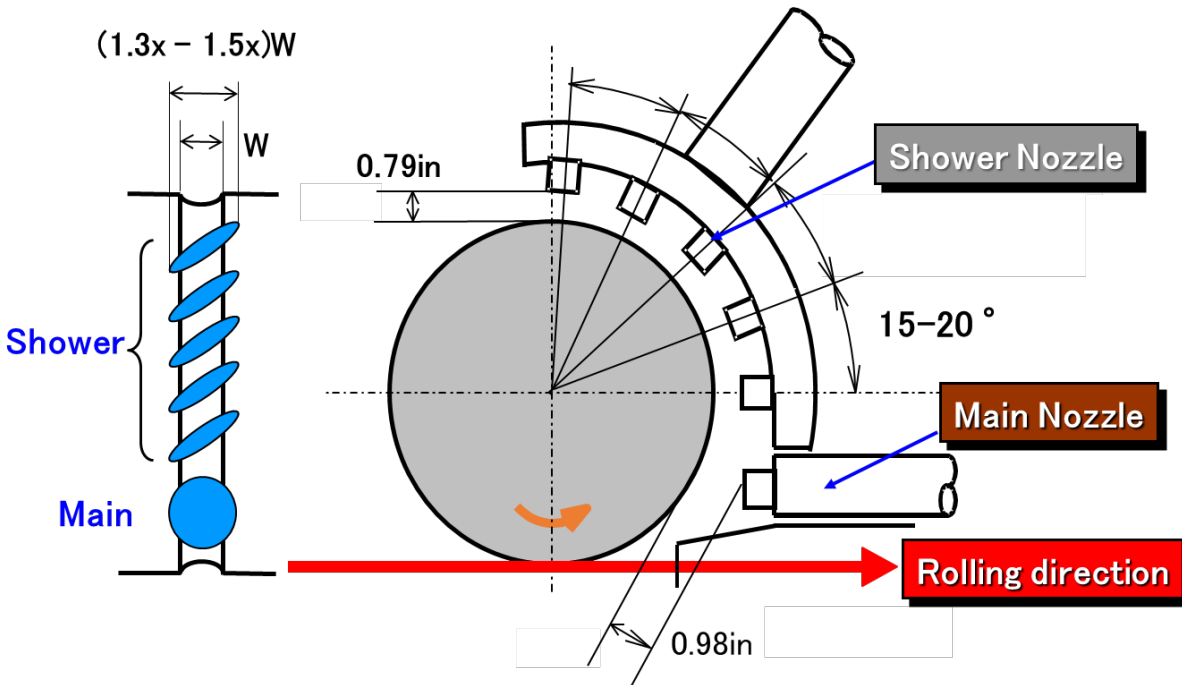
And by carefully considering and handling, you can bring out the best effect.



Conclusion

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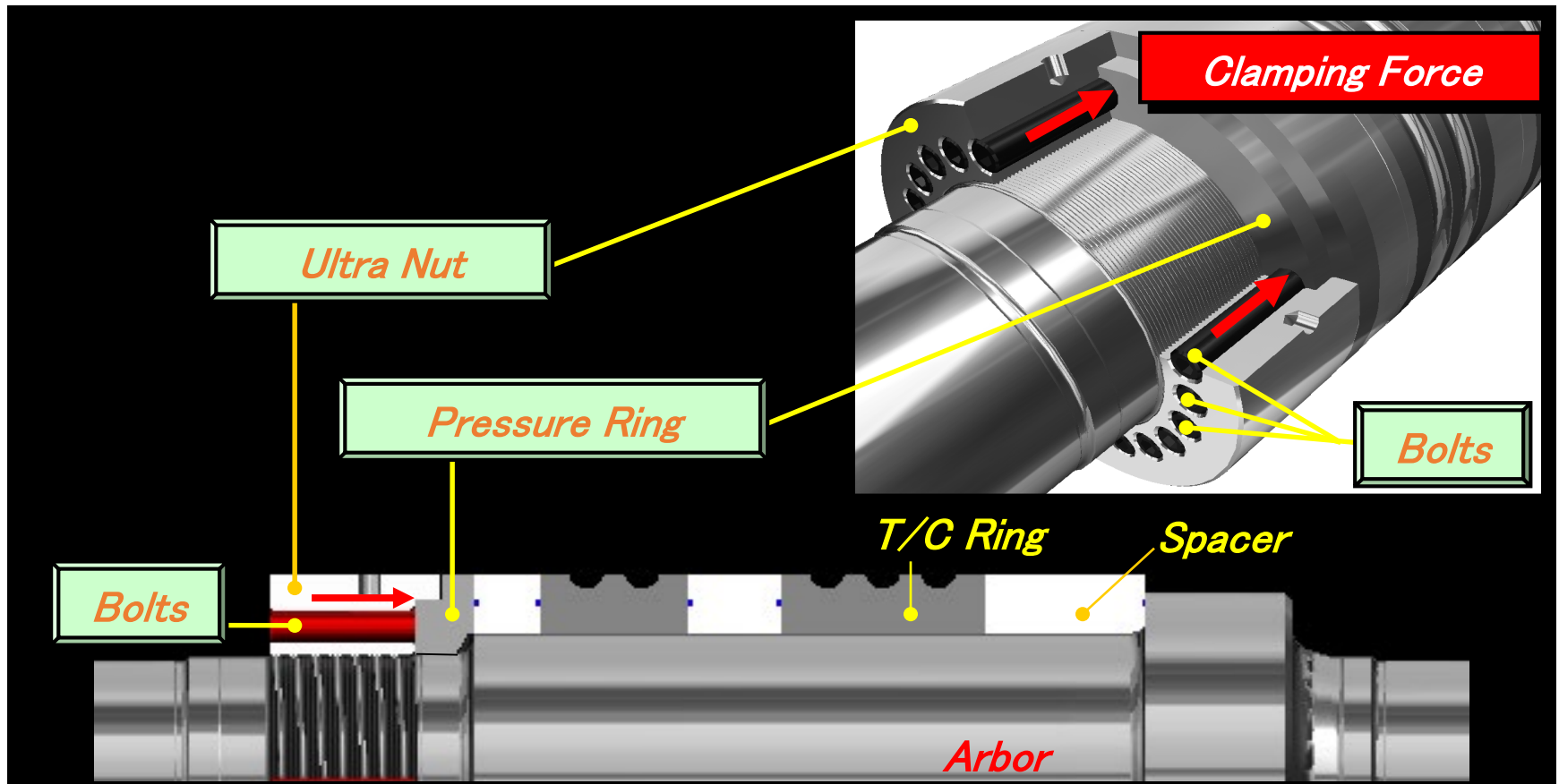
We also have knowledge for **cooling water conditions**, which are especially important to carbide rolls.



Conclusion

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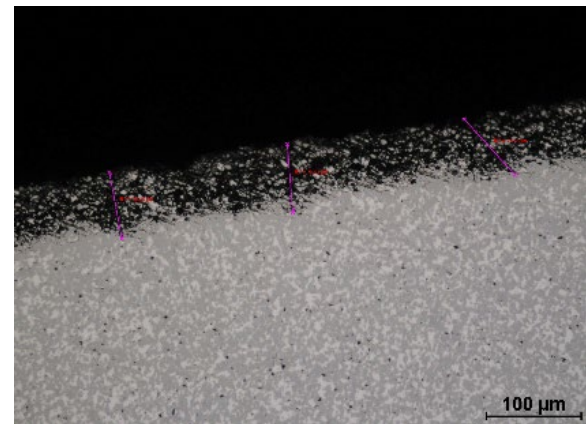
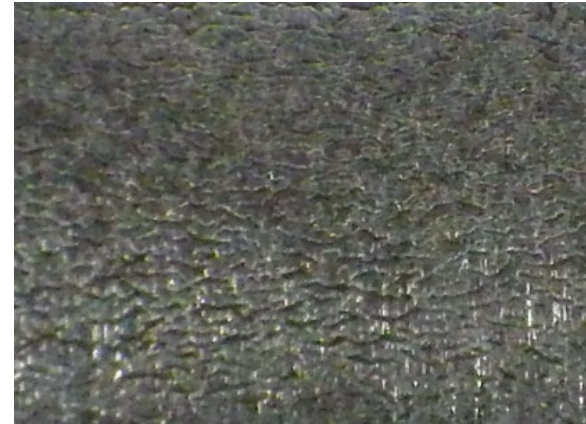
Our original "Ultra Lock" clamping system has a strong lateral pressure to prevent ring slips.



Conclusion

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We have recently developed a **new carbide grade** which **reduces thermal cracks** used at the **first intermediate stands**, which requires much higher load and high temperature.



At last,

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A Group Company of MITSUBISHI MATERIALS



Cemented Carbide

For People
Society and
the Earth

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