September 20, 2022

News Release

Hitachi Metals, Ltd.

CR^2, High Performance Cast Roll for Cold Rolling of Steel

~ These cast rolls[*1] overcome the performance limitations of forged steel rolls[*2] ~
~ deliver 3 to 5 times their wear resistance, twice the fracture toughness, and 5 times the crack resistance ~

Hitachi Metals, Ltd. (hereinafter "Hitachi Metals") has developed and launched the CR^2 (Cast Roll for Cold Rolling, hereinafter "CR^2"), high-performance cast rolls for cold rolling of steel[*3].

CR^2 shows high wear resistance (roughness retention) and crack resistance[*4] required in cold rolling processes, thereby expected to contribute to improved productivity.

1. Background

Hitachi Metals is the Japan's leading manufacturer of cast rolls, supplying high-performance rolls for hot rolling[*5], including steel sheets, steel plates, and shaped steel. Leveraging our advanced development and technical capabilities, we have been continuing to supply a variety of cast rolls — including high-performance cast high-speed steel rolls[*6] for hot rolling — to meet our customers' needs.

In recent years, the use of high-tensile steel (high-tensile material)[*7] has been on the rise in the field of automotive steel sheets due to the growing need for weight reduction as companies seek to address the trend towards carbon neutrality. In addition, the production of electromagnetic steel sheets[*9] used in drive motors is also on the rise as the number of xEVs[*8] continues to grow. These steel sheets all have high strength, and steel mill rolls used in their production require high levels of performance in terms of wear and crack resistance. Going forward, in light of the growing need for further weight reduction, better motor efficiency, we expect the steel sheets for these applications will become even more difficult-to-roll by advanced microstructure controls or alloying designing. These advancements may lead to a rise in manufacturing problems such as slipping[*11] and sheet breakage[*12] during steel sheet rolling. For this reason, performance requirements for steel mill rolls are expected to become even more demanding accordingly.

There has been no significant performance improvement of forged rolls, which have been used in cold rolling, in terms of wear resistance and so on, which in recent years have become significantly demanding for rolling high-tensile steel and electromagnetic steel sheets.

Cast rolls have not generally been used for cold rolling since this process is inferior to forged process in terms of uniformity of microstructure and high hardness which are required more than hot rolling.

At Hitachi Metals, we have been developing advanced cold rolls by casting process not forged, utilizing our special technology which has been bult up through hot roll production.

2. Overview

At Hitachi Metals, we have been working to develop cast rolls for cold rolling based on the expertise we have accumulated through our research and development of hot rolling rolls, casting technology for preventing casting defects, and high-precision manufacturing technology. As a result, we have now succeeded in the development of CR^2. CR^2 delivers 3 to 5 times the wear resistance, twice the fracture toughness, and 5 times the crack resistance of forged steel rolls. Now, this roll is available as work rolls[*13] for cold rolling, a new application for cast rolls, and are now included in our lineup of products.

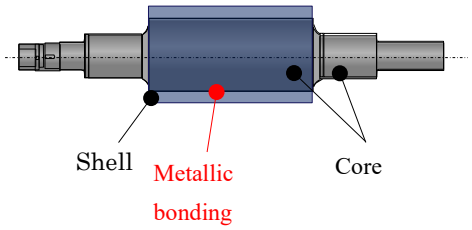
High performance work roll "CR2" (artist's rendition)

3. Lineup

CR^2 is available in two different materials which can be selected according to roll usage conditions: centrifugal composite cast rolls "NCW10" and composite cast rolls by the continuous-casting-for-cladding process "NCW20."

CR^2 rolls (Cast Roll for Cold Rolling)

NCW10 ⋯ Centrifugal composite cast rolls
Wear resistant shell material + Strong ductile iron core
NCW20 ⋯ Composite cast rolls by the continuous-casting-for-cladding process
Shell material with even greater wear resistance + Even stronger forged steel core



Material	Wear resistance	Crack resistance	Sticking resistance	Dent resistance	Grindability	Overall performance
Conventional forged steel material (5Cr)	△	△	×	◎	◎	△
NCW10	○	◎	◎	○	○	○
NCW20	◎	◎	○	◎	△	◎

While forged steel work rolls for cold rolling are currently mainly made of 5% Cr material, we believe that CR^2's high wear resistance (roughness retention) and crack resistance can help our customers improve their productivity. We are also able to provide solutions for grinding wheels and grinding conditions for customers' post-rolling grinding.

4. Manufacturing plant

Hitachi Metals Wakamatsu, Ltd.
(100% subsidiary of Hitachi Metals, Ltd.; Wakamatsu-ku, Kitakyushu-shi, Fukuoka, Japan)

5. Sales target

1,000 million yen/year (FY2030)

6. Public announcement

We are scheduled to give a presentation on the characteristics of this material at the 184th ISIJ Autumn Meeting in 2022 organized by the Iron and Steel Institute of Japan.

*1. Cast roll: Roll formed into the shape of steel mill roll by pouring molten iron into a mold.

*2. Forged steel roll: Roll manufactured by heating steel material to a high temperature, forging and shaping it in a forging press.

*3. Cold rolling: Rolling process that is basically performed at room or ambient temperature. The temperature of the rolled material will rise from the heat generated when the material is deformed by rolling.

*4. Incident resistance: Rolling incidents refer to cracking and sticking that occur on the surface of rolls during rolling due to sudden thermal load, etc. Resistance to these rolling incidents is determined in comprehensive assessments based on quantitative values for cracking, degree of seizing, and fracture toughness.

*5. Hot rolling: A rolling process in which the material is heated to soften it and make it easier to process. Steel is heated to 900-1200°C.

*6. High-speed steel rolls: Rolls made of material with higher hardness at elevated temperature than conventionalroll grades.

*7. High tensile steel: Steel material with higher tensile strength than general steel materials. In addition to containing additives such as silicon and manganese, the steel material is given heat treatment such as quenching and tempering. High tensile steel refers to materials with a tensile strength of 490 MPa or more.

*8. xEV: General term for electric vehicles (EVs), hybrid electric vehicles (HEVs), and plug-in hybrid electric vehicles (PHEVs)

*9. Electromagnetic steel sheet: Steel material with high conversion efficiency between electrical and magnetic energy, and low iron loss when used in electrical components. These come in two types, non-directional and directional, depending on the application. Non-directional material is mainly used for motor cores and generators, while directional material is used for transformer cores.

*10. High alloying: This refers to increasing the content of major additive elements.

*11. Slipping: Slippage that occurs between the sheet to be rolled and rolls due to unsuitable rolling conditions. Rolling conditions include rolling load, rolling speed, friction coefficient, and tension. Rolls may need to be replaced in some situations.

*12. Sheet breakage: Phenomenon where a sheet breaks when it is being rolled. The broken plate may wrap around or seize onto rolls, causing severe damage to their surface.

*13. Work rolls: Rolls that make direct contact with the objects to be rolled (see figure on page 5)

End of report

Madia inquiries: Corporate Communications Dept.
https://www.hitachi-metals.co.jp/e/ir/ir-cntct.html
Customer inquiries: Roll Business Unit, Advanced Metals Division
https://www.hitachi-metals.co.jp/e/cntct/indx_cntct.html

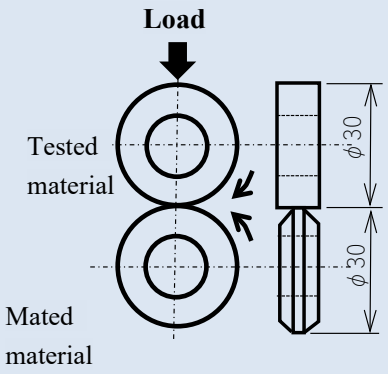
[Supplementary information] CR^2 Characteristics (NCW10 and NCW20)

■ Higher roughness retention can be achieved by improved wear resistance (extends rolling periods for difficult-to-roll materials)

~ Wear test (Nishihara method) ~

Hertzian stress: 2.3 Gpa; Slip rate: 9%

Tested material: 90HS; Mated material: 75HS



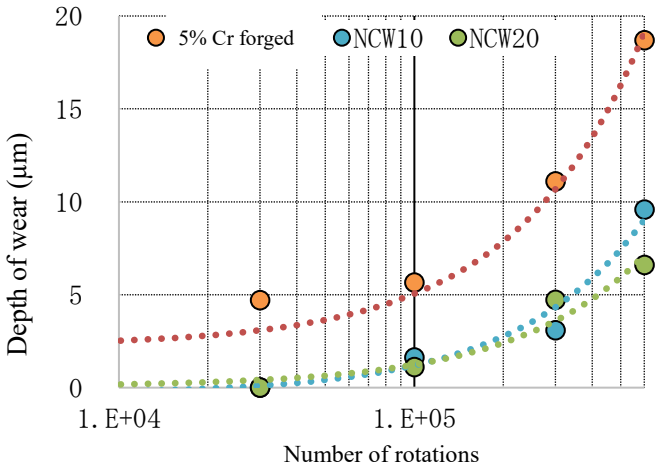
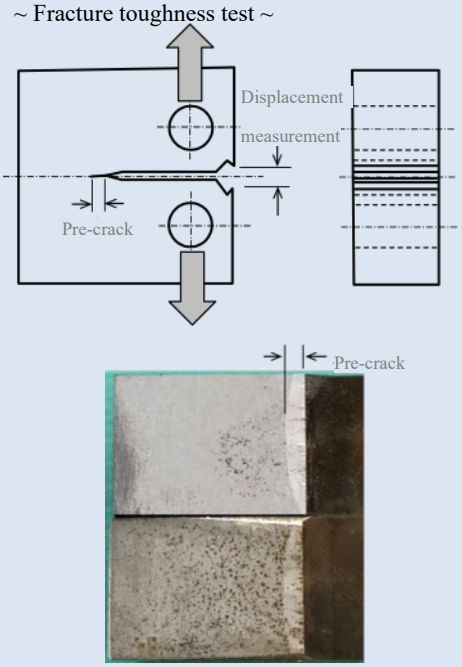


Fig: Number of rotations and depth of wear in wear test

■ Improved fracture toughness reduces crack propagation

~ Fracture toughness test ~



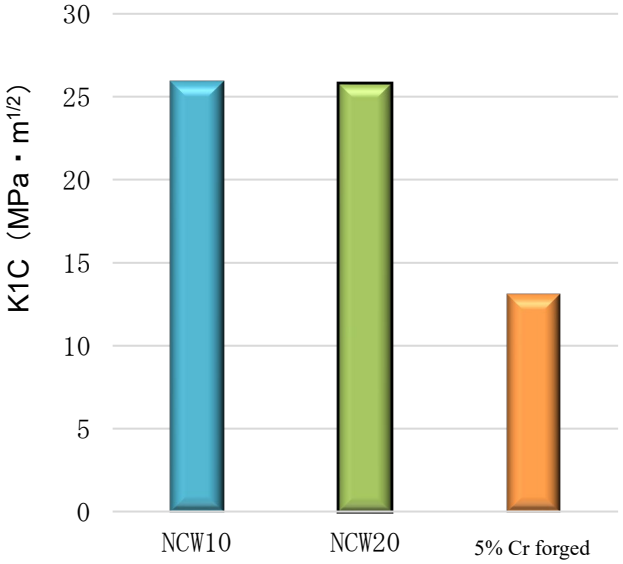
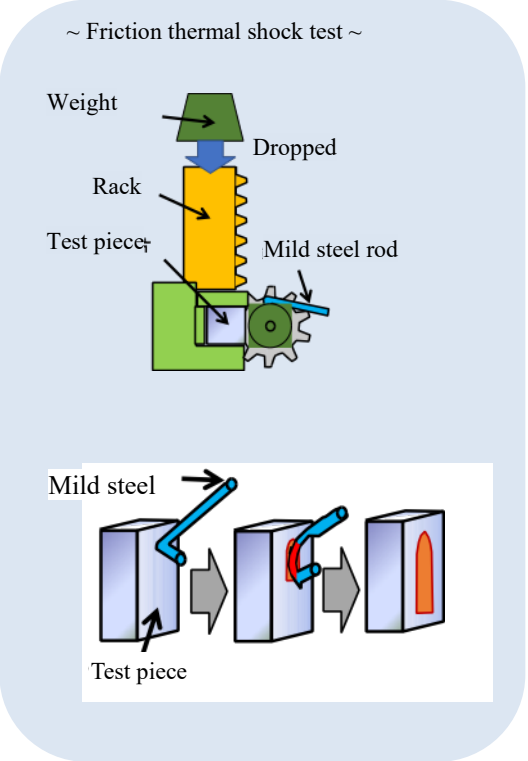
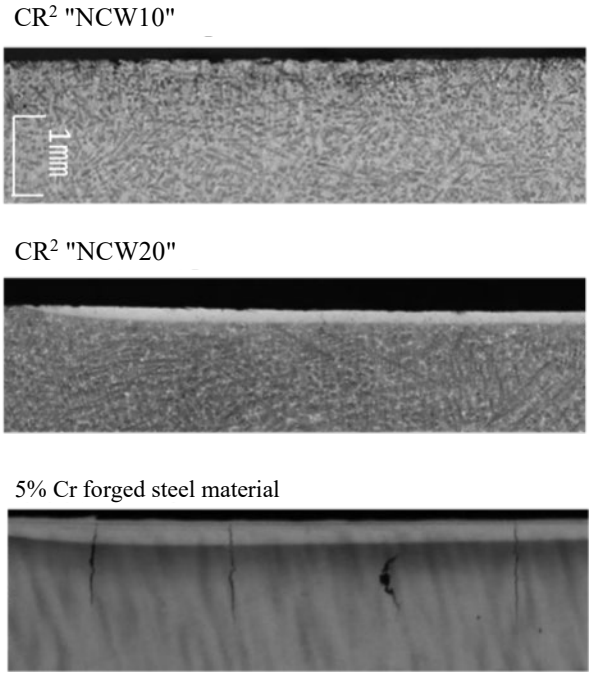


Fig: Fracture toughness test results

■ Improved crack resistance reduces roll damage during incidents

5% Cr forged steel material





◎ "NCW20" is currently used as work rolls in actual steel mills in Japan, and performing as expected.

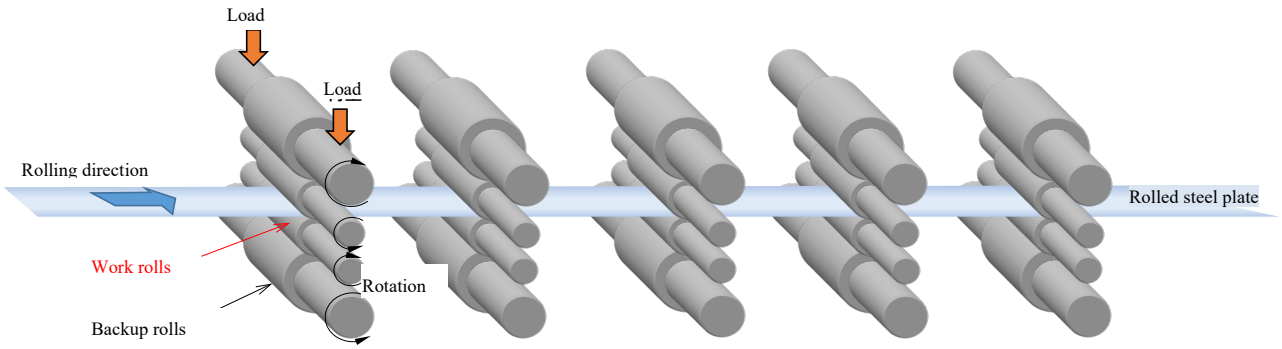


Fig: Schematic diagram of a cold-roll tandem mill (example of 4-High rolling mill x 5 stands)