

Rolling Mill Load Cell by JFE Advantech

1. Introduction

In Japan, the load cells used to measure the roll force of rolling mills are mainly products of two foreign companies. However, the long delivery time and high frequency of breakdowns in the high-temperature, high-humidity environment of hot rolling mill were problems, and some customers had expressed a desire for improvement.

To solve these problems, JFE Advantech Co., Ltd. developed a rolling mill load cell applying technologies cultivated in the severe environment of the steel works. Field tests of a product resulting from joint research and development with JFE Steel were carried out at various steel works, and sales began in 2022.

In order to respond flexibly to requests from customers, JFE Advantech also independently designed and manufactured a 30 MN load testing machine, which is the largest class load cell testing machine in Japan, and constructed a quality inspection system for load cells.

2. Development of Rolling Mill Load Cell

2.1 Structure

The two main detection methods used in rolling mill load cells are the magnetostriction type and the strain gauge type. In the magnetostriction type, laminated silicon steel sheets are used as the material of the load cell body, but this type is weak against thrust loads in the lamination direction, and damage may occur due to misalignment of the laminated layers under uneven loading, etc., making measurement impossible in some cases^{1,2)}.

Because the strain gauge-type rolling mill load cell developed by JFE Advantech has a 1-piece structure which is machined from precipitation hardening type stainless steel, it has excellent load bearing capacity and impact resistance, and the possibility of mechanical failure is extremely low. In addition, since the body of the load cell is filled with an inert gas and has a sealed structure with a thin welded diaphragm which is relatively unaffected by deformation during loading, stable long-term output can be expected.

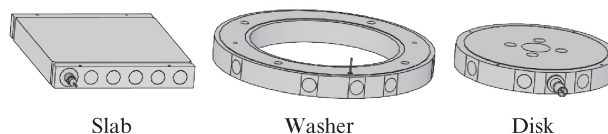


Fig. 1 Load cell type



Photo 1 20 MN slab type load cell

2.2 Shape Types

Existing rolling mill load cells are available in three shapes, the slab type, washer type and disk type, as shown in **Fig. 1**. These are custom products with different outer dimensions depending on the equipment with which they are to be used, even the rated load is the same. **Photo 1** shows the appearance of a 20 MN slab type load cell. JFE Advantech designs each individual product to match the dimensions of the existing load cell, achieving smooth equipment renovation by securing mechanical compatibility.

2.3 Evaluation of Load Characteristics

During development, products of the three shape types with multiple capacities were fabricated, and load characteristics generally satisfying a target accuracy of 0.5% were obtained (**Table 1**). A comparative evaluation with the products of the existing foreign manufacturers was carried out by installing the developed load

Table 1 Load test results

Shape type	Capacity	Linearity	Hysteresis
Slab	20 MN	+ 0.3%	- 0.2%
Washer	9 MN	+ 0.6%	- 0.2%
Disk	16 MN	+ 0.3%	+ 0.2%

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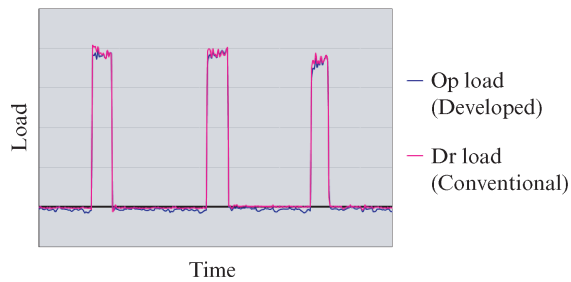


Fig. 2 Field test results

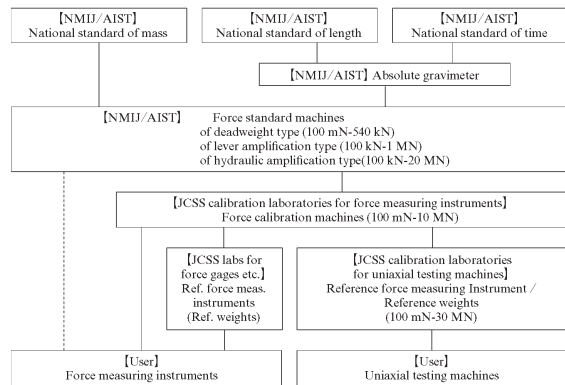


Fig. 3 Force measurement traceability system

cells in rolling equipment at JFE Steel, and satisfactory results were obtained, as no problems for use, including the response speed, were found.

3. Construction of 30 MN Load Cell Test Machine

3.1 Load Cell Test Machines in Japan

The national measurement standard for force is achieved by force standard machines at the National Metrology Institute of Japan, National Institute of Advanced Industrial Science and Technology (NMIJ/AIST), and has a maximum force of 20 MN³⁾. Although it is also possible to conduct 30 MN load cell tests using third-party uniaxial (unconfined compression) material testing machines based on the force measurement traceability system of the Japan Calibration Service System (JCSS) (Fig. 3), this is both costly and time-consuming.

The load cells of rolling mills are mainly large-capacity units with rated loads exceeding 10 MN. In conducting large-capacity tests in Japan, it is necessary to use equipment owned by an external organization, as mentioned above, resulting in a higher product cost and longer manufacturing time. Since this was considered to be a major reason why domestic manufacturer cannot enter this market, JFE Advantech decided to construct a new 30 MN load cell test machine at the

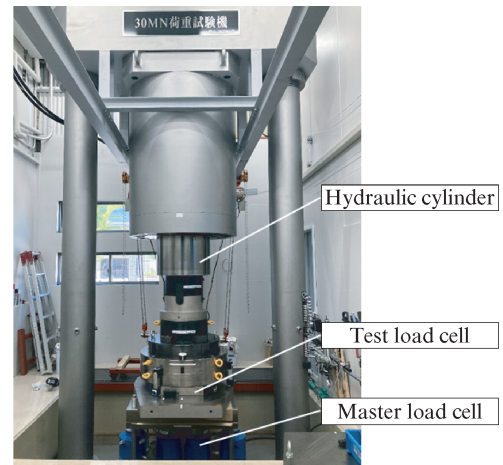


Photo 2 30 MN load cell test machine

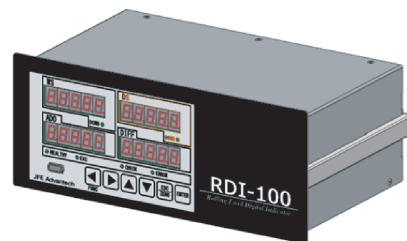


Photo 3 Rolling mill load cell indicator

company's own plant.

3.2 Structure

The 30 MN load cell test machine is a comparison type (build-up type). A build-up type load test machine, as shown in Photo 2, is a test system in which a hydraulic cylinder applies a load to a known load cell (master cell), for which the output data when loaded are known, and the test load cell being tested. The load cell outputs of both load cells are read simultaneously and compared, and the applied load and the output of the test load cell is obtained.

The traceability of the output data of the master cell is secured by using values obtained by testing by an external organization linked to the national measurement standard. JFE Advantech has actual results of the construction of multiple test machine having the structure described here, and has verified that the machines have ample performance for the required rolling mill load cell accuracy of 0.5%.

4. Conclusion

This article has introduced the rolling mill load cells that JFE Advantech Co., Ltd. developed and began selling in 2022. These load cells have received a high evaluation from customers to whom they were deliv-

ered. In the future, JFE Advantech will work to achieve further improvements in performance and cost reduction.

The 30 MN load cell test machine is used not only in inspections of the load cells manufactured by JFE Advantech, but also in commissioned testing of load cells manufactured by other companies, contributing to improved convenience for customers.

In FY 2025, JFE Advantech also began sales of the rolling mill load cell indicator shown in **Photo 3**, which features a high response time of 1 ms. We hope to promote updating from existing product using this device as part of a rolling load measurement system.

References

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- 2) Kawasaki, R. Rolling mill load cells. *Tetsu-to-Hagané*. 1974, vol. 60, no. 13, p. 402–408.
- 3) National Metrology Institute of Japan (NMIJ) Force and Torque Standards Group. Force and Torque Standards in Japan.

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