

Regarding the Defects during Manufacturing Process of Series N700 Shinkansen Train Bogie Frames

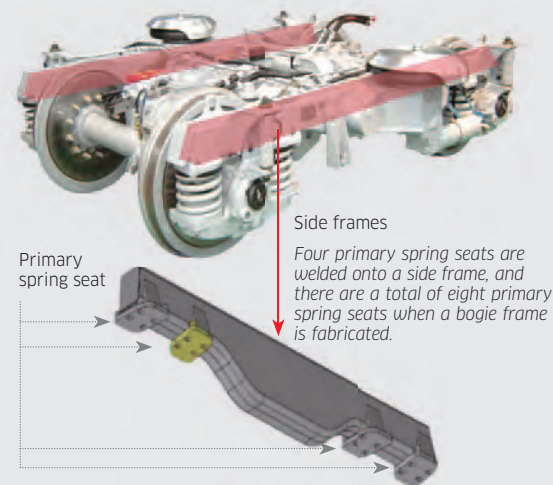
Background to and Purpose in Establishing Companywide Quality Control Committee

With reference to the crack*¹ (structural failure) of the bogie (or truck) frame (hereinafter referred to as the "Failed Bogie Frame"), manufactured in February 2007 at Kawasaki's Rolling Stock Company, Hyogo Works, of the series N700 Shinkansen train that occurred at Nagoya Station on December 11, 2017, two defects during the manufacturing process were discovered during our investigation: a) grinding off of the bottom plate of the side frames, and b) provability that the residual stress was not relieved by annealing or some other process after the entire bottom surface of the primary spring seat was treated with deposit welding*².

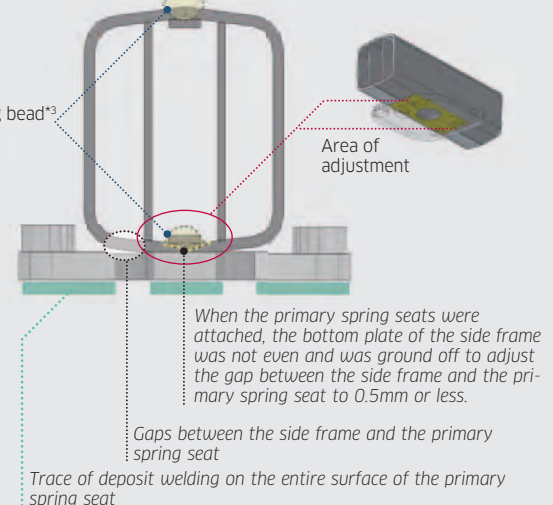
We established the Companywide Quality Control Committee (hereinafter referred to as the "Committee", Chairperson: Professor Takeshi Nakajyo of the Department of Industrial and System Engineering, Chuo University) in April 2018 as an internal committee to investigate and identify the root

Bogie side frame of rolling stock

Side frames are key parts which support the train carbody.



Cross-section image of a side frame where a primary spring seat is attached



*1 Crack: A flaw or fissure that has developed further and become larger as a result of fatigue.

*2 Deposit welding: A common procedure used to compensate for grinding off and repair dimensional adjustment.

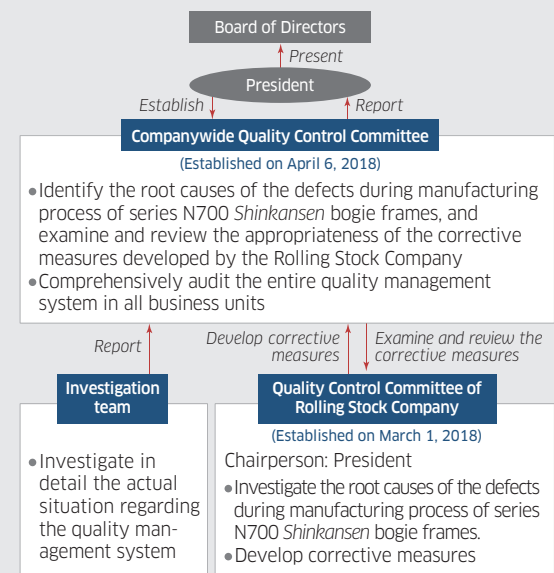
*3 Welding bead: A bulge of welded metal created as a result of fusing a welding rod, etc., at the welding section and building it up.

causes and examine corrective measures to prevent recurrence. The details of the investigation and examination by the Committee are as follows:

- (1) Root causes of the defects during manufacturing process
- (2) Appropriateness of corrective measures developed by the Quality Control Committee of the Rolling Stock Company with regard to the above root causes.
- (3) Results of comprehensive audits of the entire quality management system in all business units. (currently underway as of September 2018)

In addition, an investigation team was established as an organization under the Committee to investigate in detail the actual situation regarding the quality management system and report the investigation results to the Committee. Having received the results of the examination by the Committee, the President presented the corrective measures for preventing recurrence to the Board of Directors, which endorsed such corrective measures in the Rolling Stock Company. The implementation status will be regularly monitored at the Management Committee, and will be supervised by the Board of Directors.

Function of and correlation between Committees



We announced that on the basis of results from the Committee regarding the examination of the action/judgments that led to the manufacturing defects and their root causes, the Quality Control Committee of the Rolling Stock Company developed the corrective measures, and the Committee examined the appropriateness of such measures on September 28, 2018. (see our website: https://global.kawasaki.com/news_C3180928-1.pdf)

The actions/judgments that led to the manufacturing defects and their root causes, the corrective measures for preventing recurrence (Overview)

The result of the investigation conducted by the Committee revealed that the actions and judgments that caused the defects and the root causes which led to those actions and judgments, were: vulnerabilities in the quality control and management owing to **excess reliance on the manufacturing lines** when the manufacturing process of series N700 Shinkansen train began in 2007; and **insufficient risk management to prevent defects** when a supplier for the pressing of the side frames was changed in 2006.

At this juncture, we take the investigation results seriously, and will focus our actions on the following four points as corrective measures for quality management to prevent recurrence:

- (1) In order to remove excessive reliance on the manufacturing lines and the technicians therein, we will develop a system whereby the related departments can share information on the key

points in designs that are critical for ensuring quality of products, thoroughly introduce the KPS*⁴, which will facilitate to reveal issues by standardizing and visualizing the manufacturing process, and **review work processes**.

- (2) In order to prevent manufacturing defects, in addition to reviewing work processes, we will thoroughly control in design, manufacturing, and other processes, identify any potential issue that might occur, and **tighten the risk management**.

- (3) In order to remove excessive reliance on the manufacturing lines and the technicians therein and tighten the risk management, we will promote **close cooperation and communication between the related departments**.

- (4) We will **review the internal education and training curriculum** including quality, safety, and so on, and enhance the contents of the curriculum.

Correlation between the actions/judgments that led to the manufacturing defects and their root causes, and the corrective measures for preventing recurrence

| Actions/judgments (root causes) | | Corrective measures for preventing recurrence | |
|--|--|---|--|
| Insufficient risk management to prevent defects [When suppliers were changed] | A: Control of changes (June 2006) | Thorough control of changes | Thorough review of past manufacturing projects |
| | B: Preliminary verification (October 2006) | | |
| Excessive reliance on manufacturing shop [When the manufacturing started] | C: Share of technical information (January 2007) | Adherence to adapt KPS | Review of preparation process prior to manufacturing |
| | D: Management of manufacturing shop (January 2007) | | |
| Root causes common to A to D | (1) Inter-departments communication was not active. (2) Education on quality control and management was insufficient. | Review of the work processes | |

Strengthening cooperation between departments
Reshuffling education curriculum

With regard to bogie frames for Shinkansen trains and conventional trains in Japan and overseas other than the series N700 Shinkansen train, construction, shape, and manufacturing method of those bogie frames are different from the ones of the series N700 Shinkansen train, and we have reconfirmed that the manufacturing process in the Manufacturing Department conformed to the work procedures and the drawings. Also, since the incident of the Failed Bogie Frame, we have reviewed the inspection checking method in the inspection process for the first product (or first train), and have included areas which cannot be assembled for inspection after completion of manufacturing, to inspection items.

Our group places "providing safe products and services of superior performance and quality for people all around the world" among its management principles, and, since regular audits of the quality management system are extremely effective to enhance and maintain the level of quality control and management, we will continue to audit the quality management system once a year, and thereby tighten the quality management system of the entire group across the board, and strive to provide products and services that can be used without any concern.

*4 KPS (Kawasaki Production System): A set of production control techniques that are unique to Kawasaki Heavy Industries, Ltd. The aim of the KPS is to establish the standardized work practices in order to achieve the same quality constantly whoever does the work; and shop rules to adhere to the standardized work practices.

*5 Concurrent activities: Activities whereby multiple processes in product development are conducted simultaneously in parallel. Design, Development and the other departments in the upstream processes, and Purchasing, Manufacturing, Quality Assurance, After-Sales Service and the other departments in the downstream processes share information, and work together through cross-departmental cooperation to achieve, for example, designs that take into consideration using structures that will be easy to manufacture, and cost effective product development.