Newsletter on the Latest Technologies Developed by RTRI

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Railway Technology Newsletter

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GENERAL INFORMATION

ARTICLES

Open Innovation and International Cooperation

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In recent years, attention has been focused on "open innovation". This concept refers to technical innovation being brought about by properly combining in-house technologies any particular organization has with external technologies and ideas. Behind this trend is the belief that an organization that solely relies on a self-developed unique technology is likely to face difficulty in meeting the dynamic needs of society undergoing drastic change. Another driving factor is the possibility of being able to quickly secure competitive advantages improves through collaboration with other organizations. A similar trend is now intensifying in the R&D sector, and parties concerned are expected to produce innovative results of research and development by reinforcing cooperation and collaboration with other domestic and foreign organizations.

RTRI is actively advancing cooperative research with domestic and foreign universities or businesses. RTRI is implementing various research topics through comprehensive joint research agreements with the China Academy of Railway Sciences (CARS), the Korea Railroad Research Institute (KRRI), National Society of French Railways (Société Nationale des Chemins de fer Français: SNCF), and the Rail Safety and Standards Board (RSSB) of the UK. In addition, RTRI is engaged in joint studies with the University of Cambridge, the University of Bristol, the Polytechnic University of Milan (Politecnico di Milano), and with other universities in the world to study individual research issues.

Today, as the values and advantages of railways are increasingly recognized around the globe, often with a focus on high-speed railway services, we think it necessary for each country to globally share problems, industrial visions, and technical challenges with railway technicians and engineers in other countries in order to enhance the values of railways in general and, at the same time to further strengthen our collaboration towards common goals. RTRI is going to continue the efforts to help people in various regions in the world to utilize railways as an effective tool for enhancing their mobility.

Visit to RTRI by High Officials of India's Ministry of Railways

RTRI received visitors from the Ministry of Railways of India on January 29. The visiting party consisted of five high officials: four from India's Ministry of Railways, namely Mr. Arunendra Kumar, the chairman of the Railway Board, Mr. Arvind Khare, an additional member of the Railway Board, Mr. A. K. Maitra, an additional member of the Railway Board, and Mr. Girish Pillai, the adviser to the Railway Board, and one from Dedicated Freight Corridor Corporation of India Ltd., Mr. R. K. Gupta, the managing director. RTRI presented its major R&D projects to these guests. RTRI members and visitors then exchanged views, specifically related to RTRI's collaborative research work with overseas countries, acceptance of trainees from foreign countries and other issues related to collaboration. Afterwards, the guests toured the facilities of RTRI.

Visit of High Officials of India's Ministry of Railways

Wheel and Rail Damage Workshop

A workshop on wheel and rail damage with Chalmers University of Technology was held on March 24, 2014 at RTRI. Chalmers University of Technology is based in Sweden and has a research center in railway mechanics named CHARMEC (CHAlmers Railway MEChanics).

The program for this workshop was organized, in conjunction with Professor Roger Lundén´s (former Director of CHARMEC) visit to RTRI as guest researcher, to encourage information sharing and discussions on damage to wheels and rails. Five guest researchers, two from CHARMEC, one from Ibaraki University, and two from East Japan Railway Company participated.

A total of 60 people attended this workshop with lectures on two issues from CHARMEC and eight from Japanese attendees (including 5 from RTRI).

Prof. Anders Ekberg (CHARMEC)

Prof. Jens Nielsen (CHARMEC)

Lecture by a Tunnel Expert from Swiss Federal Railways

A lecture presentation by Mr. Jan Dirk Chabot, a senior specialist on tunnels for Swiss Federal Railways (SBB/CFF/FFS), was held at RTRI on March 17.

In Switzerland, the Gotthard Base Tunnel is under construction. It will be the world's longest railway tunnel (57 km) and longer than the Seikan Tunnel in Japan. Mr. Chabot, who is in charge for following this project, described the status of construction of the tunnel, which is expected to be opened to traffic within 800 days. He also talked about infrastructure inspection and maintenance technologies used by the Swiss Federal Railways. After his presentation, engineers of RTRI participated in a lively discussion with Mr. Chabot on the status of technological development in both RTRI and the Swiss Federal Railways.

At present, the tunnel excavation has been completed by Alptransit (ATG) and Swiss Federal Railways are responsible for installation of track and signal equipment with the aim of starting commercial operation in middle of December 2016.

Lecture by Mr. Chabot

Fatigue strength improvement by modifying the geometry of press fitted part of railway axle

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1. Introduction

The fatigue strength of the press fitted parts of axles such as wheel seats and gear seats is lower than that of the axle bodies because of fretting damage. It is well known that fretting fatigue strength is improved by overhanging of wheel hubs to wheel seats or modifying the geometries of press fitted parts of axles. On the other hand, the relationship between fretting fatigue strength and the axle geometries has not been evaluated systematically. In this study, the relationship between the press fit geometries and fretting fatigue strength has been evaluated.

2. Fatigue tests of one-third scale axles

Fatigue tests with one-third scale axles were carried out. The axle specimens were made of SFA65 which has been used in Japanese conventional railway axles. Fig. 1 shows the fatigue limit of the specimens with different tangential angle θ. The fretting fatigue limit of specimens increased as the value of the tangential angle θ increased. Thus, the effect of the press fit geometries on fretting fatigue strength was able to be evaluated.

3. Fatigue tests of full-scale axles

Fatigue tests with full-scale axles were conducted to verify the fretting fatigue strength improvement by modifying wheel seat geometries. Two axle specimens were examined: one with the actual wheel seat geometry for a commuter train design (the "normal axle"), and the other (the "improved axle") with improved geometry based on the fatigue testing results with the 1/3 scale axles. The fracture surfaces of the specimens after the full-scale fatigue tests are shown in Fig. 2 and Fig. 3. The maximum crack of 20 mm in circumferential length and 5 mm in depth developed in the improved axle. On the other hand large cracks regarded as fractures developed in the normal axle. These results indicate that crack growth was prevented by improving wheel seat geometry.

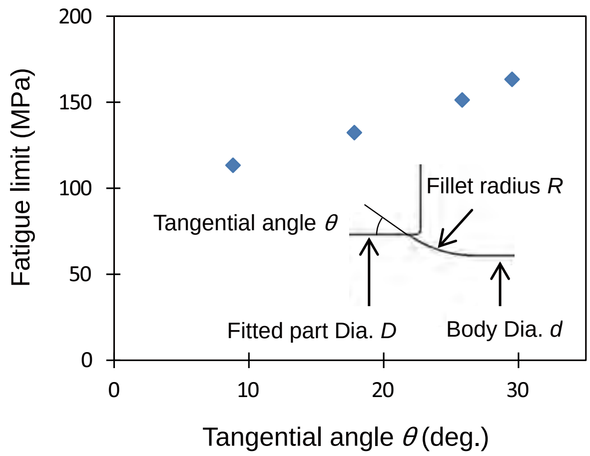

Fig.1 Relationship between fatigue limit and tangential angle θ

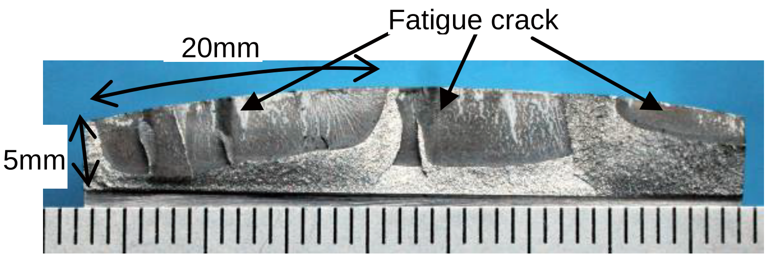

Fig.2 Fatigue testing results of full-scale axles - Maximum fatigue crack observed in the improved axle -

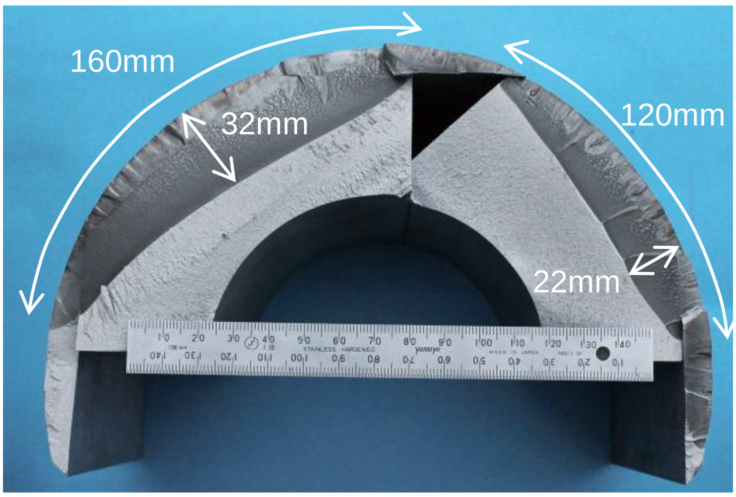

Fig.3 Fatigue testing results of full-scale axles - Fracture surface of the normal axle -

Development of a Composition Brake Shoe for Reducing Damage to the Wheel Tread

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1. Introduction

In rail vehicles that use composition brake shoes acting on the wheel tread, the friction coefficient between the wheel and the brake shoe tends to decrease under wet conditions, and the brake force reduces. Although a metallic block has previously been inserted to counteract the reduction in friction coefficient under such wet conditions, this metallic block rubs excessively on the wheel tread under dry conditions, and causes a localized increase in the temperature of the wheel tread. Such heat load is one of the factors that produce the wheel tread damage referred to as “heat crack and concave wear”.

2. Outline

We studied composition brake shoes from a structural point of view and developed a shoe that does not use metallic blocks to restrict increases in the temperature of the wheel tread but maintains brake performance under wet conditions. We have evaluated the performance of the developed composition brake shoe (Fig. 1) in dynamo tests, running tests and long-term running tests. As described below, tests have verified that the developed brake shoe will control concave wear and it will produce a longer wheel life span while maintaining good brake performance.

3. Test results

A brake performance running test was carried out using the developed shoe. The test train set consisted of two vehicles. The developed shoe was able to maintain the brake distance under wet conditions (Fig. 2) and reduce the damage to the wheel due to a reduction in heat load. A long-term durability running test was carried out using the developed shoe in service. A comparison of estimated wheel shapes (after 80000 km running) is shown in Fig. 3. The wear shape of the wheel with the conventional shoe shows some concave wear with the concavity covering the slide width of the shoe. In contrast, the developed shoe certainly has an inhibiting effect on wheel concave wear. A comparison of wheel life span is shown in Fig. 4. The life of the wheel with developed brake shoe is as much as 1.8 times the life of the conventional shoe. Additionally, maintenance costs with the developed shoe will be reduced as wheels will need to be replaced less frequently.

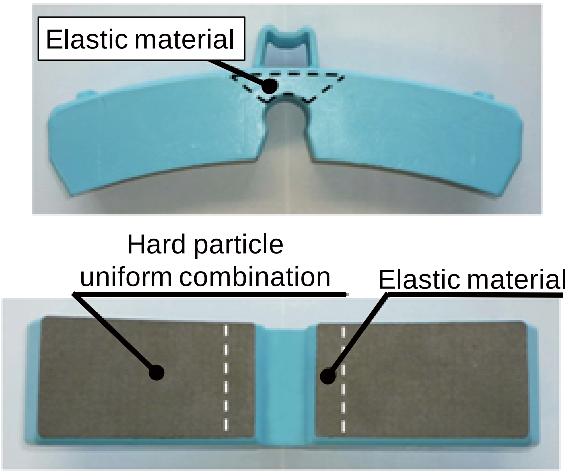

Fig. 1 Developed composition brake shoe

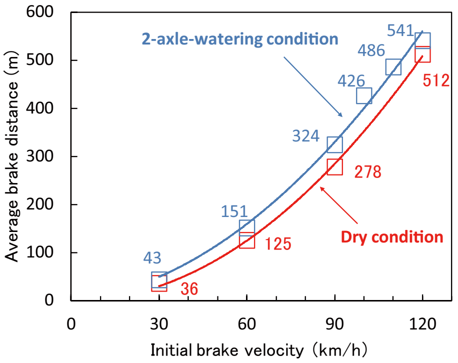

Fig. 2 Results of brake distance

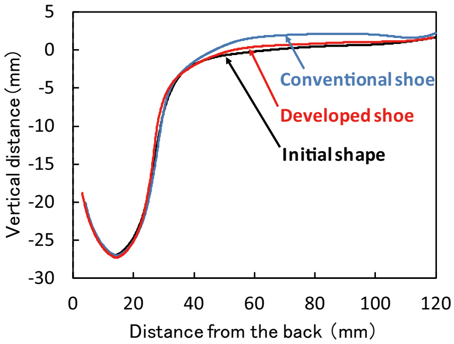

Fig. 3 Estimated shape at 80000 km

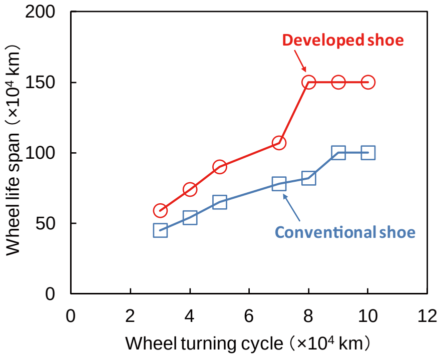

Fig. 4 Estimated wheel life span

Evaluation of Tsunami Wave Forces on Railway Bridges

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1. Introduction

Japan's east coast suffered tremendous damage, with many coastal railway bridges washed away, in the Great East Japan Earthquake. And, it is anticipated that the Tokai, Tonankai, Nankai Consolidated Type Earthquake will occur in the near future and might cause considerable damage to the railways along the coasts of Japan. Thus, RTRI has conducted evaluations of the forces applied by tsunamis in order to develop a method to predict tsunami damage to bridges and develop a countermeasure method for bridges to resist tsunamis in the future.

2. Outline of Evaluation

We conducted hydraulic tests and numerical analysis to develop a method to evaluate tsunami wave forces on bridge girders. For the girders in this evaluation, we fabricated three types of specimens, reduced to a scale of one-thirtieth of the actual size. These models were constructed to the typical parameters of the T-shaped, through girder and box girder cross-sectional shapes used on the railway bridges that washed out and collapsed in the Great East Japan Earthquake. Then we duplicated how tsunami-induced quasi-steady flow velocities acted, measured the drag and lift forces acting on the bridge girders, and performed detailed PIV (particle image velocimetry) analysis of the flow velocities around the test specimens using high-speed camera images. Two of the waveforms used for the test are shown in Fig. 1.

Fig. 2 shows cross-section shape of test specimen. Fig. 3 shows an example of the flow velocity distributions measured using the PIV, and the pressure distribution at the instant when the moment (M_{y0}) acting on the bridge girders has reached its maximum. In a bore where the water level rises in a relatively short period of time (Wave 14), generation of a high wave pressure was found on the upstream side, and the wave pressures acting on the floor slabs were unsymmetrical between the right and left. On the other hand, more uniform pressure was generated on the floor slabs in a split wave (Wave 15) though there were differences among the fluid forces acting on the sides. The difference between waveforms appears prominently in the moments and is considered to greatly affect girder stability. However, a downward force acted on the girders after the crest of the wave passed, which indicates that the risks of girder movement are high at the crest of a wave.

3. Conclusion

We understand the results of the tests and numerical analyses of the fluid action on bridges caused by tsunami waves and we determined the fluid forces acting on the girders depending on the shapes and dimensions of girders. In the future, we will conduct further studies to verify the effectiveness of reinforced concrete bridge structures to withstand tsunamis.

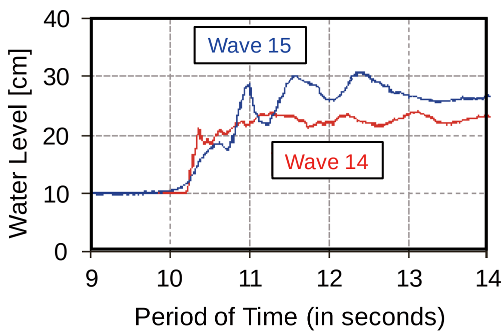

Fig. 1 Tsunami waveforms used for test

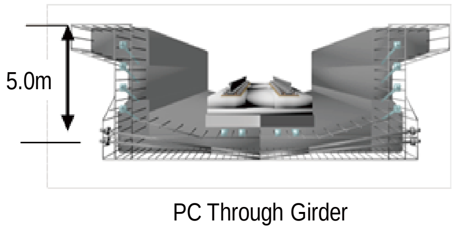

Fig. 2 Cross-section shape of test specimen

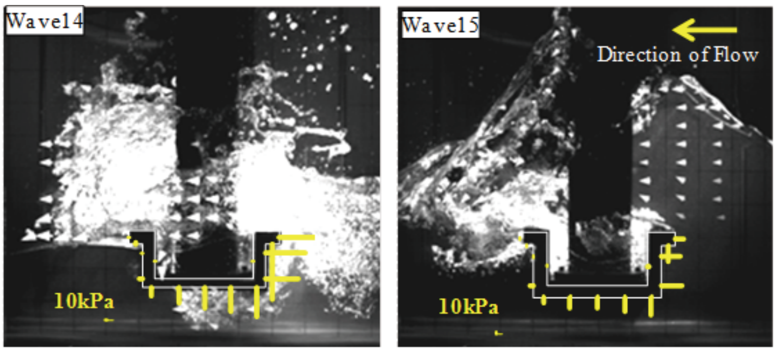

Fig. 3 Flow velocity distributions around girders measured using PIV and pressure distribution (at max. moment (M_{y0}))

Corrosion Prevention of Galvanized Steel

Tadanori USUKI
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1. Introduction

Since the contact line members are structural members, they are galvanized to resist corrosion. The metal fittings of the porcelain insulators are also galvanized because this is an effective and low-cost measure for enhancing the corrosion resistance of steel. However, if the corrosion of metal fittings progresses despite the galvanization and the corrosion product (rust) adheres to the porcelain parts, the insulation properties of the insulators are likely to deteriorate. The strength of the metal fittings might also degrade due to corrosion, consequently leading to an accident of the equipment. Therefore, it is critical to enhance the corrosion resistance in the metal fittings of porcelain insulators.

2. Description

We developed a corrosion resistance improvement measure by coating the galvanized steel of the metal fittings of the insulators with paint having the proper electrical conductivity, This corrosion protection method is expected to maintain its rust-proofing function longer than conventional products. Generally, many of conventional protective coatings are electrically insulating, and once a conductive path is formed on such coatings, leakage currents flow freely into the path and cause significant burnout. However, if this method proposed here is applied to the metal fittings of insulators, the coating films have dispersed conductive paths and burnout is less likely if any conductive corrosion product should become attached to the coating film. Thus, with this method, the insulator performance retention period is expected to be longer.

3. Conclusion

We performed a field test by applying a 1.5kV direct current voltage at our anti-salt testing station and verified the effects by measuring the leakage currents. Fig. 1 presents photographs of a "Treated fitting" (coated with the above paint) and Conventional fitting (uncoated) taken 7 months after the start of exposure. Fig. 2 shows the measurement results of leakage currents of the fittings. The photos show no difference in appearance between the two fittings. However, the leakage current record chart indicates that the peak value of the Treated fitting was less than a quarter of that of the Conventional fitting, and the mean value was almost a half. This suggests that the Treated fitting effectively suppressed the leakage current. Though the effect of this protective coating at the no-power applied points has not been confirmed, judging from the leakage current measurement results, it is considered that the outflow of the coating material, not of the galvanizing material, was dominant 7 months after the start of exposure and therefore the effect of the protective coating lasted for this 7 month period. We will continue the leakage current measurements to verify the long-term effect of the coating.

Conventional fitting

Treated fitting

Fig. 1 Appearances of Conventional and Treated fitting

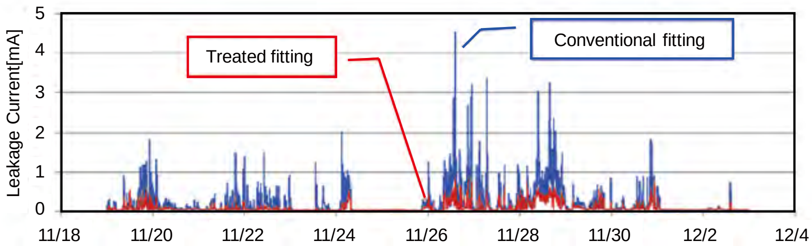

Fig. 2 Measurement Results of Leakage Currents