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DYNAMIC LOADING TESTS CARRIED OUT AFTER REPAIR WORKS OF THE YODOGAWA BRIDGE

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ABSTRACT

Yodogawa Bridge having a total length of 723.3m is composed by 30 spans, 6 of which are simply supported truss bridges with span length of 32.918m. Completed in 1926, the bridge is located on a heavy traffic route and underwent repair works after being severely damaged during the World War II.

A series of site measurements and inspections were carried out in the previous year with the objective of evaluating the structural health of the 85 years old truss bridge and, as a result, repair works were executed at locations having inadequate structural details, defective welds or cracks. The present paper presents a report on the dynamic loading test and stress measurement under traffic load that were carried out to verify the effectiveness of the executed repair works.

The results of the loading tests and stress measurements were compared to that of obtained in the former year before the execution of the repair works. Comparisons were also made between the fatigue lives of the retrofitted members before and after the execution of repair works. The repair works proved to be effective for some members, such as a transverse beam whose lower flange had been inadequately repaired in the past, after being severely damaged. This transverse beam, in particular, had its fatigue life extended to 10 times of the life obtained for the case before the execution of the repair works.

Keywords: Dynamic loading test, stress measurement, fatigue life, truss bridge.

1. INTRODUCTION

The Yodogawa Bridge, completed in 1926, has a total length of 723.3m, consisting of 30 spans, 6 of which are single truss bridges. Surveillances carried out in 2005 revealed that the total volume of

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traffic crossing the bridge exceeded 20,000 vehicles in half a day (12hr.) and that 12.7% of this volume consisted of heavily loaded vehicles.

With the purpose of extending the service life of the 85 years old bridge, repair works were carried out as a result of investigations carried out during the first year of the "Research Project on structural diagnosis and life extension of aging long-span bridges" (Sakano, 2011), which provided a deterioration scenario for the bridge. With the objective of verifying the effectiveness of the repair works, dynamic loading tests and strain measurements under traffic load were carried out.

Figure 1: Yodogawa Bridge.

2. MEASUREMENT POINTS

Based on the deterioration scenario obtained from the series of investigations carried out in 2011 (Natsuaki et al., Kohno et al., Ichinose et al., 2011), critical members were selected for repair and, after the execution of repair works, stress measurements were carried. Stress measurements were carried out through strain gages installed at the measurement points shown in Figures 2 and 3.

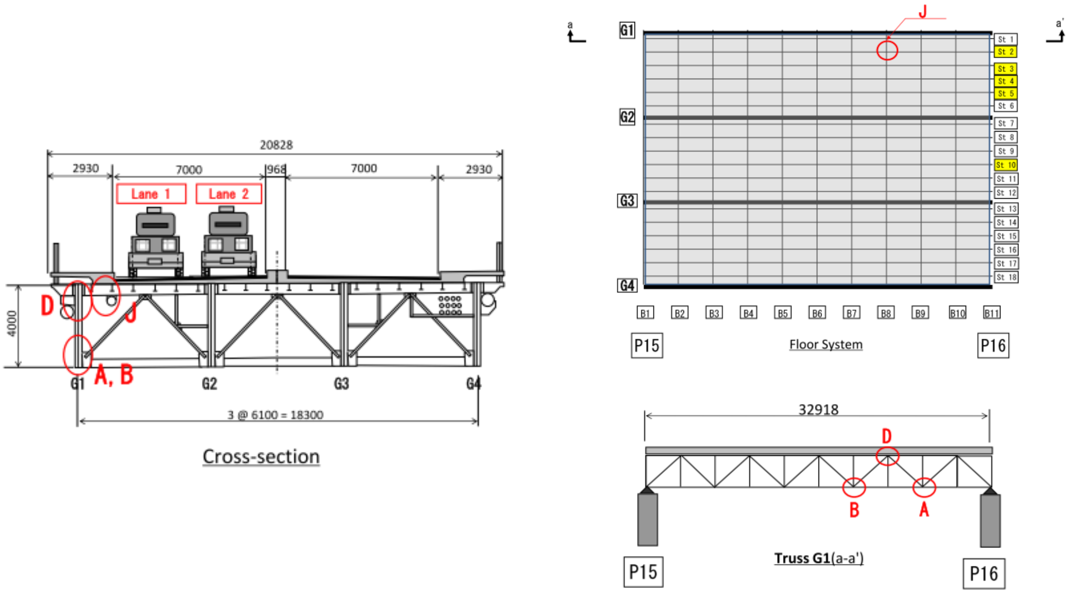


Figure 2: Measurement points

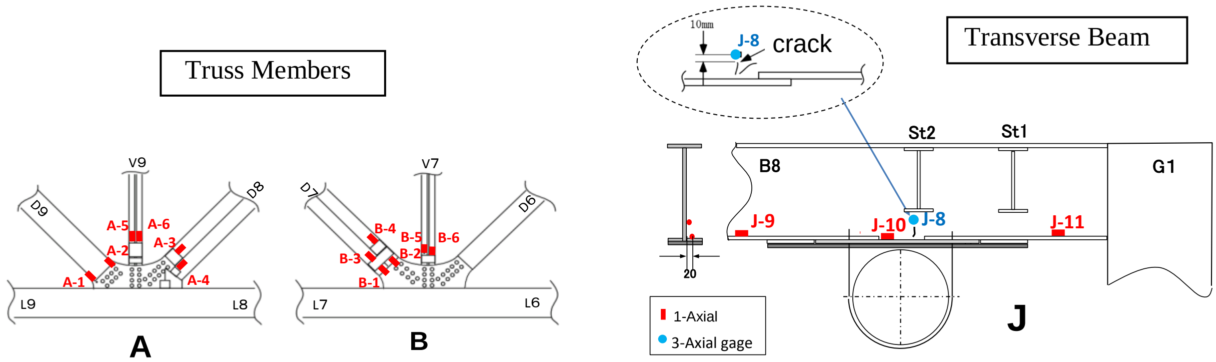
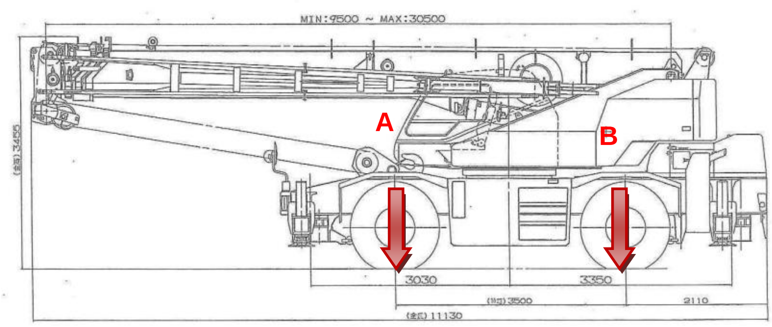


Figure 3: Example of strain gage installation

3. STRESS MEASUREMENT

3.1. Dynamic Loading Test

Dynamic loading tests were carried out by loading the test vehicle shown in Figure 4 on the two traffic lanes shown in Figure 2. The vehicle moved at a velocity of about 40 km/h and stress measurements were carried out at night when the number of vehicles crossing the bridge is relatively small and the influence of temperature can be considered small.



	A	B	Total
Load	14270kg	12820kg	27430kg

Figure 4: Test vehicle

3.2. Stress Measurement under Traffic Load

Stress measurements under traffic load were carried out after completion of repair works and the measurement results were compared to that of the measurements carried out in the previous year to verify the effectiveness of the retrofit works.

The measurements were carried out during consecutive 72 hours (week day) and fatigue life was evaluated based on these measurement results.

4. RESULTS

4.1. Dynamic Loading Test

The results of the dynamic loading test, compared to the results obtained in measurements carried out before the execution of repair works, showed relatively small differences for stresses measured in the truss members, whereas considerable improvements were observed in the transverse beam stresses. Measurements results for lane 1 are shown in Figure 5. The figure presents the measured stresses for the structure before and after the execution of repair works. In particular, it was observed that stresses at the lower flange of the repaired transverse beam presented a considerable reduction of stress (about 40%) after being retrofitted.

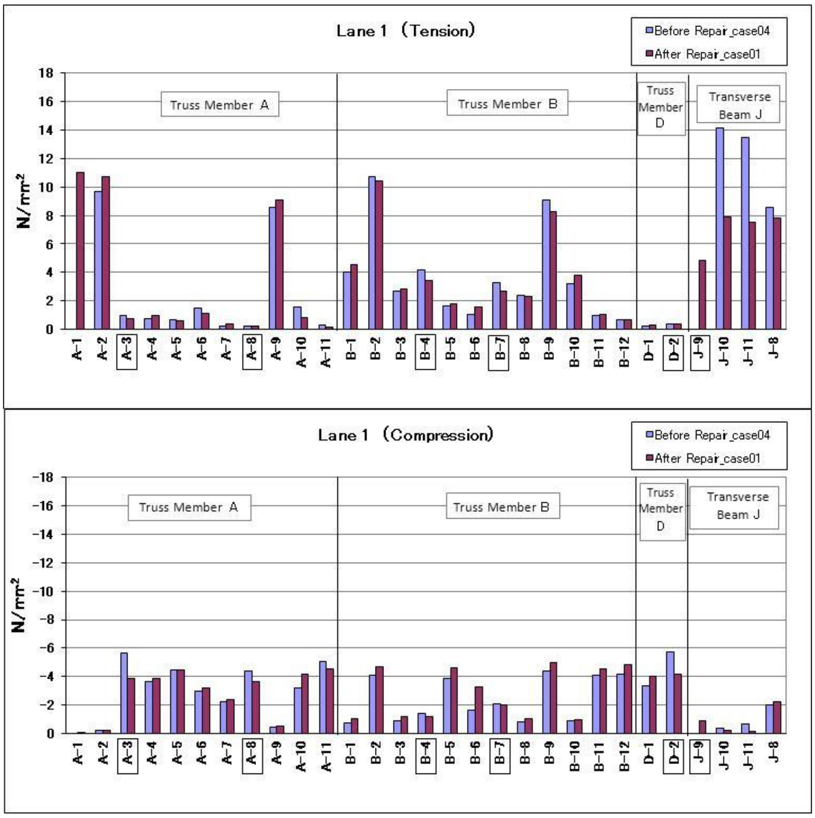


Figure 5: Stresses before and after repair works (Dynamic loading test)

4.2. Stress Measurement under Traffic Load

The stresses measured during the 72 hours (3 consecutive week days) presented relatively small values, being most of them within the fatigue limit. Maximum stresses observed in truss members and transverse beam during the measurements are shown in Figure 7 and 8, respectively.

Under traffic load, stresses were considerably improved in both truss members and the transverse beam, what can be also seen in Figure 9 which shows a decrease in the stress range ($\Delta\sigma$) after the execution of repair works for almost all the measurement points. The transverse beam, in particular, had its predicted fatigue life extend to more than 10 times of that of before the execution of repair works.

(Unit: N/mm^2)

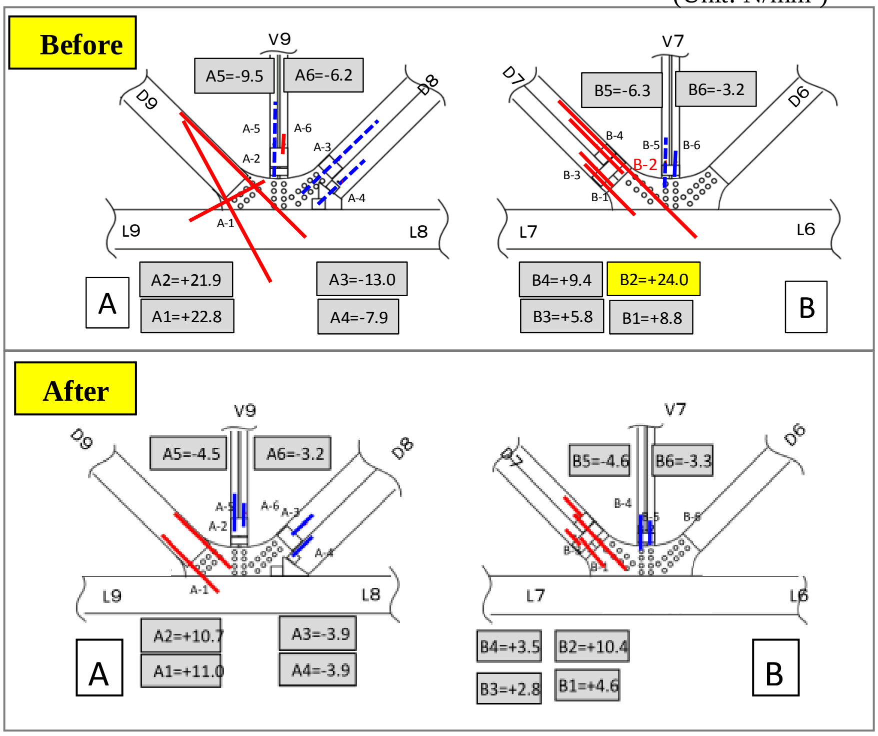


Figure 7: Stresses under traffic load before and after repair works (truss members)

(Unit: N/mm^2)

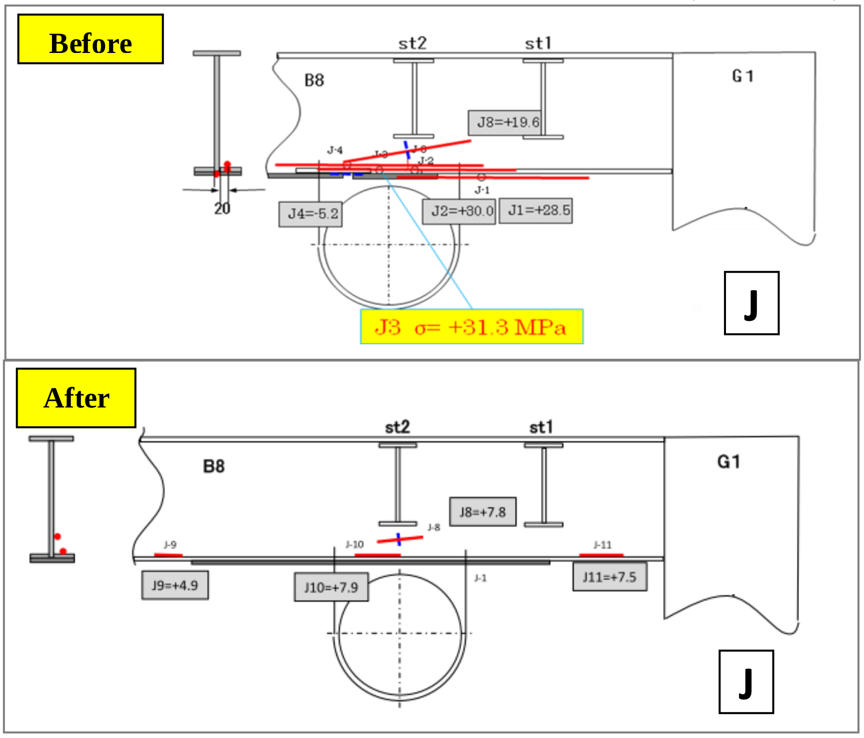


Figure 8: Stresses under traffic load before and after repair works (transverse beam)

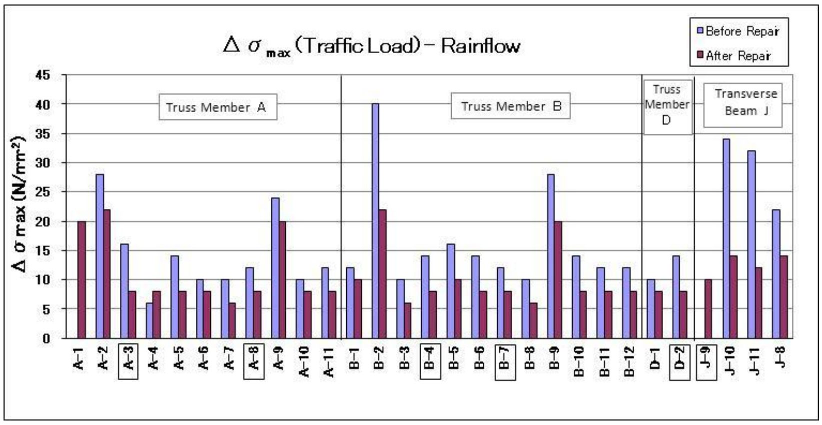


Figure 9: Maximum stress range before and after repair works (Traffic load)

5. CONCLUSIONS

In the dynamic loading tests, stresses at the truss members did not present considerable differences compared to that measured before the execution of retrofitting works, whereas the stresses at the lower flange of the reinforced transverse beam presented considerable stress reduction (40%), proving the effectiveness of the retrofitting works.

Measurements carried out under traffic load showed improvements in the stress range for almost all the measurement points. However, the fatigue life obtained based on these measurement results did not show dramatic changes in the fatigue lives of most measured members, except for the lower flange of the retrofitted transverse beam, which presented a fatigue life improved to 10 times of that of before retrofitting .

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