Fatigue behavior of riveted beams removed from Amarube bridge

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Abstract

Corrosion and fatigue are main deterioration factors to control durability of steel bridges. On corrosion, we can find most of corroded members easily, and usually take countermeasures against corrosions easily, which are attachment and so on. But we can't detect fatigue cracks so easily when they are short. When they are long, it is critical situation for bridges. Countermeasures including cause investigation are not easy generally.

Some cases are reported corroded parts are conducted. Corrosions influence on fatigue strength about stress rising arise from session loss and stress concentration arise from asperity. We have reports that degrees of asperity have limit if corrosion fatigue period is long. Cases act corrodes and fatigues at the same time are called corrosion fatigue. It is well-known as declining strength sharply. Generally, steal bridges are done antirust countermeasure. So we consider we can control corrosion effects to measure strength of corroded parts mostly. In this study, we could get riveted beams from Amarube bridge. So we do fatigue test at achingly corroded parts. And we try to determine property of fatigue strength of steel bridges.

Fatigue cracks occurred from bottom flanges of depressive corrosion parts and of loss parts of the edge parts and rivet holes of angle member of cross-section parts. Fatigue cracks occur from depressive corrode parts and loss parts of the edge parts make progress and cut off lower flange.

Keywords: Steel railway bridges, riveted structures, pier specimens, fatigue test

1. Introduction

Corrosion and fatigue are main deterioration factors to control durability of steel bridges. Hence if we control corrosion and fatigue, it is easy to improve durability. On corrosion, we can find most of corroded members easily, and usually take countermeasures which are attachment and so on against corrosions easily. But we can't detect fatigue cracks easily when they are short. When they are long, it is critical situation for bridges. Countermeasures including cause investigation are not easy generally.

Some cases are reported corroded parts are conducted. (Miki 1987, Yamada 1990, Otsuka 1991) Corrosions influence on fatigue strength about stress rising causing for session loss and stress concentration causing for asperity. We have reports that degrees of asperity have limit if corrosion fatigue period is long. (Sakano 1989) But cases which act corrodes and fatigues at the same time are called corrosion fatigue. It is well- known as declining fatigue strength sharply. (Sakano 1988, Sakano 1992) Generally, steal bridges are done anticorrosion countermeasure. Hence we consider we can control corrosion effects to measure fatigue strength of parts which is corroded mostly.

In this study, we could get riveted beams from Amarube bridge, and we conducted fatigue test at achingly corroded parts. Therefore we try to determine property of fatigue strength of steel bridges.

2. Specimen

Figure 1 shows location which is removed from steel girder. (Abe 2004) We cut off specimen from 8 lane, 11 lane and 13lane, which is confirmed particularly corroded bottom flange in the prior survey. (Civil engineering department traffic policy office in Hyogo 1999) In this time, we report about the specimen of 8 lane. 8 lane girder is 30ft girder. Figure 2 shows location which is cut off specimen from a removal girder. We cut off specimen from the end part, which is received corrosion of bottom flange particularly at mountain side.

3. Corrosion circumstances

Figure 3 shows locations of measuring plate thickness and corrosion circumstances, and figure 4 shows distribution of remaining plate thickness of direction to flange width, which is parts received corrosion particularly. Some points in the angle of bottom flange at mountain side in girder at mountain side were received corrosion particularly, and their minimal remaining plate thickness was about 2.5mm (10.5mm decrease by corrosion) against 13mm of original plate thickness.

4. Static loading tests

Figure 6 shows loading procedure and locations pasting strain gage, and figure 7 shows distribution of bridge axial direction of bridge axial direction stress. Stress measurements of healthy parts are scattered, but conventional stress could be calculated by considering vertical angles of bottom flange because these measurements are distributed around calculated stress. On corrosion parts, measurements are scattered widely, and some measurements are measured lager 1.5 times than conventional stress. We couldn't measure at corroded undersurface of bottom flange, but, on upper surface, it is interested in the stress of corroded edge parts is small, and stress of web parts is large.

5. Fatigue test

Fatigue test was conducted same loading condition of static loading test, and loaded specified stress rage that minimal stress is 20kN and maximal stress is controlled. The speed of cyclic loading is about 3Hz. We stop the test equipment our discretion, and we detected cracks by visual observation, PT and MT. The fatigue cracks were confirmed to occur from depressive corrosion parts which is received corrosion particularly. Since then, the crack progresses to flange width direction and flexor of the girder became large because of breaking horizontal parts and vertical parts of angle. Figure 43 shows relationship of corrosion parts between maximal measured stress and fatigue life.

6. Conclusion

(1)There was noted corroded angle members of the flange at mountain side in the girder at mountain side. They were angle members of lower flanges at mountain side of beams at mountain side. The minimum of its residual through-thickness was about 2.5mm against original through-thickness 13mm.

(2)Local stress measurements of depressive corrosion parts was scattered widely and was measured around 1.5 times measurements against conventional stress.

(3)Fatigue cracks occurred from bottom flanges of depressive corrosion parts. And the fatigue crack progressed and broke bottom flange.

(4) Cracks occurred from depressive corrosion parts was regretted fatigue strength is about category B of the old standard.

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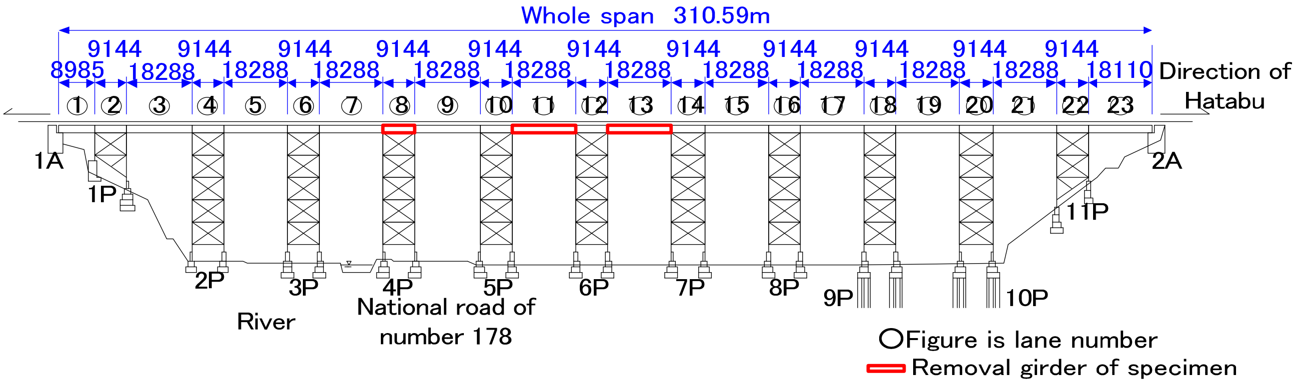
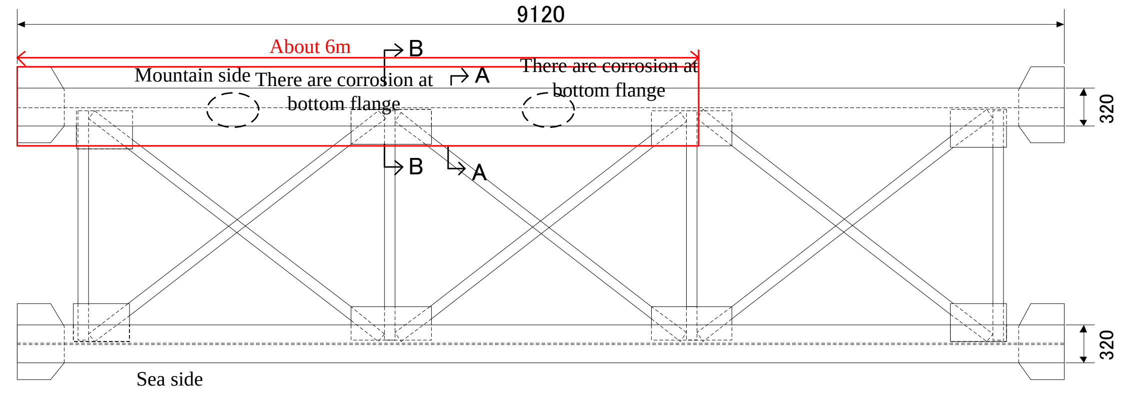
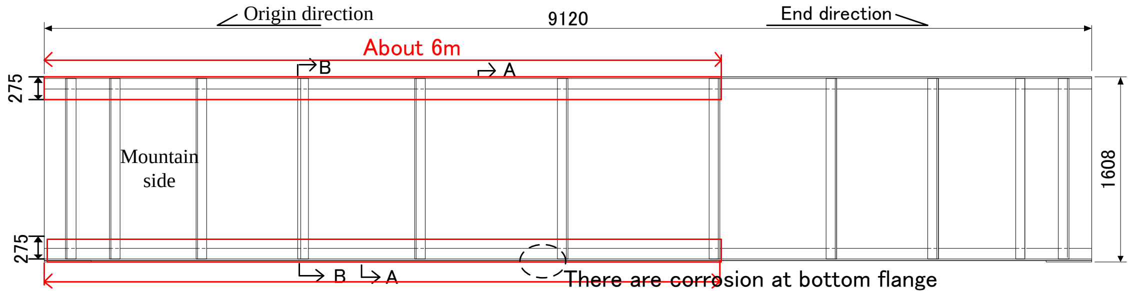


Figure 1: Whole of bridge and removal girder of specimen



(1)Plan view



(2)Side view

Figure 2: Removal location of specimen of 8 lane

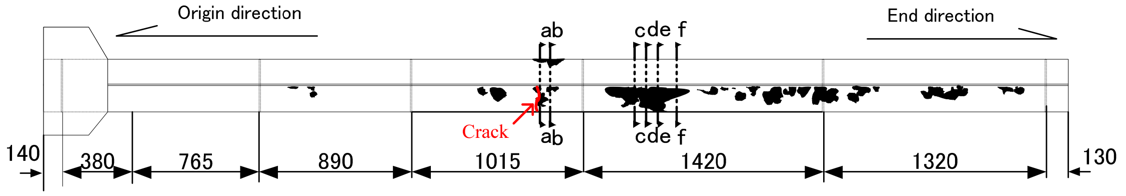


Figure 3: The locations of remaining plate thickness in bottom flange

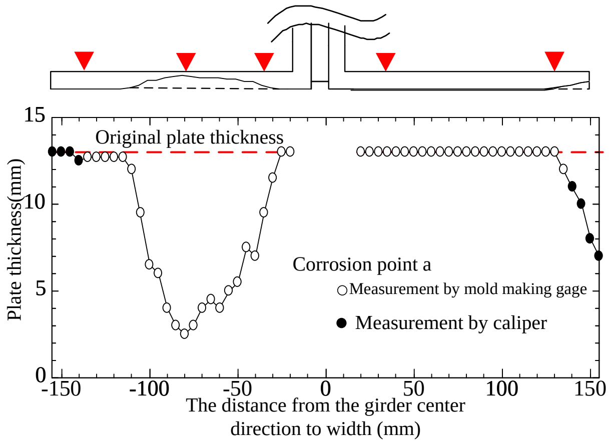


Figure 4: The remaining plate thickness of corroded plate a in bottom flange

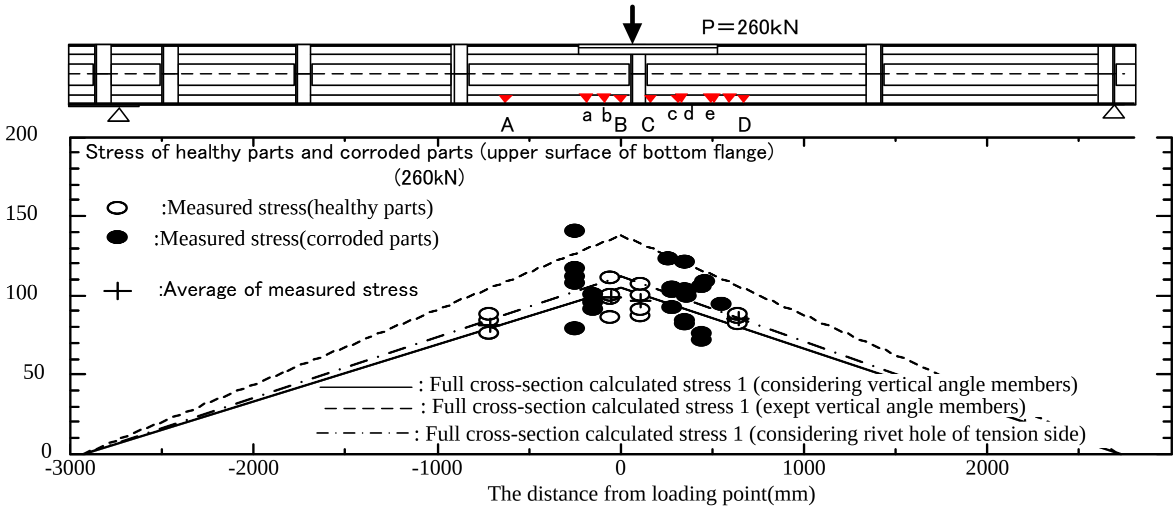


Figure 5: The distribution of axial direction stress of longer direction of specimen (upper surface of bottom flange)

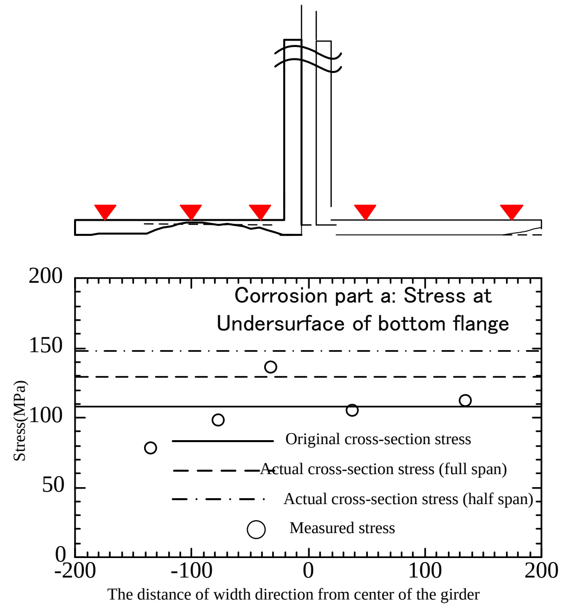


Figure 6: The distribution of width direction of the bridge axial stress at corrosion part a