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CORROSION DAMAGE MODELS FOR STEEL GIRDER BRIDGES

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1. INTRODUCTION: The deterioration of steel bridges is a serious problem throughout the world. The necessity for determining the capacity of existing bridges has arisen, and has been recently discussed in U.S.A.[1,2]. In this study, the deterioration of painted bridge girders is measured in terms of stress ratio and allowable stress ratio.

2. CORROSION DAMAGE MODELS: The process of modeling the effect of corrosion begins with estimating the amount of section loss at a particular time. The loss can be determined using the model of Matsumoto et al [3]. In this model, uniform and local corrosion depth of painted bridge girders in the form of probability function are predicted based on steel exposure test, corrosion ratio, and paint life. Predicted local corrosion depth, which is rather major, is used for determining the effect of corrosion on the strength of bridge sections. However, past investigations showed that the weakest section of corroded steel materials is defined by the effective corrosion depth. Therefore, local corrosion depth is converted to effective corrosion depth by Eq.1 and Eq.2 where Y_{max} represents local corrosion depth (mm), Y_{ave} represents average corrosion depth (mm), and Y_{eff} represents effective corrosion depth (mm). This two equations were determined from the results of tension test of corroded steel materials.

$$Y_{ave} = -0.124 + 0.803\,Y_{max} \geqslant 0 \tag{1}$$

$$Y_{eff} = 0.192 + 1.055\,Y_{ave} \tag{2}$$

From this effective corrosion depth, the reduced thickness of the section components, upper flange, web, and lower flange are calculated and the new dimensions are used to compute the updated strength of the bridge girders. Two cases are considered in this study. Case one is for the middle cross-girder while the other case is for the end cross-girders.

a) Stress ratio for the middle cross-girder: Bending stress ratio, the ratio of bending stress value of uncorroded section to that of corroded section is used as an index to determine the effect of corrosion. Fig. 1 shows a representative girder section used in calculation. It is assumed that plain sections will remain plain after bending. Bending stress ratio is determined based on predicted local corrosion depth for environment of Osaka City by the model of Matsumoto et al. From this result, if the girder section is made of SS41 steel, which its allowable bending stress is 1400 kg/cm^2 and its allowable shear stress is 800 kg/cm^2, and if the initial bending stress is 1333 kg/cm^2 at the middle cross-girder, the allowable bending stress ratio can be determined by the following equation

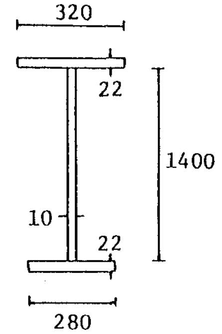


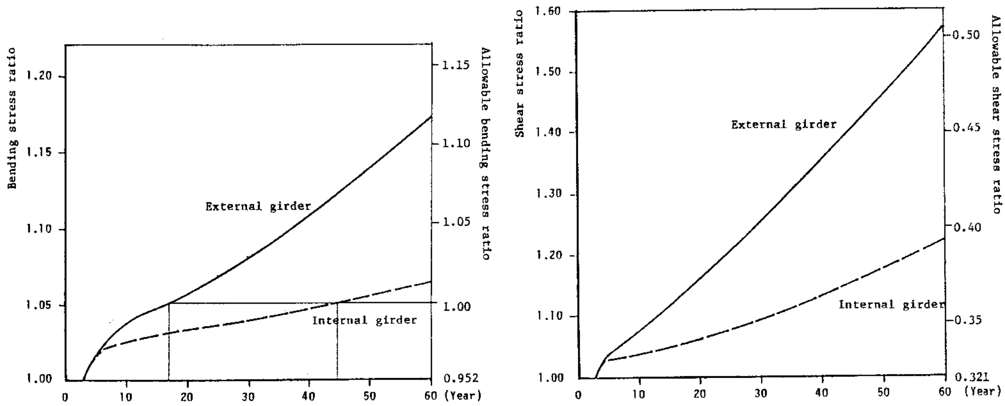
Fig. 1 Girder section

Allowable bending stress ratio = (Bending stress ratio)x(1333/1400) (3)

b) Stress ratio for the end cross-girders: Shear stress ratio, the ratio of shear stress value of uncorroded section to that of corroded section is used as an index to determine the effect of corrosion, and also determined based on predicted local corrosion depth for Osaka City. From this result, if initial shear stress is 257 kg/cm^2 at the end cross-girder, the allowable shear stress ratio can be determined by the following equation

Allowable shear stress ratio = (Shear stress ratio) x (257/800) (4)

The results of determined stress ratios for both the middle cross-girder and the end cross-girders are shown in Fig. 2.



a) For middle cross-girder b) For end cross-girders

Fig. 2 Effect of corrosion on the strength of bridge sections

3. CONCLUSION: This paper has outlined the models for determining the effect of corrosion on the strength of steel girder bridges. From these results, it is shown that corrosion damage of external girders is more severe than internal girders for this environment. Corrosion damage at the end cross-girders is greater than at the middle cross-girder. However, the effect of corrosion on the allowable stress ratio is rather minor for shear stress at the end cross-girders. For the middle cross-girder, the allowable bending stress ratio increases over the limit, 1.0, after the exposure time of about 17 years for external girder and about 44 years for internal girder.

4. REFERENCES:

1) J. Kayser and A. Nowak, Evaluation of corroded steel bridges, Bridges and Transmission Line Structures, ASCE Publication, 35-46 (1987)
2) J. Kayser, T. Malinski, and A. Nowak, Loss of strength due to corrosion in steel girder bridges, Effect of Damage and Redundancy on Structural Performance, ASCE Publications, 9-22, April (1987)
3) M. Matsumoto, N. Shiraishi, and S. Rungthongbaisuree, Prediction of corrosion for the structural steel bridge, Proc. of the Second East Asia-Pacific Conference on Structural Engineering & Construction, Vol.2, 1312-1317, Jan. (1989)