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Ultimate flexural strength of steel beams with pitting corrosion

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Abstract

Pitting corrosion is typical corrosion observed on coated steel member which exclusively carry oil, coal and iron ore. Extensive survey on the effect of pitting corrosion on structural strength under a wide variety of loading conditions is necessary to clarify the relationship between pitting intensity and residual strength in detail. It is important to understand the effect of pitting corrosion on local strength of steel beam. A series of non-linear FE analyses has been conducted on structural models to investigate the effect of pitting corrosion on strength of web plates. The ultimate strength of a steel beam with pit corrosion and under a patch loading is governed by the DOP (degree of pit corrosion intensity). The ultimate strength is found to be decreasing with increase in the degree of pitting intensity.
Keywords: Pitting corrosion, Ultimate strength, Steel beam, ABAQUS

1. INTRODUCTION

The behavior and strength of hot rolled beams and fabricated plate girders, subjected to localized edge or patch loading in the plane of the web, is analyzed. Numerous tests have indicated that failure occurs due to web crippling, which is characterized by elasto-plastic post buckling of the web plate accompanied by the formation of a plastic collapse mechanism in the flange. The tests have also indicated that ultimate loads are approximately proportional to the square of the web plate thickness, other parameters such as web depth; flange width and thickness; and even material yield strength, being relatively much less significant [1].
Outlines field inspection guidelines, different forms of corrosion for steel bridges such as uniform corrosion, localized corrosion, deposit attack, and pitting, types and techniques of corrosion inspection, and condition rating of bridges based on the corrosion level [2].
Nowak and Kayser developed a corrosion damage model for simple-span steel girder bridges. This paper defines five common forms of corrosion which can affect a steel girder bridge namely (1) general corrosion, (2) pitting corrosion, (3) galvanic corrosion, (4) crevice corrosion and (5) stress corrosion [3].
Pitting corrosion is a localized type of corrosion occurring on steel structures that are in contact with water or subject to wind and water conditions as well as in the tanks carrying liquid cargoes or ballast. In addition exclusively that is in contact with coal and iron ore (Figure 1). The marine environment is a sea water environment and this means that corrosion in marine structures, which are generally fabricated from various grades of steel, is often very severe, not only under sustained immersed condition in ballast tanks but also under general exposure to atmospheric conditions. The existing typical achievements were mainly developed in the past decade. Paik et al. proposed a new parameter, i.e. the smallest cross-sectional area, to represent the ultimate strength reduction characteristics due to pitting corrosion by a series of nonlinear FEM analyses for steel plate elements under axial compressive loads. Nakai et al. found that compressive buckling strength of pitted members is smaller than or equal to that of members with uniform thickness loss in terms of average thickness loss by a series of compressive buckling tests and the FEM analysis. Daidola et al. proposed a mathematical model to estimate the residual thickness of pitted plates using the average and maximum values of pitting data or the number of pits and the depth of the deepest pit, and presented a method to assess the effect of thickness reduction due to pitting on local yielding and plate buckling based on the probabilistic approach. Furthermore, they developed a set of tools which can be used to assess the residual strength of pitted plates [4-12].