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Remaining Moment Capacity of Corroded I-Beam Sections

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Abstract

Steel structures are subjected to corrosion due to environmental exposure. As a result, the carrying capacity and hence the level of safety of these structures diminishes with time due to accumulation of corrosion damage. The rate of corrosion in these structures is often non-uniform and difficult to predict. Therefore, the remaining life of the structures is functions of materials properties and section loss. In this paper a simple modeled has been developed for the beams with varying thickness loss in the flanges and web in order to obtain relations between percentage remaining moment capacity and percentage thickness loss of corrosion damaged I-beams.

Keywords: Corrosion, Varying thickness loss, Moment capacity.

1. INTRODUCTION

Corrosion of steel is an electro-chemical process in which iron, Fe, reacts with oxygen to from iron oxides. Steel has been used extensively throughout the world for the construction of bridges, buildings, factories, etc. Corrosion is one of the most important causes of deterioration of steel [1]. In the United States 40% of the bridges are built of steel. In some states, such as Michigan, the number exceeds 60%. The primary cause of corrosion is the accumulation of water and salt (marine environment or deicing media) on steel. The source of water and salt is either from deck leakage or from the accumulation of road spray and condensation. The source of the moisture often determines the pattern of corrosion on a beam. The rate of corrosion will depend upon the contaminants in the moisture and the ambient temperature [2].

According to the 2003 Michigan state bridge inventory, 40% of state-owned bridges built in the last decade are steel girder bridges. This number is even greater if one considers all the existing bridges in the state. Corrosion of steel beams primarily due to deicing media made of salt and water is a very common problem in the state of Michigan. This generally takes the form of localized deterioration of steel beam ends usually from deck joint leakage and occasional spray from passing vehicles. The deterioration usually consists of thinning sections in the web or irregularly shaped holes in the web just above the flange and may decrease the load carrying capacity in shear, bearing, and bending [3].

There are a large number of steel structures where structural members and components are corroded and corrosion has been concealed by paint and may not be visually identified [4].

Regular inspection of steel structures is usually based on visual examination and classification into condition categories which identify the need for appropriate action. The most severe visual category refers to the presence of serious structural defects and the consequent need for full structural assessment and repair. Gallon [5] found that the current inspection and assessment methods, while being safe, were significantly conservative in some instances. This may lead to plant closures with consequent financial penalty when the corrosion damaged structures may be able to carry the required loads.

Therefore, it is very important to recognize and fully understand the mechanism of steel corrosion, forms of corrosion and rate of corrosion penetration. These factors indicate that there is an urgent need for a more realistic assessment method for quantifying visual inspection so that the capacity of corrosion damaged steel structures may be assessed more reliably. In this paper by combining information on the location and rate of corrosion with the structural analysis of corroded members, a model of deteriorating capacity is developed and universal I-beams with uniform corrosion were used to calculate their remaining moment capacity. The results of this study can be used for a better prediction of the service life (remaining moment capacity) of deteriorating I-beams.