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Failure of Chauras bridge

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ABSTRACT

Sudden collapse of 190 m long Chauras bridge in Uttarakhand, India, which was a three span (40 m + 110 m + 40 m) continuous deck type truss bridge, took place during casting of the deck slab after successful launching of the truss. The incidence occurred when 52.5 m length of the deck slab was cast starting from middle of the 110 m span towards the right pier. Whereas, collapse of I-35W bridge took place due to failure of one of its gusset plates, analysis results show that Chauras bridge collapsed due to buckling of its U13U14 top chord compression members when 173.8 N/mm^2 stress in the member occurred against calculated permissible compressive stress of 149.8 N/mm^2. Sudden collapse of the bridge claiming six lives with it, due to slight increase in stress beyond the permissible compressive stress indicates that steel girder bridges must also be checked for reserve strength at the limit state of strength. As per Indian and European Standards, in addition to 1.1 material safety factor and 1.5 load factor used for compression and tension members in limit state of serviceability for fatigue design, additional load factor of 1.5, both for dead and live loads, for laterally unsupported compression members should be used for checking the design at the limit state of strength. No such additional load factor for tension members and joints is required.

1. Introduction

In the past a number bridges have failed during various stages of construction or service. The failures have been partial, or total collapses have taken place. In case of truss bridges, failure of gusset plates connecting members of truss, and buckling failure of compression members are the most happening failures [1].

In 1892 the Semi-parabolic truss arch bridge near Ljubičevo over river Morava in Serbia, failed during load testing. The cause of failure was buckling of compression chord due to defective connection of two part compression members [1].

Lessons from these failures may be treated as learning experiences, because when a bridge collapses it has certainly been pushed to the limit in some way. Therefore, structural collapses in general, and particularly bridge collapses, which are often most spectacular, have a significant effect on the development of the knowledge of structural action and material behavior and have spurred research into particular fields [2].

Failures may happen in service, but probably more often during construction. Physical causes are various such as erosion, reversal of stress, impact, vibrations, wind, and extreme events [1]. Failure during construction is due to unexpected increased load on the bridge which many times might be beyond the scope of structural designer's knowledge.

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Bridge collapse or collapse of any structure is either progressive or sudden. In progressive collapse one can judge probable failure of structure by inspection of various critical parts of the structure and can take preventive measures to fix the problems in the structure. But sudden collapse takes place without any warning and the collapse may occur within few seconds taking many lives and property loss with it.

1.1. Failure of I-35W bridge

One such notable example of sudden collapse is collapse of I-35W bridge [4] over the Mississippi River in Minneapolis, Minnesota on August 1, 2007 resulting in deaths of 13 people and injury to more than 100 others.

The superstructure of the bridge consisted of two main longitudinal trusses continuous over three spans of 81 m, 139 m and 81 m. The two longitudinal trusses were connected to each other with transverse trusses at each panel point. There were eight lanes of traffic on the bridge [2].

All joints of the bridge were connected by 1 inch thick gusset plates, except top chord joint U10, where half inch thick gusset plates were used (Fig. 1) [4]. Investigation and Finite Element analysis by many researchers concluded that, the undersized gusset plate at joint U10 was the cause of catastrophic and sudden failure.

2. Failure of Chauras bridge

Failure of 190 m long Chauras Bridge in Uttarakhand, India, which was a three span (40 m + 110 m + 40 m) continuous deck type truss bridge, took place during casting of the deck slab (Fig. 2). The bridge was proposed to connect two cities namely, Srinagar on left bank and Chauras on right bank of the river Alakhnanda. After launching of the steel truss on two piers and two abutments, casting of deck slab was initiated on 24.03.2012 at 11.00 AM from mid portion of the 110 m span of the bridge towards right pier. During deck slab concreting, when concrete was placed in 52.5 m length from middle of the 110 m span towards right pier, bridge suddenly collapsed calming six lives with it (Fig. 2).

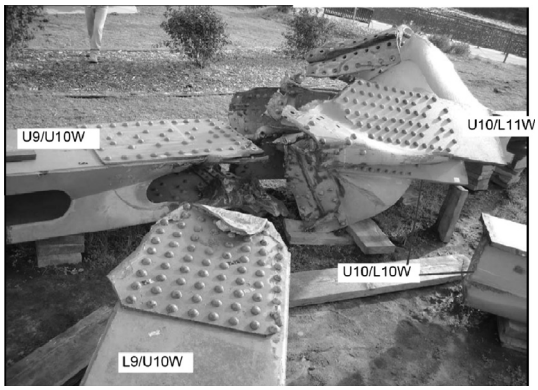

Fig. 1. Failure of gusset plate at U10.

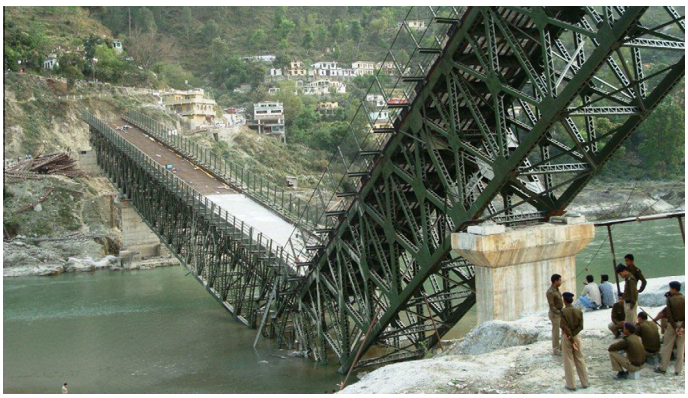

Fig. 2. Failure of Chauras bridge during casting of deck slab.