

Strengthening of a Twin Arch Bridge in Goa, India for Stability

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Abstract

A recently constructed bridge comprising parallel twin tied arches were observed tilted on one side soon after the cast-in-place concrete deck was poured. A three dimensional (3D) analysis of the as-built structure including both the material non-linearity and the initial imperfections demonstrated that the stiffness and strength of the existing Vierendeel lateral bracing between the arches were inadequate for developing the design capacity of the structure subjected to dead, live and wind loads. A retrofit of the structure by replacing the Vierendeel-bracing with X-bracing was proposed, which increased the limit load of the structure many folds. A step-by-step retrofit scheme for replacing bracing system was developed through virtual simulation. The study enabled developing a cost-effective retrofit measure for the bridge, and identified the need for stability bracing design guidelines for steel arches within the existing design specifications.

Keywords: steel arch; stability; retrofit; non-linear analysis; Vierendeel bracing.

1 Introduction

1.1 Background

A recently constructed 80 m span steel arch in India for the main crossing of a 400 m long bridge over the Cumbarjua Canal, connecting Gaundalim in Old Goa on east to Cumbarjua island on west, was observed tilted on one side soon after construction, before the bridge was even opened to traffic. The main crossing consists of two parallel parabolic tied arches rising 16 m above the deck level, connected by a Vierendeel lateral bracing and floor system, and a composite concreted deck. The bridge carrying the Gaundalim-Marcel Road is 12.5 m wide,

accommodating 7.5 m wide carriageway carrying two lanes and 1.5 m wide walkways on either side of the carriageway. The skeletal steel arch weighing about 2600 kN was assembled on the ground nearby and was moved and erected in position at a height of 12 m using a self-propelled barge and trailers and utilizing the tidal variation. The concrete deck was cast-in-place after structural framing was erected in position. Because of this relatively uncommon erection scheme, the project was considered as a landmark.

It was reported that the tilt of the structure including lateral movement at the deck level was observed during the casting of the deck. A survey of the as-built structure verified that the arch had