Case Study of Rochdale Canal Bridge Assessment using Non-Linear Finite Element analysis

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Abstract

Rochdale Canal Bridge is a single skew span railway under bridge to be assessed under Civils Assessment Framework Agreement 2020-2024. The scope of work is limited to the decks supporting the railway lines.

The methodology used to develop a finite element model that accurately represents the structure, the complexities of the structure due to load effects from neighbouring decks etc., are also discussed in the paper. Furthermore, material non-linearity was considered along with geometric non-linearity. The most onerous buckling mode derived from linear Eigen value buckling analysis is used for the initial geometry imperfection of structure. Non-linear analysis was carried out at both SLS and ULS to identify the failure modes through excess stress, strain, yielding and buckling. Through this study, the reserve strength of the structure was captured and is found to be adequate for the current loading which is an improvement from previous assessment. The assessment of these kind of bridges and suggesting strengthening measures etc, will help reduce the environmental impact as compared to the new constructions thereby contributing to sustainability.

Keywords: underbridge; finite element; material non-linearity; geometric non-linearity; Eigen value buckling analysis; Non-linear analysis; stress; strain; yielding; buckling; sustainability.

1 Introduction

1.1 Project Background

Network Rail Limited (NR) is the owner and infrastructure manager of most of the railway network in the United Kingdom. To cope with the increasing passenger and freight traffic, NR has been undertaking programme of upgrades, inspections, assessments, and other maintenance activities to the network.

Atkins, a member of the SNC Lavalin Group, was appointed by Network Rail Limited to provide consultancy services to assess various bridges and report their current load carrying capacities under Civils Assessment Framework Agreement 2020-2024. Rochdale Canal Bridge is one of those bridges in the work bank.

1.2 Description of the Structure

Rochdale Canal bridge is a single skew-span underbridge with 7 subdecks carrying: High Level Road; a single track of the Rochdale to Manchester Victoria Metrolink line; three tracks of the Manchester Victoria West Jn. to Hebden Bridge line; and a disused area. The structure crosses disused land, which was formerly a canal (now infilled).

The superstructure comprises 2 Nos. riveted wrought iron truss girders on the downside and 6 Nos. riveted wrought iron plate girders on the upside, which support wrought iron cross girders, rail bearers and deck plates. The skew angle varies between the different subdecks from approximately 5 to 18 degrees.

https://doi.org/10.2749/newdelhi.2023.0464