Evaluation of the Structural Behavior of Prestressed Concrete Bridge Girders under Diagnostic Load: A Test-Case Study

Oday A. Abdulrazzaq
Department of Civil Engineering, College of Engineering, University of Basrah, Basrah, Iraq
oday.abdulrazaq@uobasrah.edu.iq

Jaffar A. Kadim
Department of Civil Engineering, College of Engineering, University of Basrah, Basrah, Iraq
jaffar.kadhim@uobasrah.edu.iq (corresponding author)

David Abed Mohammed
Department of Civil Engineering, College of Engineering, University of Basrah, Basrah, Iraq
david.jawad@uobasrah.edu.iq

Received: 11 January 2025 | Revised: 7 February 2025 and 20 February 2025 | Accepted: 22 February 2025

 DOI: https://doi.org/10.48084/etasr.10196

ABSTRACT

This study deals with the structural behavior of prestressed concrete bridge girders consisting of 4 spans using the field diagnostic load test method and comparing the results with the mathematical model of the CSiBridge program. The bridge under study is located in the city of Basra in southern Iraq and was constructed more than 40 years ago, which makes it necessary to determine the actual structural conditions in order to decide whether it is safe to keep using it or not. A 48.5 tn vehicle was used for the test, where each area was divided into 3 load paths, and then the site data values were simulated utilizing the CSiBridge program. The field test data cleared the durability of the bridge for all spaces from any structural defects, and the correlation test results were very close with the analytical study results. The field results indicate that half of the lanes tested behave linearly and the other half behave non-linearly, with the source of the non-linearity being related to the potential problems of the prestressed girders. The theoretical results also proved that vehicles with a load of 72.4 tn can go through, without causing any damage to the different parts of the bridge.

Keywords-bridge loading test; diagnostic load test; proof bridge test; Prestressed Reinforced Concrete (PRC) girder; bridge rating; CSiBridge program

I. INTRODUCTION

For nearly the entire 20th century, prestressed concrete girder bridges have been widely constructed, due to their simplified design and the least formwork requirements compared to the reinforced concrete bridges. In Iraq, simple-support prestressed concrete girders have been mainly adapted in the last decades for 2 to 6-span configurations with lengths of 18 m to 36 m. There is little documentation of the design and construction of these bridges, and many of them are still in moderate to good condition (adequate service, performance, and appearance). Consequently, a comprehensive evaluation of the current state of these bridges is necessary, noting that the visual inspection and/or conventional analytical methods are not sufficient to answer the potential behavioral problems (material and structural behavior) related to these bridges after passing 40 years from their constriction. In addition, an accurate assessment of both their material composition and load-bearing capacity is important. In situ testing is a methodical and quantitative method pattern, used to determine the strength of the bridge. The diagnostic load test is classified as a non-destructive load test because the applied load does not reach the ultimate bridge capacity, but it is applied by finding the Rating Factor (RF) as specified in the ASSHTO standard [1]. A common practice involves comparing the test bridge's results with theoretical models developed using Finite Element Method (FEM) software, such as CSiBridge, to ascertain the coefficient of correlation between the two types of results. Ultimately, the rating process is derived from the relationship between both destructive and nondestructive tests. The diagnostic load test has a variety of applications including verifying the specific characteristics of bridge elements and comparing the test results with the structural analysis results. It can also provide information on the relationship between