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Retrofit Study of Existing Bridge with Girders in Vore Railway Overpass

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Abstract— **This paper presents a case study of superstructure retrofitting with girders on Vore railway overpass, Albania. This study aims of providing an overview on assessment of existing structure based on original project, comparing models of traffic loads under existing code in our country with standart Eurocode traffic loading. Superstructure is all precast with total length L=313.24 m .The existing overpass was constructed and built approximately 25 years ago. It is located in a national axis with a significant movement of vehicle flows which has been increasing nowadays .Overloading due to increase in wheel loads and exposure to environment lead to degradation of overpass structure. Poor quality of construction and lack of regular maintenance lead to major retrofit in the overpass structure. Assessment analysis determine that superstructure should be retrofitted. The general approach to retrofitting superstructure is to increase the shear or flexural strength of the girders and deck, to carry standart Eurocode traffic loading . Concrete jacketing have been used for external strengthening of concrete structural components.**

Keywords— retrofit , overpass, retrofit techniques , superstructure

I. INTRODUCTION

The railway overpass is located on national road axis Vore - Lac, in the triangle of Vora railway overpass, with a total length L = 313.24 m. Existing overpass was built in 1989. It consists of 19 light space with span up HD = 15 m. Superstructure is consists of simply supported girders on each side and is all precast. In recent years, increasing the flow of vehicles along with the degradation have been damage the superstructure. Its degradation is a major problem and brings the necessity of the structure rehabilitation. Damage of bridges superstructure is usually as a result of corrosion and increased traffic load in recent decades. The construction is designed for highway normative loads of albanian codes N-18; T-80. Gauge G-7 + (2 + 1) m for sidewalks. Modeling the structure with finite elements method FEM using existing project, Eurocodes standart made it possible to determine the strain in positions where we care. The primary function of superstructure is to support the vehicular vertical loads and to distribute these loads to the substructure. The purpose of the study is to increase the carrying capacity of superstructure based on european normative. Retrofit protects it from destruction, bringing in this way and an economic benefit.

Fig. 1. General view of Vora brigde

II. INSPECTION AND EVALUATION OF CONCRETE SUPERSTRUCTURE

A. Technical conditions of the existing superstructure

The evaluation of the current technical condition of the existing reinforced bridges structure will be realized with the help of site investigation, tests of materials and original design which depends in a high percentage on the engineer qualification. On site investigation it is recommended to insist on the appeared fatigue defects, critical details, corrosion level, concrete hardness, the structure deformations due to traffic, bridge bearings, similar construction of the same age and type.

1. From carefully inspection are observed visible cracks on beams and decks.
2. Detachment of concrete cover.
3. Corrosion and reduction of cross section rebar.
4. Quality and strength of concrete is low.
5. Spalling .
6. Paint is in poor condition and lead based.

Fig. 2. Overview of girders superstructure

Fig. 3. Schematic view of vehicle loads N-300 and K-800

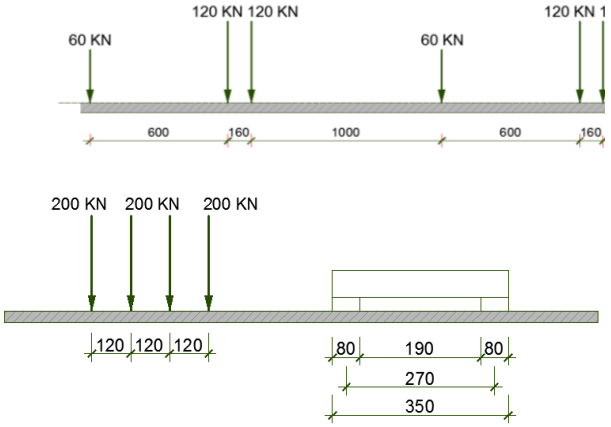
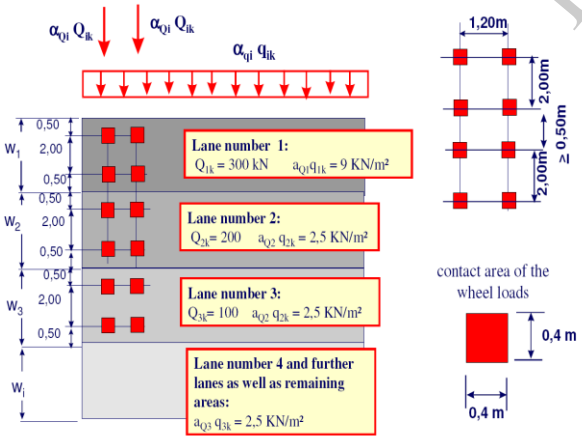


Fig. 4. Schematic view of load traffic model LM1

Concentrated and distributed loads (main model – For general and local verifications)[1]



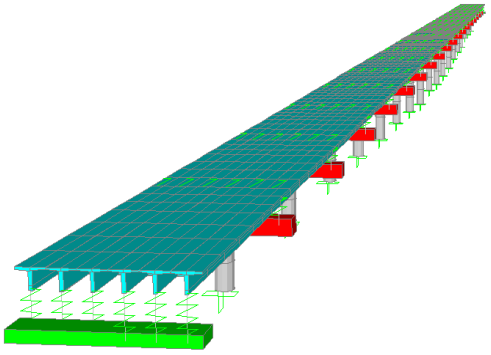
III. OBJECTIVE

- Assessment of existing structure be realized based on original project, on site investigation.
- Analysis of two model: First model, capacity assessment of superstructure with Albanian technical conditions of vehicle loads N-300 and K-800. Second model, capacity assessment with european normative traffic loads model for road bridges LM1. Interpretation of the result and problem identification.
- Comparing the results obtained by available date from modeling, original project and retrofit study.

IV. ANALYSIS MODEL WITH SAP2000 PROGRAMME

Overpass structure is modeling with sap2000 programme , which have in based of it finite element method FE . Overpass is 1st class bridge: international heavy vehicle traffic, with two direction, and width lane w = 3.8 m. Retrofit study of superstructure be realized by creating two model.

Fig. 5. 3D view of modeling structure



The first model be realized based on Albanian codes, with traffic load combinations and material specifications used in Albania country .The second model be realized according distribution loads to European normative .

Fig. 6. Stresses diagrams S11 from N-300

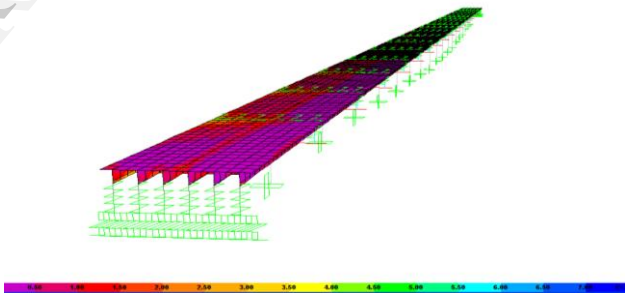


Fig. 7. Stresses diagrams S11 from K-800

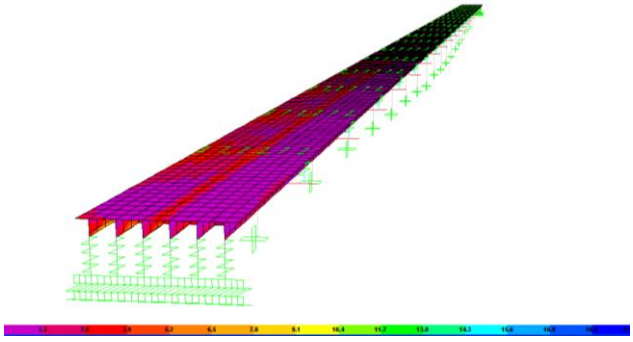
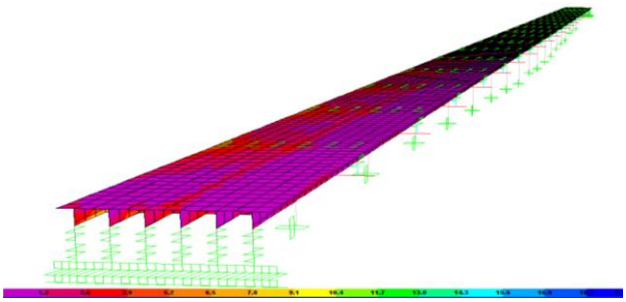


Fig. 8. Stresses diagrams S11 from LM1

[1] Eurocode EN 1991-2



V. FEM ANALYSIS OF THE INTERNAL FORCES

Below are presented as graphical performance the result of internal forces for the longitudinal girders.

Fig. 9. Graphical view as a comparison way of the moment M3 induced by the K-800 and LM1

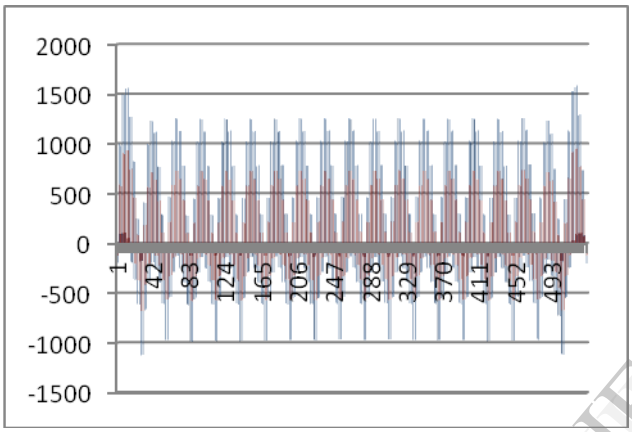
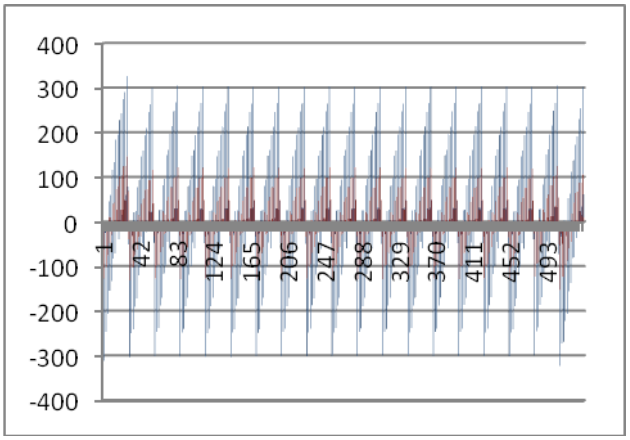


Fig. 10. Graphical view as a comparison way of the shear force V2 induced by the K-800 and LM1



Analysis results from loads model LM1 (european normative) are greater than control loads K-800 (albanian loads) .

VI. RETROFITING TECHNIQUES USED FOR STRENGTHENING OVERPASS SUPERSTRUCTURE

The general approach to retrofitting beams to increase the shear or flexural strength of the girders .There are three ways to achieve the enhanced strength in the bent beam: with post tensioned rods, external shear reinforcement or through addition of concrete or steel bolster.

Measures for concrete beam repairs can be summarized as the following steps:

1. Beams repairing to be in the length between two diaphragms

2. Removal and cleaning of the damaged concrete. Removal of concrete within the saw – cut area may be performed by jack hammering or hand chipping. After removal the remaining concrete surface should be cleaned of loose concrete using high pressure air or water. Properties of the repair material should conform as closely as possible with the existing concrete. Cement based cast in –place concrete is used for the repair of deteriorated areas 75 mm deep no more. (A pre mixed micro concrete, modified with special additives to reduce shrinkage)3. Steel corroded beyond acceptable levels normally requires supplemental reinforcement. The entire surface of beams from both sides will place grill 7x7 that can be created by stirrups and additional longitudinal bars. The whole surface to be filled with special materials (Sika or Mapei) or retrofit with CFRP sheets [2].

4. Reinforced bar can be realized with Fe-44k and concrete M-300

Fig. 11. Existing beam of superstructure [3]

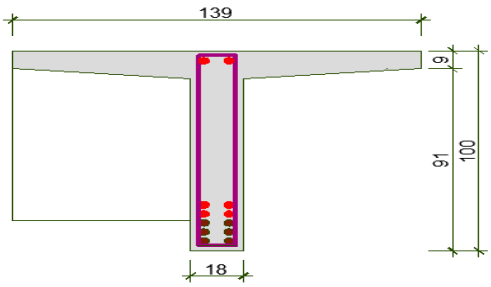
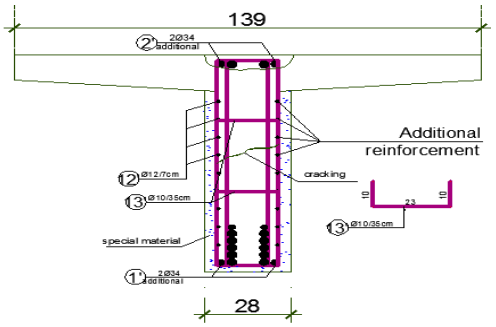


Fig. 12. Retrofitting beam of superstructure



[2] DEIDOT bridge design manual

[3] Original project 'Railway overpass, triangle of Vora"

TABLE I. TABLE SPECIFICATIONS FOR EXISTING BEAM

TABLE OF REINFORCEMENT SPECIFICATIONS				
Type	Pos	d	l(cm)	weight
EXISTING GIRDER	1	34	1650	247.00
	2	34	1845	276.00
	3	18	191	16.00
	4	34	1629	243.00
	5	18	187	15.00
	6	34	1374	205.00
	7	18	182	31.00
	8	18	919	38.00
	9	18	179	3.70
	10	30	1949	227.00
	11	10	226	81.00
	12	8	1666	69.00
				1451.70

TABLE OF REINFORCEMENT SPECIFICATIONS				
Type	Pos	d	l(cm)	weight
RETROFITTING GIRDER	1	34	1650	246.00
	2	34	1845	276.00
	1'	34	1650	246.00
	2'	34	1845	276.00
	3	18	191	16.00
	4	34	1629	243.00
	5	18	187	15.00
	6	34	1374	205.00
	7	18	182	30.00
	8	18	919	38.00
	9	18	179	4.00
	10	30	1949	227.00
	11	10	226	81.00
	11'	10	238	86.00
	12	8	1666	69.00
	12'	12	1650	307.00
	13'	10	43	13.00
				2378.0

Based on FEM results, the internal force values of eurocode model are approximately 70 % greater than the first one . Retrofitting procedure be achieved by external shear reinforcement or through addition of concrete.

VII. CONCLUSIONS

Assessment of existing overpass superstructure be realized based on original project, on site investigation and loads analysis. Loads analysis has been available by comparing technical conditions under Albanian codes with normative European traffic vehicle loads.

TABLE II. TABLE SPECIFICATIONS FOR RETROFITTING GIRDER

REFERENCES

[1] Eurocode EN 1991-2 .
[2] Original project " Railway overpass , triangle of Vora '
[3] Evaluation of conventional repair techniques for concrete bridges ,Florida department of transportation , December 2000
[4] DelDOT Bridge design Manual May 2005