Quick Scan on Shear in Existing Slab Type Viaducts

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Summary

Due to the large number of slab type bridges and viaducts that have to be assessed on shear resistance, a Quick Scan is developed by the Dutch Ministry of Infrastructure and the Environment in cooperation with TNO Research, Delft University of Technology and Royal HaskoningDHV. This Quick Scan is based on a continuous girder as the structural model. For concentrated loads an effective width based on laboratory experiments is taken into account. For skew slabs a factor is implemented in the Quick Scan which is determined by a parametric (quasi) linear elastic analysis with plate/shell elements.

The developed Quick Scan is linked to a database which contains the geometrical, reinforcement and material data of the structures. With the database acting as an input and output container the Quick Scan can be quickly executed on the complete set of hundreds of slab structures. With this automated Quick Scan re-examination the 'engineer-effect' is reduced.

The Quick Scan has to give more conservative results than extensive refined linear static (plate/shell) analyses with finite element models. On the other hand, the Quick Scan has to be fast and easy to use. For this reason it is based on a simple Excel tool. Furthermore, it has to be as accurate as possible, otherwise a large number of slab structures would have to be strengthened or replaced.

Keywords: Structural Assessment, Existing Structures, Quick Scan, Shear, Slab Type Viaducts.

1. Introduction

The concrete load-bearing structures of bridges and viaducts built prior to 1976 and managed by the Dutch Centre for Infrastructure have been inventoried [1]. With about 2000 structures, this group concerns about 60% of all concrete viaducts in the Dutch National Highways (see figure 1).

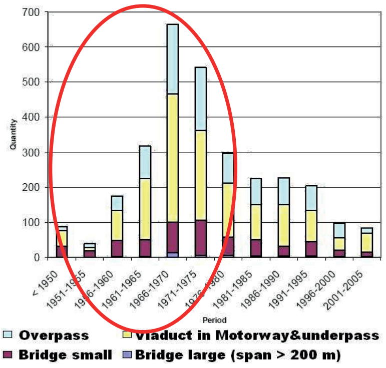

Fig. 1: Period of construction

According to current design standards [2], many of these structures do not meet the required capacity related to shear based on their original concrete strength. For structures without shear reinforcement, such as reinforced slabs, there is a risk that the structure could suffer a brittle failure.

The first phase of the inventory consisted of desk research and an inspection of the structures. Approximately 800 structures, for instance post-tensioned slabs and slabs with a low slenderness-ratio (L/d<15), have been marked as less critical. This has resulted in 1194 load-bearing structures in bridges and viaducts that still had to be assessed on shear [3]. Due to the fact that such a large number remained, investments have been made in the development of an assessment method. For this reason, five main types of load-bearing structures are considered.

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2. Results from the Quick Scan

The results of the Quick Scan are verified with extensive refined (quasi) linear static plate analyses with finite element models. The structural model is (independently) validated and tested by some 20 dummy slabs. All basic results are also automatically stored in the 'Shear Database'. With these data a global output Excel file can be created in which graphs are automatically plotted for different sub criteria or groups. If only the maximum unity check (see figure 2) for each structure is plotted then the scatter is quite large. Also the difference between the Eurocode and the Dutch Regulations for Concrete (VBC) [4] is large for high unity checks based on the Eurocode.

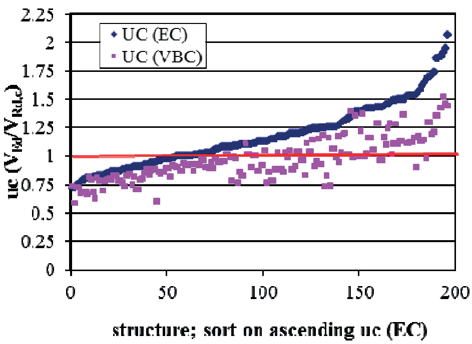

Fig. 2: Maximum Unity Check on shear per structure

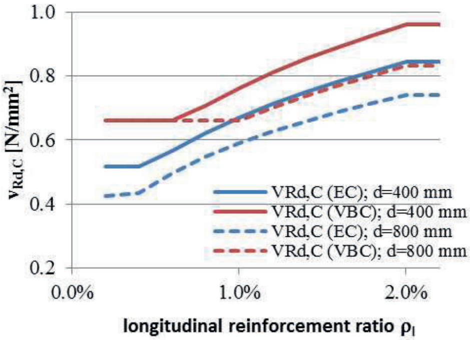

Fig. 3: Shear capacity (C35/45) based on EC & VBC

3. Discussion

In the results of the Quick Scan the differences (see figure 3) between the shear strength according to Eurocode 2 and the Dutch Regulations for Concrete are significant. A value corresponding to the latter ($v_{min} = 0{,}43 \times f_{ctd}$) could be more appropriate for existing slab type viaducts.

4. Conclusions

From the study it can be concluded that an automated Quick Scan can reduce the 'engineer-effect'. The developed automated Quick Scan is fast and gives interesting results. An advantage of an automated calculation is that if an extra hidden capacity or change in calculation insight (or error) is found, it is easy to implement in the tool and all structures can be evaluated again within a day.
As seen from the figures, a large amount of reinforced slabs has a Unity Check above 1,0. Still hidden capacities, improvements in calculation or input have to be found.

5. References

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