Monitoring Based Evaluation of Design Criteria for Concrete Frame Bridges

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Summary

Concrete frame bridges (CFB) are characterized by integral abutments associated with the lack of bearings and expansion joints. These reinforced concrete structure types have several advantages in comparison with traditional structures mainly based on maintenance and inspection considerations. However, currently there is little experience concerning this type of design in Austria thus leaving designers with a lot of uncertainty regarding general design principles, appropriate modeling, necessary load cases and structural detailing. In consequence, research projects were initiated with the goal to (a) monitor structural response of real structures, (b) verify current design assumptions and finally (c) derive recommendations for a future guideline. Within this paper a case study is presented focusing on the observation of the soil structure interaction.

Keywords: frame structure, reinforced concrete, joint-less, monitoring, fiber optic, strain gages, geotextile

1. Introduction

Concrete frame bridges (CFB) are characterized by integral abutments associated with the lack of bearings and expansion joints. This type of reinforced concrete structures, which are restricted in their dimensions due to e.g. the soil structure interaction, are nowadays preferred to traditional structures by bridge owners mainly due to maintenance and inspection considerations and the related likely cost savings. However, concrete frame structures differ essentially in their statical characteristics and their especially in their sensitivity to changing boundary and loading conditions. For example, structural loadings and effects from temperature, creep shrinkage, which in general dart no special problem for the traditional structural layout, can yield to unwanted difficulties in case of CFBs.

Furthermore one particular characteristic of concrete frame bridges is their lack of expansion joints. Temperature loads as well as creep and shrinkage thus lead to significant problems in the transition area between structure and the soil next to the abutment, which increase with the total length of the structure. Since these situations are not fully covered by codes, a research project was initiated in order to obtain real data regarding structural response under varying conditions from fiber optical sensor (FOS) systems and other sensor technologies.

In particular a recently constructed three span concrete frame bridge was instrumented with in total five different sensor systems including 54 sensors that have been combined into an integrative permanent monitoring system. Areas of interest include (a) the performance of the superstructure during construction as well as under service loads, (b) the soil-structure interaction in general and (c) the performance of the chosen slab detail to accommodate the large dilatations in particular. The data obtained by the sensor systems will be analyzed with respect to temporal processes, statistical characteristics and compared to current design assumptions. A recently performed prove loading furthermore will provide the necessary data basis to calibrate finite element models that in consequence can serve for parameter studies and the optimization of certain structural details.

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