Monitoring of a Bridge with Integral Abutment

Martin Nilsson, MSc
PhD student
Luleå University of Technology

Wylliam Husson, MSc
PhD student
Luleå University of Tchnology

Hans Petursson, Tech. Lic.
Ramböll and PhD student at Luleå University of technology

Milan Veljkovic, PhD,
Associate Prof.
Luleå University of technology

Peter Collin, PhD,
Professor
Ramböll and Luleå University of technology

Summary

Preliminary results obtained from short term test-loading are used to illustrate possibilities of FEM used to calibrate complex interaction characteristics between a pile and soil in a bridge with integral abutments. The measurements are obtained during the winter season on the bridge over Ledån, Northern Sweden. The bridge is built in 2006 and used for long term monitoring within the international project supported by RFCS. The main objective of the on-going research project is to proposed recommendations for rational analysis and design of bridges with integral abutments.

Keywords:bridges with integral abutments, steel pile, bridge monitoring, FEA, soil-pile interaction.

1. Introduction

Integral abutment bridges are bridges without any expansion joints, and their largest benefits are the lower construction and maintenance costs. The abutments are generally supported on a single row of steel piles to provide the required flexibility for accommodating the longitudinal bridge movements due to daily and seasonal temperature variations. Such movements impose cyclic lateral displacements on the abutments, backfill and the steel piles. The magnitude of these cyclic displacements is a function of the level of temperature variation, type of the superstructure material and the length of the bridge.
The first bridges with integral abutments have been built in 1960's in USA and in recent years this type of bridges gain popularity in Europe, primarily in UK and Scandinavian countries. The maximum span width as well as a total bridge length has been increasing through the years. The length of the longest concrete bridge is 358 m Tennessee State Route 50 over Happy Hollow Creek. The longest steel girder integral bridge has span of 318 m in Colorado state [1]. It is obvious that countries, such as USA, with design requirements more open towards new technologies encouraging implementation innovative solutions even if they not thoroughly examined. Although nationally accepted design specifications for integral bridges do not exist, each highway department is allowed to make decisions depending on their own expertises.

In Sweden, the maximum and minimum characteristic temperatures, which statistically occur once in 50 years, are varying between 30ºC and 38ºC respectively -20ºC and -48ºC. This rather large temperature differences decreases the upper length limit, compared to the USA. Some states in the USA allow plastic strains to be developed in the steel piles used below the abutment back walls.

Just a few bridges with integral abutments were built in Sweden in 1980's. The main obstacle for wider acceptance of this type of bridges is a lack of recommendations for rational analysis and design. According to Swedish code for bridges BRO 2004

[2] no plastic strains are allowed at serviceability limit state even if the critical section is at the top of a pile. Such high strain may occur due to seasonal temperature variation, a couple of time a year, and are limited at the very narrow region. These effects may cause low-cyclic fatigue which will be

https://doi.org/10.2749/222137807796120508