# Swedish experiences of integral bridges

# Swedish Experiences of Integral Bridges

**Håkan SUNDQUIST**
Professor
Royal Inst. of Techn.
Stockholm, Sweden

Håkan Sundquist, born 1944, received his MSc degree from KTH 1967, and a PhD degree 1979.

**George RACUTANU**
Licentiate of Techn.
Royal Inst. of Techn.
Stockholm, Sweden.

George Racutanu, born 1962, received his MSc degree from KTH 1989 and Licentiate degree 1998, from the same University.

## Summary

Sweden has a long tradition of the design and construction of integral bridges, i.e. bridges without expansion joints. The experiences of these types of bridges are very good and the cost for maintenance is lower than for other bridge types. The design is based on simple frame models justified by experience. These models are supposed to be conservative so there are many design problems not yet properly solved.

**Keywords**: bridges; integral bridge; concrete; design; maintenance.

## 1 Introduction

For over 70 years, the integral reinforced concrete slab frame bridge, according to *Fig. 1*, has been one of the most common bridge type in Sweden. In the latter years, another integral bridge type is increasingly popular with road and railway holders, bridges with integrated abutments according to *Fig. 2*.

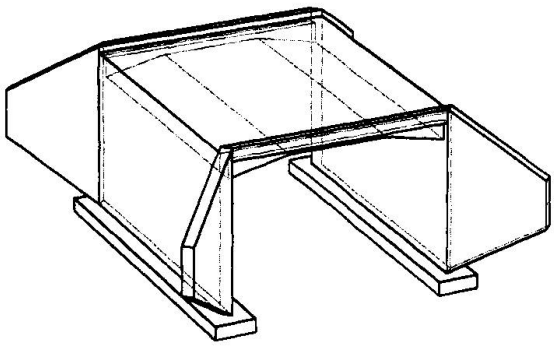

*Fig. 1, Integral slab frame bridge.*

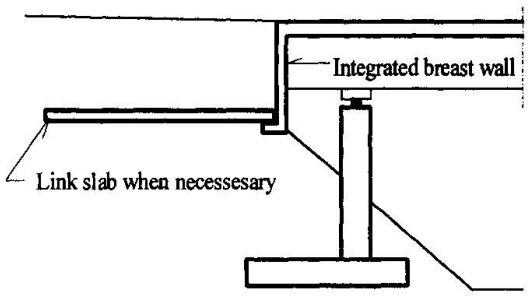


*Fig. 2, Integrated breast wall.*

In Sweden there are at least 8 000 bridges out of 14 000 bridges owned by the Swedish Road Administration, of the type shown in *Fig. 1*. A great part of medium span bridges up to a total length of 80 m are now designed using integrated breast walls in principle according to *Fig. 2*. Both road and railroad bridges with composite or concrete superstructure are designed with integrated abutments. The experiences of these types of bridges are very good and the cost for maintenance is lower than for other bridge types. There is however many design problems not yet properly solved i.e.:

- Soil pressure against the abutments, especially for load cases with large breaking forces from trains
- Interaction between the structure and soil
- Settlements in the soil behind the abutments due to repeated movements from temperature variations.

## 2 Design methods

The design methods used for integral slab frame bridges are based on experience and on simple elastic frame models. The bridge is modelled as a frame based on a strip with a width of 3 m. For bridges with larger widths and for bridges with many lanes there are some simple rules transforming the bridge to the width 3m.

Many of the slab frame bridges are skew. An approximate calculation method was developed at the Dept. of Structural Engineering, KTH already 1963 by Uppenberg (1963). The method was based on a large series of elastic models, and the method is based on some correction factors for transforming the skew bridge into a straight model.

Bridges with integrated breast walls, see *Fig. 2*, is nowadays widely used for bridges with a total length of not more than 80 m for concrete bridges and not more than 60 m for steel or composite bridges. The allowed total length is also dependent on where in Sweden the bridges are situated. These bridges have proven to be more economical both in construction and maintenance than bridges with expansion joints.

## 3 Learning from history

Information from elderly inspections has been collected, and put into a database called BEA (Bridge Element Analysis), Racutanu (1998). The information in the database shows how the structural members have served in time. *Fig. 3* shows an example of the development of total condition class (CC) where condition class 3 means that the bridge must be repaired immediately

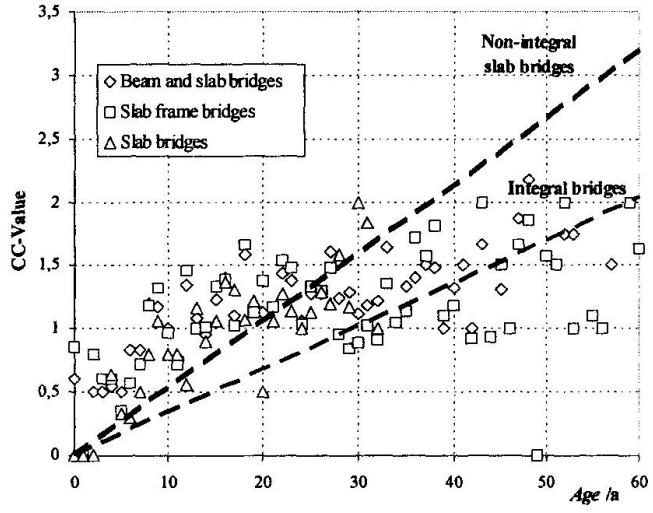


*Fig. 3* *Development of damage measured as the equivalent overall condition class for the three compared bridge types. The bridges of integral type slab frame bridges and beam and slab bridges compared with the non-integral type slab bridge. The evaluation shows that the integral type has a slower increase of damage than the non-integral type.*

## 4 Conclusions

The evaluation of concrete bridges shows that the integral type has proven to be cost-effective and causes lesser maintenance costs than the bridges with expansion joints. The evaluation of the performance of the bridges is done using a detailed database, BEA. This database has proven to be useful to achieve important information about the service life of bridges and their structural members. The historical and empirical information from former bridge inspections can be used to determine the growth of damages in time, certain service environment and bridge generation.

The evaluation of the design methods used, based on simple structural models and experience has proven to be somewhat conservative but adequate.