Importance and Organisation of Bridge Inspections in Germany

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Summary

The key element of the safety philosophy in bridge maintenance is the regular check and inspection of the bridges by engineers which are specially trained to perform bridge inspections. Therefore, bridge inspections are an important and integral part of the bridge management system (BMS) and include, besides the inspection activity itself, also inspection-oriented construction, the provision of inventory data, a uniform evaluation method, several expert systems as well as the continuous training of the engineers performing the inspections including a regular exchange of experiences.

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A well developed infrastructure is the essential prerequisite for economic growth and the mobility of the population. In all industrialised countries the roads are mode of transport no. 1 which bears – in addition to rail and shipping – the main burden of private and goods transport. Disturbances on this highly frequented and complex road network very quickly lead to restrictions of the freedom of movement and to considerable economic damage. Therefore the competent road construction agencies or operators have an extremely high responsibility, because they have to ensure not only the safety of the road users, but also the functional capability of the roads and all installations at all times.

Bridges and tunnels are the most expensive and elaborate road installations and they make great demands on planning, construction, operation and conservation. Due to the very long planned serviceable life these structures often are subject to extreme strains which were not always foreseeable at the planning stage. They include especially strains caused by the over-proportionately growing goods transport with heavier and heavier and sometimes overloaded vehicles or by the stresses due to large quantities of de-icing salt used to make roads serviceable regardless of weather.

There are about 120,000 bridges in Germany of which 38,000 form part of motorways and federal highways for which the Federal Government is the construction agency. This represents assets amounting to approximately 40 billion € (60 billion US $). The stock of structures comprises, in addition to the bridges, tunnels with an overall tube length of 213 km, and a large number of retaining walls, noise protection walls and signal gantries.

The total area of the bridges is 28.6 mio square km, with the largest share of 87 % for the concrete and pre-stressed concrete bridges. Steel (7 %) and composite (4 - 5 %) bridges have a relatively small share, but in most cases they are major valley or river bridges and therefore very important.

Regular structural inspections have a long tradition in Germany. A first standard with the title DIN 1076 „Guideline for the control and inspection of iron road bridges“ was issued by the state authorities in 1930. It was later supplemented with regulations for massive bridges and is to a large extent still valid today as DIN 1076 “Engineering structures in the course of roads and ways – control and inspection”. There are similar provisions for railway bridges.

According to DIN 1076 regular visual checks, every 3 years basic inspections and every 6 years comprehensive main inspections have to be carried out for all structures. In addition a special main

inspection has to be carried out before new structures are accepted or opened to traffic, and this inspection has to be repeated after 5 years before the warranty expires. Main inspections always have to be carried out physically, i.e. all the constructional parts of the superstructure and of the substructures as well as the bridge equipment have to be subjected to a direct visual check and an examination with suitable instruments. For certain structures this can be a very complex exercise and often special equipment is needed to gain access. This includes lift bridges, maintenance stands, bridge inspection equipment or rope inspection equipment. In case of tunnels the first procedure is an examination by means of a measuring vehicle equipped with laser scanner, infrared thermography and camera. This is followed by a physical inspection at the recognized damage spots.

In order to facilitate the work of the inspection engineers good accessibility of the structural parts and of the bridge equipment should already be part of the considerations when the structures are planned. This is why in Germany the „Guidelines for the design of structures“ lay down the precautions to be made for the structures. It contains, for example, minimum dimensions for hollow parts which on principle should be accessible and walk able, or information on the accessibility and exchangeability of bearings or the shape of abutments so as to be able to examine bridge decks through maintenance walkways from below.

In order to facilitate the registration by data processing technology of damage found at bridges and other engineering structures and to harmonise it nationwide, the “Guideline on the uniform registration, assessment, recording and evaluation of the structural inspection according to DIN 1076” (RI-EBW-PRÜF) and the connected programme Road Information Data Base Structures (SIB-Bauwerke) was introduced in 1988 already. By now all road construction administrations and many municipalities use the Guideline and the programme. The Federal Ministry of Transport, Building and Urban Affairs regularly issues the necessary updates.

The inspection engineer enters the damage directly at the structure by means of a notebook. The damage is evaluated separately for stability, traffic safety and durability with figures between 1 and 4 corresponding to damage assessment according to RI-EBW-PRÜF. For harmonisation purposes a comprehensive catalogue containing examples of typical damage and its evaluation was developed. Subsequently and taking into account all the individual damage assessments and the extent of the damage the programme system SIB-Bauwerke determines the overall mark of the condition of the structure according to a fixed algorithm.

With the assessment of the damage the inspection engineer makes recommendations for the repair measures to be initiated; these recommendations are entered into the bridge management system for further assessment and planning. If a final evaluation of the condition of the structure is not possible for the inspection engineer on the basis of the damage, an object-related damage analysis (OSA) by applying non-destructive inspection procedures has to be induced. In case of damage which could impair the stability of a structure an additional static calculation is required.

A report on the inspection according to DIN 1076 is automatically made on the outcome of the inspection by the programme system “SIB-Bauwerke” and it has to be enclosed to the manual which exists for every structure. On the basis of the regular supply by the Laender all the structural and conditional data are stored in a data base. This data base for the 38,000 bridges and tunnels in the course of federal trunk roads is kept by the Federal Highway Research Institute (BASt) and the Federal Ministry of Transport, Building and Urban Affairs has access to it at any time. By way of an annual evaluation of the data the responsible agencies have a continuous overview on the condition of the structures and on the maintenance measures required.

The collapse of bridges which is reported again and again worldwide has, as a rule, multiple reasons, which only lead to a sudden failure of a structure in case of an extremely unfavourable concurrence of factors. Regular and technically qualified bridge inspections make it possible in most cases to determine and eliminate a part of the causes already in the forefront of an actual failure which makes a sudden collapse virtually impossible. The prerequisite for this is that the inspection engineers have an above-average technical knowledge and long experience so that they are able to recognize the potential deficits at a variety of designs.