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A Note on Steel Railway Bridges

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Introduction

Steel has been utilised in the construction of railway bridges since the Victorian era, both in major long-span structures and smaller spans such as those over local roadways. Because of an on-going programme of maintenance, refurbishing, and upgrading to meet changing needs, many of these older steel bridges are still in use. Most railway bridges are now built to replace older buildings; however others are being built wholly new on new alignments or routes, most notably for the Channel Tunnel Rail Link.

Steel construction can provide minimal construction depths for replacement bridges, which is critical where the track level is fixed but adequate underlying clearance is required for highways or other services below the bridge. Steel structure lends itself to prefabrication and preassembly, and because of its low self-weight, it can be carried or hoisted into place in the limited time that the railway may be closed to traffic. Greater construction depths are possible for bridges on new alignments, where there is more freedom with the vertical profile of the route, and thus open up the potential of using slab-on-beam composite construction, similar to that used for highway bridges [1].

A bridge carrying a railway must meet two key functional requirements:

i. Providing enough support for railway traffic and infrastructure throughout the bridge's life.

ii. Adequate clearances between the structure and traffic on and beneath the bridge.

The first criterion can be broken down into two parts: strength and fatigue endurance.

- Keeping bridge deformation to a minimum
- Sturdiness
- Robustness

Description

The second criterion is described in terms of different 'clearance gauges' established by railway and highway authorities. To ensure that the requirements are met throughout the life of the structure (i.e., to provide on-going serviceability), access to inspect and maintain the structure's elements must be provided in a safe and convenient manner [2].

The railway infrastructure consists of the permanent track that conducts railway traffic, access roads alongside the track, and the plant, equipment, and services that enable the railway to operate.

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The traditional ballasted, cross-sleepered kind of track is used on the majority of UK railways. The rails are attached to transverse sleepers (made of wood, steel, or pre-stressed concrete) that are embedded in a crushed stone ballast bed. This sort of track is frequently accommodated by new or replacement bridges and the weight of the ballast add a significant amount to the superimposed dead load. Rails are fixed to longitudinal timbers that are fixed straight to the bridge frame without any ballast on many older steel bridges. Due to track maintenance issues, particularly run-on/run-off effects and a lack of flexibility in track location, such construction elements are now rarely employed for new bridges on main line railways [3].

Rails in the United Kingdom were generally of the "bullhead" type until the 1950s, weighing around 95 lb/yd. These are still common on the London Underground, but they are being phased out in favour of the "flat-bottom" type. Bullhead rails have almost all been replaced on the national network by flat bottom rails, which typically weigh 113 lb/yd (56 kg/m). Rails weighing 60 kg/m (also known as CEN60 or UIC60 rails) have lately been adopted that are heavier and deeper.Rails were once installed with bolted fish-plated connections at 18.3 m (60 ft) intervals. While some jointed track exists, all main lines and most secondary routes now use continuous welded rail (CWR), which does not have fish-plated joints [4].

The majority of sleepers are made of pre-stressed concrete, which is recommended for heavily travelled high-speed lines, but some timber sleepers and a growing number of steel sleepers are also in use. To reduce abrasion, the rails are clipped directly into the sleepers, with a robust elastomeric pad under the rail foot. The rail is clipped to a cast iron base-plate that is fastened or spiked to the sleeper on timber sleepers. Although standard concrete sleepers are deeper than timber or steel equivalents, special shallow depth variants are available for use on Network Rail bridges with limited construction depth.

Ballast is often made up of hard, angular crushed stone fragments ranging in size from 50 to 65 mm. It supports the sleeper, distributes the load on the bridge surface, and allows for drainage. It also allows you to change the track's alignment and level. The standard practise is to put at least 300 mm of ballast under the sleeper (230 mm for London Underground track), however if construction depth* is limited, it may be essential to give less.

Ballasted track bridges are built in the shape of a trough, with the sides raised enough to accommodate the ballast and some room for future track-raising during maintenance. Bridge constructions are occasionally inclined transversely to minimise extra ballast where tracks are canted [5].

However, this should be kept to a minimum, as a tilted deck is more likely to facilitate ballast migration. Ordinary mainline traffic is normally subjected to a 1 in 15 limit. To account for the impacts of wheel flats, recent strain gauge measurements on rails in service show that local deck parts of direct fastening bridges must be constructed for substantially higher wheel loads than ballasted track (because there is no ballast to cushion such local effects). Baseplates specifically developed for use in direct fastening applications are available.

These allow for limited lateral and vertical rail adjustability, as well as added resilience to reduce bending loads in the rail. Noise-isolating materials are one type. For the design of transition arrangements at each end of the bridge, the railway authority should be consulted.

Aside from the permanent way and access ways alongside the track, the following infrastructure elements may require support:

- • Traction power systems
- • Signalling cables and equipment

- • Telecommunications cables and equipment
- • Power cables
- • Third party cables and pipes
- • Mechanical and electrical equipment and plant

Conclusion

Furthermore, structural vibration and noise levels of both reinforced and un-strengthened railway bridges were assessed, and the present method's noise reduction impact was proven in field tests. Furthermore, nonlinear studies were carried out, and the applied load–displacement relationships, as well as the load–normal longitudinal strain curves of aged structural steel, glass fiber–reinforced polymer plates, and rapid hardening concrete, were provided. The current rehabilitation approach may considerably improve the stiffness and reduce the stress levels of steel components, resulting in an increase of the residual service life of old steel railway bridges, according to both experimental and numerical results.

Acknowledgement

None.

Conflict of Interest

The author shows no conflict of interest towards this manuscript.

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