

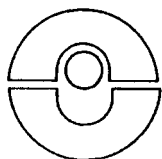
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Deformation of bridges



International Union of Railways



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Leaflet to be classified in Volume :

VII - Way and Works

Amendments

Contents

- 0 - Introduction
- 1 - Loading
- 2 - Calculation of deformation
- 3 - Limits for the natural frequency
- 4 - Total deflection
- 5 - Track twist
- 6 - Bending and vertical movement of the track
- 7 - Maximum limits on horizontal bridge deflection
- 8 - Maximum limits on vertical bridge deflection for passenger comfort

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0 - Introduction

This leaflet gives the limits for the deformations to be considered in the design of new bridges.

Excessive bridge deformations can endanger traffic by causing unacceptable changes in geometry of the track and excessive vibrations both in bridge structures, which affects the load imposed on them, and in coaches passing over the bridges, which leads to discomfort to passengers.

This leaflet recommends the limitations to be placed on bridge deformation to avoid risk to traffic and discomfort to passengers.

It supersedes the recommendations regarding bridge deformations given in leaflets :

- 773 : Recommendations for the design of joist-in-concrete bridges.
- 776-2 : Bridges for high and very high speeds.

Comments

In drawing up these recommendations the following possible causes of risk to traffic safety have been considered :

- wheel unloading due to the change of angle above a bridge bearing ;
- derailment of certain heavy freight vehicles due to creation or change of track twist caused by deformation of either skew bridges or the differential deflection of the main girders of multi-track bridges ;
- additional forces and bending moments caused in the track by vertical movement due to the rotations at the end of the bridge, and changes in length of the bridge at rail level, which could lead to broken welded rail joints over bridge bearings ;
- sharp changes in level alignment of the track at ends of spans due to horizontal deformation of the bridge ;
- dynamic effects in bridges in excess of those given in UIC Leaflet 776-1, because the natural frequency of vibrations of the unloaded bridge lies outside the limits, on which those recommendations were based ;
- destabilisation of ballast on the bridge deck by excessive vibration of the unloaded bridge after the passage of traffic.

Passenger comfort is essentially affected by the movements caused by coaches passing over single-span or multi-span viaducts at various speeds.

The limits given for vertical movement are based on the results of the work of ORE Committee D 160.

The limits given for track twist to avoid the risk of derailment of freight vehicles will also ensure reasonable passenger comfort, when crossing such bridges.

The limits for the change of direction due to horizontal movement are based on the entry angles permitted for switches.

R**1 - Loading**

All deformations due to permanent loading should be calculated under all permanent loads ; those due to live loads should be calculated under the full UIC load scheme, for class Ko, including the dynamic effects recommended in Leaflet 776-1 with a partial safety factor of 1.00.

All horizontal deformations should be calculated by making allowance for wind loading, lateral and centrifugal forces and the effects of temperature differentials between the two sides of the bridge, as recommended in Leaflet 776-1 with a partial safety factor of 1.00.

Comments

Certain very severe limits on the deflection of bridges need only be applied in the case of high speed passenger trains. These trains impose much lighter loads on the structure than design load ; such limits have been adjusted to relate directly to the design load.

The deformation limits given in this leaflet refer to real deformations, which may be less than those calculated by generally accepted approximate methods and which neglect, for example, the stiffening effect of the concrete in tension zones of the structure. It must be remembered, however, that the repeated application of load during the life of the bridge may lead to increases in deformation, especially due to extension of cracks in the concrete.

R**2 - Calculation of deformation**

Unless indicated otherwise, the limiting values given for bridge deformation refer to the total deformation caused to the rails laid on the bridge.

As far as vertical deformation is concerned, they are made up of the deflection of the main girders, the deformation of the bridge bearings, on which the main girders rest, cross girders and rail bearers or bridge slabs, considering the least favourable case with one or two tracks loaded.

For horizontal deformation, they include the deformation of the bridge deck and the sub-structure (including piers, piles and foundations).

3 - Limits for the natural frequency

The deflection of the main girders or bridge slabs as a whole under all self weight and fixed load should be limited to the range of values shown on Fig. 1. This is to ensure that the natural frequency of the unloaded bridge lies within the range considered in leaflet 776-1.