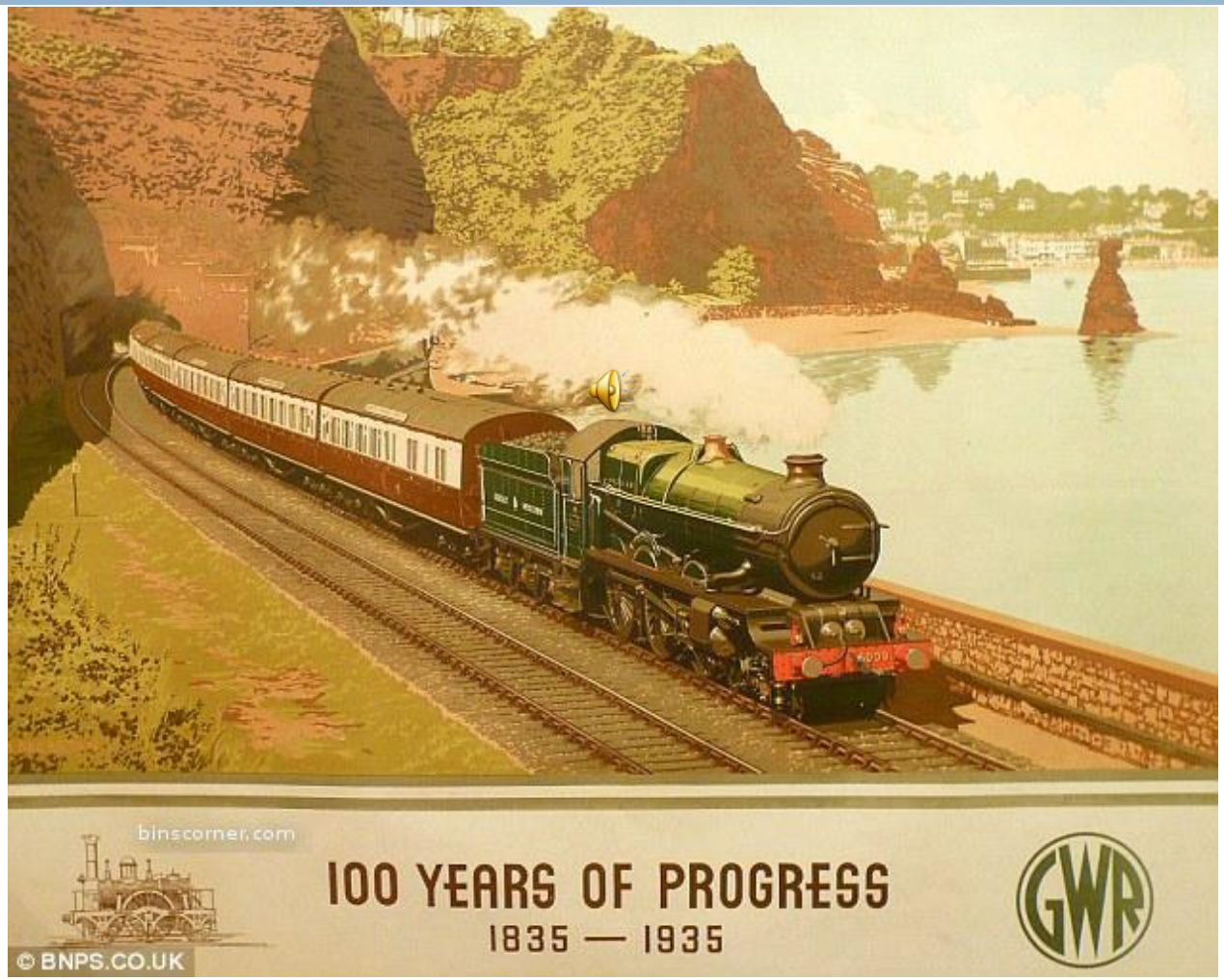
Railway Infrastructures

Let's begin


binscorner.com
100 YEARS OF PROGRESS
1835 — 1935
GWR
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Contents

- Railway Stations
- Railway Structures

Station design

- Customer needs first, followed by rail operator
- Access – accessibility and inclusivity
- Safety – platform gaps, height
- Security – CCTV
- Space –capacity, pedestrian flow
- Platforms – length, width, good visual
- Luggage/Parcels (suburban &intercity)

Station design

- Platform Screen Doors
- Toilets
- Entrance and Exits
  - Closed or Open concept, Paid and Unpaid area
- Retailers
  - can be like a small shopping mall
  - good estate management, unhindered passenger flow
- Lifts & Escalators
  - space at the boarding point, robust

Station design

- Welcoming, acts as a beacon
- Pleasing to the eye, comfortable and convenient for the passenger as well as efficient in layout and operation.
- Design for maintainability
- Railway projects tend to be large scale engineering projects that need to have town planners, architects, urban designers and maybe environmental lawyers on board

Station design

- Station layout design must begin early
- Get the architects involved early while determining and fixing the alignment, station manager's location, security and control room, depth and elevation of tracks
- Interface with Systems
- Interface with surrounding & always bear in mind the railway is a subsystem of the transport system

Station design

- For underground stations, aim to be human & friendly
- The more space you provide, the more human the design will be.... but this costs money.
- Difficulty in a D+B contract.... control will be difficult because you would be trying to define a subjective end result. It's like saying the 'station shall be beautiful'.... but beautiful is in the eye of the beholder.
- Do not be surprised if your contractor has a different 'view' of human or beautiful

Station Inclusive Design

- Design guide or code of practice

  UK example:

  http://www.dft.gov.uk/publications/accessible-train-station design/

- Crowded stations: risk of accidents to disabled people

Station Inclusive Design

Good example: The Stockholm Metro in Sweden where the requirements for the disabled are given a strong focus

- Lifts at almost all stations
- All public buildings are **required** by law to be accessible to people with disabilities and have automatic doors.

Bad example: ……..

Station Inclusive Design

However, heavy investments need to be made in the infrastructure for accessibility for the disabled and training of personnel

Station design

- Provide the safest and most direct route between destinations. Routes need to be as simple and clear as possible.

- Design must account for operations of trains and technical and operational expertise need to be integrated so that final design are as safe as reasonably practicable.

- Escape routes and hazards to be identified and tried out for fitness of purpose.

New Delhi Metro

Delhi Metro

Metro shows steely resolve to make passengers behave

MOHD ZAKIR/ HT

The newly installed guardrail at the Rajiv Chowk Metro Station.

HT Correspondent
New Delhi, C...

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Saint-Lazare, Paris

A mysterious blue light hovering on line 14 platform in **Châtelet, Paris Metro**

Stockholm Metro Art

Beijing

Columns hindering flow

Dresden Station, Germany

The whole substructure for the diaphragm roof weighs approx. 1000 tonnes and consists of the following individual components:

- Curved tubular diaphragm structures
- Skylight constructions
- Funnel constructions
- Rain gutter constructions, some curved
- Edge girders and walkway constructions

Ballybrophy, County Laois, Ireland

Useful references

- http://engineering.railcorp.nsw.gov.au/Disciplines/Buildings/Station_Functional_Spaces.pdf
- *Guide to Station Planning and Design by Network Rail*
  - Accessible at www.networkrail.co.uk
- Planning Passenger Railways: a Handbook by Nigel G. Harris & Ernest W. Godward (Transport Publishing Company Limited, 1992)

Railway Civil Infrastructures

Railway Bridges Terminology

- Railway bridge – underbridge (RUB) or overbridge (ROB)
- Railway underbridge is a structure intended to carry railway tracks together with locomotives and rolling stock, over or through a physical obstruction or hazard
- Railway overbridge is a structure intended to carry vehicles, pedestrians or services over one or more railway track

Loading aspects

- In the typical railway structure, the live load dominates all of the other design considerations.
- This is a substantial divergence from the norm
- For highway bridges, the dead load of the structure itself tends to drive the design considerations
- Vehicle and individual wheel loads of railway vehicles are many times greater than road vehicles.

Loading aspects

- **Loading and unloading over a greater stress range results in fatigue considerations more prevalent in railway bridge design**
- **The unacceptability of high deflections in railway structures, maintenance concerns and fatigue considerations differentiates the design of railway structures from road structures**

Loading aspects

a) Dynamic effects (acceleration and risk of resonance)

b) Effects of repeated loading (fatigue)

c) Actions due to traction and braking

d) Nosing forces

e) Centrifugal forces

f) Deformations (including track twist)

g) Aerodynamic actions

h) Derailment actions

i) Actions due to surcharge from railway traffic on earth embankments.

Basic Difference between Railway and Highway Bridges

- Higher ratio of live load to dead load
  - Lead to serviceability issues such as fatigue and deflection control governing design rather than strength
- Design impact load on railway bridge is higher than on highway structure
- Simple-span structures are preferred over continuous structures for railway bridge
  - Continuous spans are more difficult to replace in emergencies than simple-spans

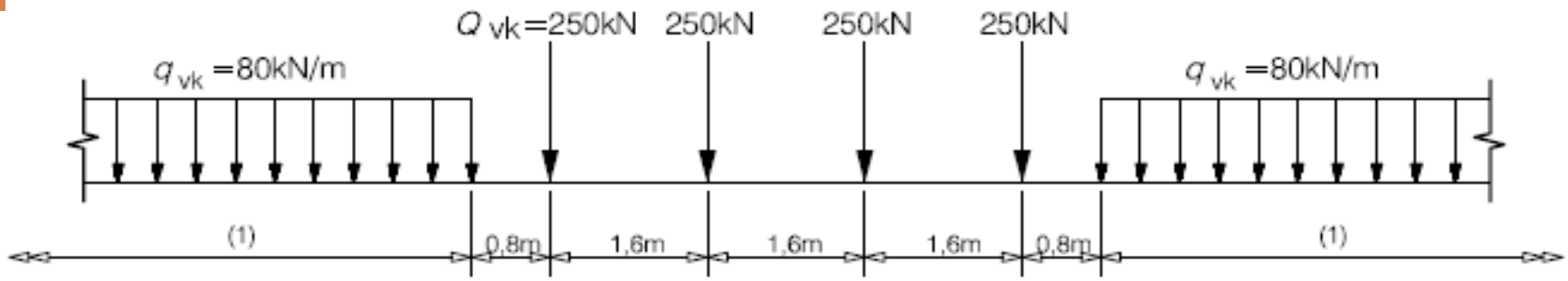
Basic Difference between Railway and Highway Bridges

- Interruptions in service are typically much more critical for railway than for highway
  - Constructability and Maintainability interruption to traffic are crucial
- Since the bridge supports the track structure, the combination of bridge and track movement cannot exceed the tolerances in track standards
  - Interaction between the track and bridge should be considered in design and detailing

Basic Difference between Railway and Highway Bridges

- Railway bridges performed well during seismic events
- Railway owners expect a longer service life from their structures than highway owners expect from theirs

DESIGN LOADING



The characteristic values given in this figure of EN 1991-2 shall be multiplied by a factor α on lines carrying rail traffic which is heavier or lighter than normal rail traffic. When multiplied by the factor α, the loads are called "classified vertical loads". This factor α shall be one of the following: 0,75 - 0,83 - 0,91 - 1,00 - 1,10 - 1,21 - 1,33 – 1,46.

The value 1,33 is normally recommended on lines for freight traffic and international lines (UIC CODE 702, 2003). (for ULS)

The actions listed below shall be multiplied by the same factor α :

centrifugal forces

nosing force

traction and braking forces

load model SW/0 for continuous span bridges

Railway loading aspects

- **All fatigue susceptible elements of bridges subject to repeated cycles of rail traffic shall be checked for resistance to fatigue.**
- **Where the track on a bridge has horizontal curvature, allowance for centrifugal forces, derived from the moving rail traffic, shall be made in designing the elements where appropriate**

Railway loading aspects

- **An effective means of containing a derailed vehicle on the bridge shall be provided**

- **For rail traffic speeds in excess of 125 mph (200 km/h) and for dynamically sensitive bridges, a dynamic analysis is required.**

Dynamic Analysis for High Speed >200km/h

- The dynamic factor calculated from BS 5400-2 may not be adequate and there could be a risk of overloading a bridge or of premature fatigue failure. The UK National Annex to BS EN 1991-2 contains a procedure to establish whether a bridge-specific dynamic analysis is necessary.
- Where a dynamic analysis is required, the deformation and vibration limits set out in BS EN1990 Annex A2, are intended to ensure the safe performance of railway bridges subject to passenger trains travelling at speeds greater than 200 km/h.
- The High Speed Load Model(HSLM) was introduced to replicate the dynamic characteristics of real high speed trains for this purpose.

Railway loading aspects

- For example: To account for the effect of multiple tracks on a structure, the proportion of full live load on the tracks may be taken as follows:
  - Two tracks—Full live load.
  - Three tracks—Full live load on two tracks, one-half live load on third track.
  - Four tracks—Full live load on two tracks, one-half live load on one track, one-quarter live load on remaining track.
  - Etc

Railway loading aspects

Structures susceptible to the aerodynamic effects of passing trains shall be designed to resist the resultant aerodynamic forces.

Structures that are particularly sensitive to transient pressure fluctuations could require a special study to consider the dynamic performance of structures subject to the aerodynamic effects of passing trains

- **eg station roofing with high speed trains passing through**

Aerodynamic actions

The passing of trains subjects any structure situated near the track to a travelling wave of alternating pressure and suction.

The magnitude depends on:–

- **the square of the speed of the train,**
- **the aerodynamic shape of the train,**
- **the shape of the structure,**
- **the clearance between the vehicle and the structure. The actions may be approximated by equivalent loads at the front and rear ends of a train**

Other considerations

- **Transition to railway bridges**
  - the vehicle running surface (the rail) is continuous.. The introduction of a fixed object (e.g. end of bridge) concentrates this loading to specific points of distribution.
- **Railings for rail worker safety**
- **Protection of highway traffic from falling objects, water or other materials during the movement of trains.**

Road over rail bridges - consideration

One of these days.....

RAIL PASSENGER NUMBERS ARE SET TO ROCKET FOLLOWING TODAYS ANNOUNCEMENT THAT A4e HAD WON A CONTRACT TO RUN A RAILWAY

Before I end…….

" Never stop dreaming,
never stop believing,
never give up,
never stop trying, and
never stop learning."

by Roy T. Bennett, The Light in the Heart

Terima Kasih