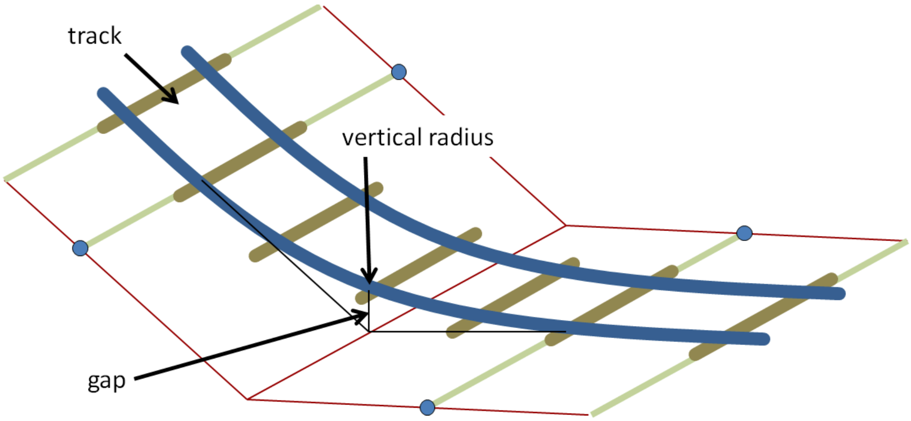
CESuRa in Future

The CESuRa concept has been selected for the I-90 floating bridge in Seattle, where they are used in pairs to provide articulated joints at each end of a long floating pontoon. Can CESuRa solve problems in other railway track applications or indeed outside of rail?

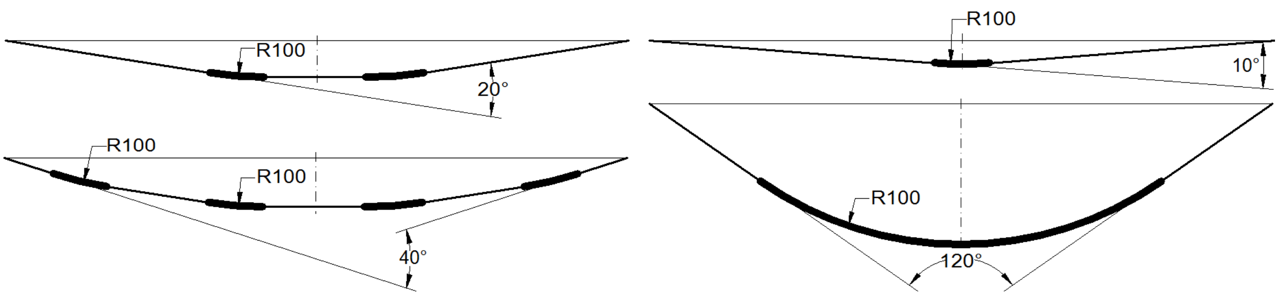
In railway trackwork, hinged joints can be found at the transitions between bridges and abutments. Rotation of the bridge deck is translated into rail bending. As the planes rotate and the hinge angle increases, an unconstrained section of track takes up a curve and a gap opens underneath. When a load rolls across the unconstrained section of track it will rely on the rail stiffness to maintain a smooth curve. In a railway, for example, it will close the gap, or there would be flexible pads or other components in the gap to help maintain a smooth curve.



The traffic loading is a key factor in determining the deflections in the structures and strength of the rails, however the rail bending stress limits the acceptable hinge angle. Moving the rail fastenings further apart could increase the rail bending radius thereby reducing the rail stresses, but doing so would at the same time increase the rail bending under traffic loading. The result is always a compromise.

Where rotations are beyond the capacity of a rail to simply bend between fasteners there is established technology to use a structural transition to divide the bend over several portions of track.

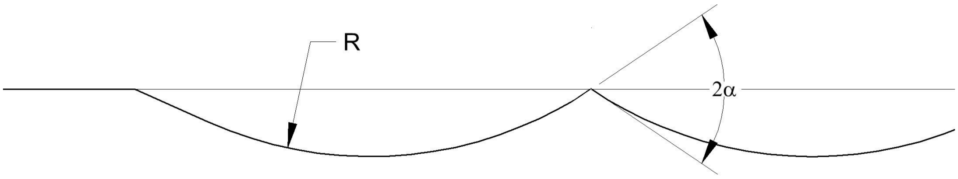
Using an intermediate beam to divide the hinge angle into two effectively doubles the acceptable hinge angle of the bridge joint. Adding spring and damping elements allows some extension of the compromise between rail bending and traffic loading. Adding two more intermediate beams divides the hinge angle again so that four areas share the rail beam bending.



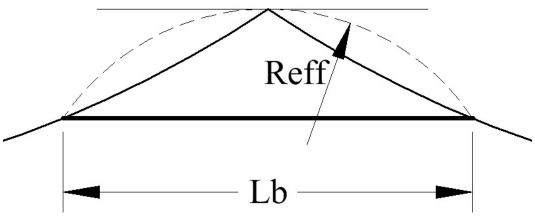
The lower right diagram achieves many times the subtended angle in the same space with a continuous curve.

Design codes for railway track assume that horizontal or vertical curvatures are built-in and substantially constant. Codes for bridges limit translational or rotational misalignment at deck joints or abutments.

The effect of a vehicle over a joint discontinuity can be described approximately by

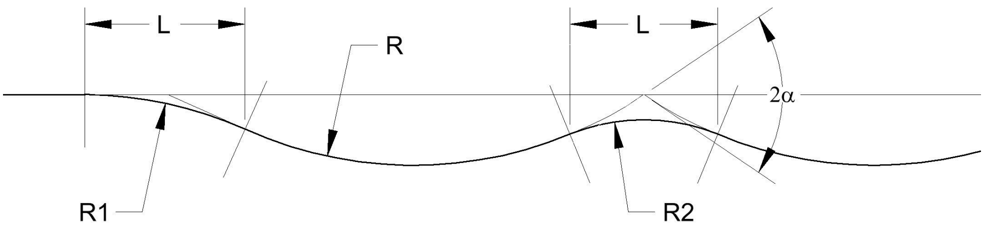


estimating the vertical radius created by the centre of gravity of a vehicle as it passes over. This is accepted practice for assessing the effective radius of a switch entry angle and is called a virtual transition. This can be constructed using a circumscribed curve.



Rail stress arises from a number of factors but, if rails are expected to bend to follow the alignment of the bridge decks, the stress due to rail bending is in addition to the stresses normally experienced in service.

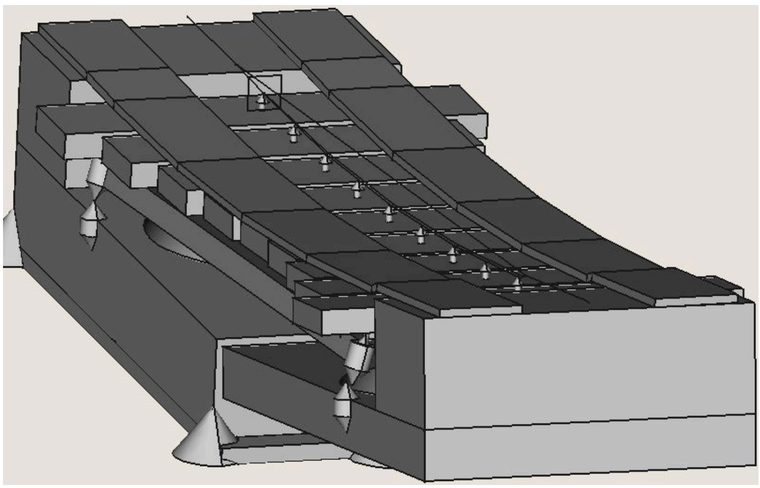
A different approach to the problem has eliminated the dependence on fastener spacing and enabled a smooth continuous curve to carry the rails across bridge joints. Potentially the hinge angle would be unlimited, so the limit would become only the practicability of the structure supporting the intermediate beam. The concept, the CESuRa joint, is a variable radius transition joint. It can be used for vertical or horizontal radii or a combination of the two.



Using a CESuRa joint the track can be arranged with a series of reverse vertical curves. The behaviour of an irregularly oscillating vertical alignment isn't specifically dealt with in standards.

This construction is effectively an inscribed curve, which gives a radius roughly twice that given by the circumscribed curve. Therefore the permissible speed is increased by $\sqrt{2}$.

So, a CESuRa joint spreads the rail bending over several metres and manages the vertical acceleration of a vehicle at speed through the use of steady variable radii. It has the potential to enable new solutions such as:



- Rail over long span bridges
- Rail over unstable ground or in tunnels (eg earthquake or flood zones, glaciers)
- Road and rail in dockyards
- Rail services to floating towns

Existing standards are written for current technologies and don't lend themselves to this novel concept, but a reasonable adaptation of virtual transition curvature is used to show the benefit of using a CESuRa joint from a vertical acceleration viewpoint. The question is what new applications become feasible with these solutions.

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