Strength of Gantrail crane rail pad

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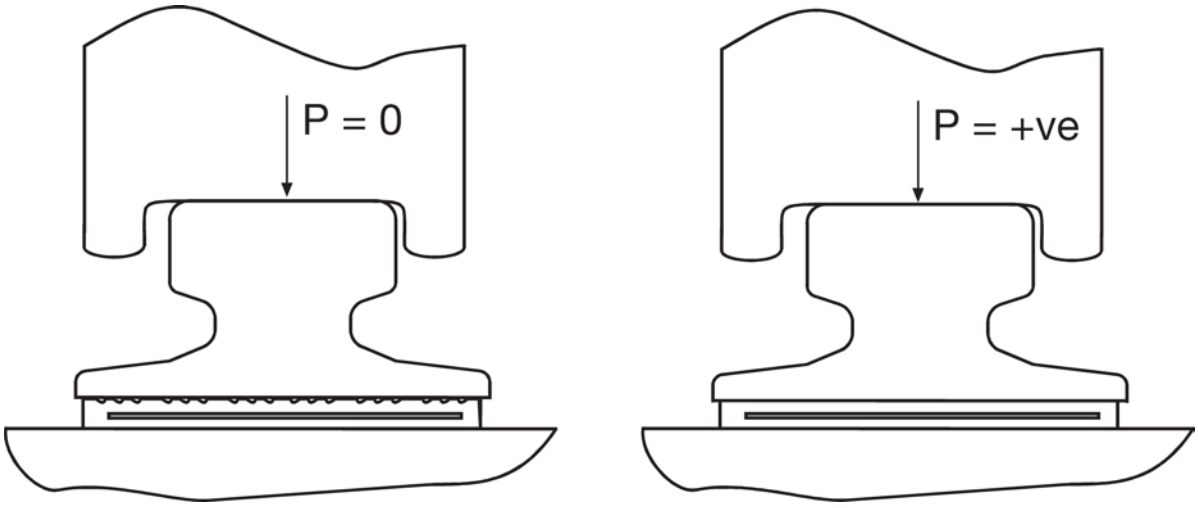
Gantrail supply two types of resilient crane rail support pad. Mark 7 pad is made from vulcanised nitrile rubber and is reinforced with a continuous steel strip. It is used under the full length of the crane rail. Mark 2 pad is made from solid Ethylene Vinyl Acetate (EVA) material. It fits between the crane rail and individual soleplates. These are typically mounted on a concrete support structure.

CHARACTERISTICS OF THE PAD

The Mark 7 pad has a grooved or fluted top surface. This is shown in the figure below.

The idea of this is to give the pad an initial softness to cushion the wheel loads and impacts and to allow the pad to fill imperfections in the top surface of the girder formed by welding distortion and the like. It also reduces the pressure below the rail where it is supported on the structure. When the pad has been compressed the grooves fill as the rubber flows elastically into the voids. This is shown in the figure below. This ensures that for heavy wheel loads the pad is not excessively compressed and the rail is not able to bend to a degree where it may fail due to being overstressed.

The solid Mark 2 pad is made of a harder material than the Mark 7 and is not normally used in such heavy applications. Its function is it also to ensure that the rail and the support below it are not over stressed.

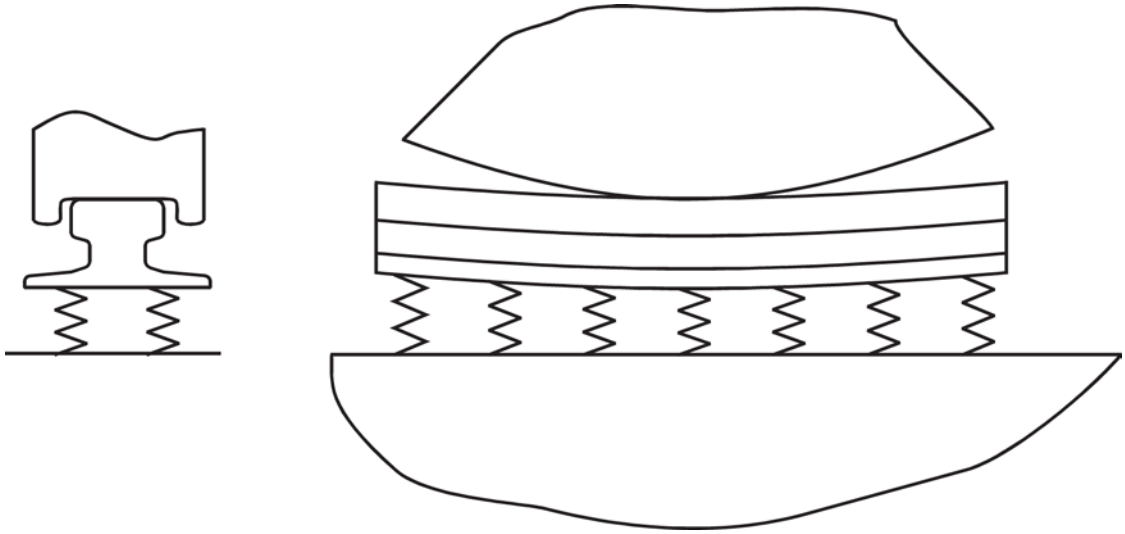


ANALYSIS

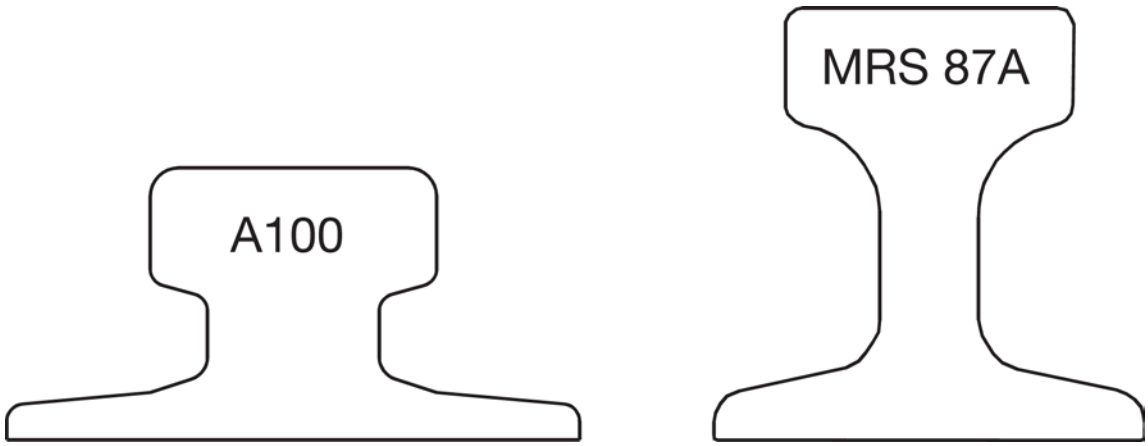
The interaction between the crane wheel, rail, pad and the support structure require a complex analysis. The rail acts as a beam and it is supported on an elastic foundation.

The situation is made difficult to analyse because the elasticity of the support is not linear i.e. the resistance of the pad is not proportional to the compressive deflection.

The diagram below indicates the type of analysis that is required. A series of springs (the pad) supports the rail. Again, this is a simplification e.g. more than one wheel may be influencing the rail.



To further complicate the practical application of the pad, crane rails come in a range of sizes and shapes. The cross sections below shows two rails that have substantially the same head width. Thus they would be expected to be able to carry the same wheel loads. However, the squatter A100 rail has only about a third of the bending resistance of the taller rail.



Complex calculations that have been performed using finite elements show the actual stress levels on the pad of between 5 and 10N/mm^2.

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It is sometimes practice to carry out crude calculations to determine the pressure below the rail. Consider as an example the two rails shown above and consider the load to be carried on the area projected from the rail wheel interface at 45º. Consider a 50 tonne wheel load. This would be a high for both rails.

	A100	MRS87A
Height mm	95	152.4
Foot width mm	200	152.4
Stressed area below rail N/mm²	38000	46451
Pad stress N/mm²	12.9	10.6

PAD STRENGTH TESTS

The complex analysis must not prevent Gantrail from understanding the degree of safety in using the pad. Thus Gantrail have had tests performed to determine the ultimate strength of the Mark 7 and Mark 2 pads. Samples of each type of pad were tested in compression between pairs of steel blocks. The blocks were chosen as 150 mm square, 105 mm square and 75 mm square. These have area ratios of approximately 4:2 and 2:1. A UK Government-recognised laboratory completed the tests. The results were as follows:

Mark VII Pad Tests

- 150 x 150 mm sample
  No failure with 2000 kN load
  Average stress without failure 88.9N/mm^2
- 105 x 105 mm sample
  Minimum load for three samples 937 kN
  Average failure stress 94.6N/mm^2
- 75 x 75 mm sample
  Minimum load for three samples 608 kN
  Average failure stress 112N/mm^2

Mark II Pad Tests

- 150 x 150 mm sample
  No failure with 2000 kN load
  Stress without failure 88.9N/mm^2
- 105 x 105 mm sample
  Failure load for one sample 1340 kN
  Stress 121.5N/mm^2
- 75 x 75 mm sample
  Failure load for one sample 550 kN
  Stress 97.8N/mm^2

SAFETY FACTOR

The safety factor for pad strength is the failure stress divided by the expected maximum stress. There is no failure stress below 85N/mm^2 and Gantrail believe the actual stress in operation will not exceed 15N/mm^2 in any case. Thus there should be a safety factor of in excess of five times in every application.

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