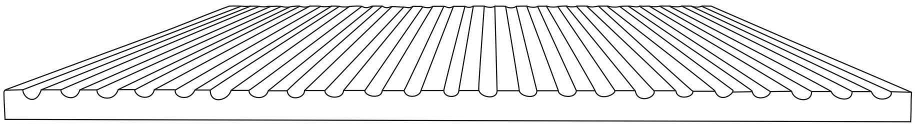
DSP-172

CRANE RAIL PAD I Continuous Rail Support Systems

DESIGN SERIES CRANE RAIL PAD



Product Details

DSP Design Series Crane rail pad is manufactured from a custom formulated polymer enabling the pad to be engineered to provide the desired stresses and dynamic response of the overall system. This custom formulated polymer possesses consistent and repeatable mechanical properties that can be tuned for a particular application which Molyneux can provide for custom projects.

DSP-172 Design Series rail pad is designed for general purpose crane runway use.

DSP-172 pad can be used with bolted splice joints, which is not recommended with steel reinforced rubber pad (the splice joints should be maintained in a tight condition).

DSP-172 pad is significantly stiffer laterally than steel reinforced pad and, consequently, considerably more resistant to escape from beneath the rail (commonly known as snaking out).

Supplied in rolls in 40 ft. (12.19m) lengths

Guidance

- Attenuates peak contact stresses while providing a greater pad bearing stress range.
- Improves rail support to reduce rail bow wave stresses.
- More resistant to “snaking out” than steel reinforced pad.

How to Specify: DSP-172/Rail Size I Example: DSP-172/175CR or DSP-172/A100

Features

- Reduces noise & structural vibration.
- Reduces rail wear & fatigue stresses.
- Reduces runway maintenance.
- Reduces stresses in the runway structure & the crane structure.
- Resistant to water, oil, grease, mildew & fungus.
- Absorbs uneven contact between the rail and supporting structure.
- Protects the crane mechanism & increases wheel, bearing & axle life.
- Eliminates runway beam and soleplate wear due to fretting corrosion.
- Distributes the wheel load over a large area, reducing high local bearing stresses.
- Has a high recovery rate to attenuate each wheel pass.

PHYSICAL PROPERTIES

Compressive modulus:	172 N/mm^2	Service temperature range (cont. use):	-50°C to 80°C
Pad thickness:	6.4mm	Permanent set:	0% after first loading
Compressive max. design stress:	28 N/mm^2	Shore hardness D:	55
Compressive strength:	55 N/mm^2	Tensile strength @ yield:	10 N/mm^2
Brittleness temperature:	-76°C	Elongation at yield:	500%

INSTALLATION & TECHNICAL NOTES

Installation: It is preferred that the rail joints are welded. Bolted splice joints should be maintained in a tight condition. The minimum lengthpad is the length spanning along three pairs of rail clips. The pad is usually installed with the ribs on top. A gap of approximately 1” (25mm) should left between contiguous lengths of rail pad. The Molyneux Engineering Department can provide help in designing the total rail support system, from the choice of the rail to the design of the load path through the rail support assembly. Molyneux can supply the complete design solutions.

Technical Notes: The compressive properties of the resilient pad act as distributed springs supporting the crane rail on its supporting structure and a more compliant pad distributes the vertical crane wheel loading over a larger area resulting in lower peak stresses. The drawback of using a resilient pad under a crane rail is the vertical loading causes rail uplift away from the load application which is referred to as a “bow wave”. A more compliant rail pad results in greater deformations of the crane rail in both the vertical and lateral directions. DSP-172 rail pad will reduce bow wave rail stresses in comparison to steel reinforced rubber pad. Crane installations impart time-varying dynamic loading on the facility which must be considered to prevent fatigue damage to the facility or operating personnel. The compliance of the resilient pad acts as a mechanical filter to reduce the amplitude of any impact or dynamic loading transmitted to the facility.

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ADDITIONAL TECHNICAL NOTES

Nitrile Rubber Pad versus Custom Formulated Polymer Pad

Nitrile butadiene rubber (NBR) was developed as a sealing product due to its excellent resistance to petroleum products and its wide temperature range. It is not primarily for use in load bearing applications and it is known to exhibit a wide variation of mechanical properties [1]. NBR is an incompressible, hyperelastic material [2] that requires advanced material models [3] for incorporation into a finite element stress analysis commonly used for mechanical and structural design purposes. A further complication of using NPR for crane rail padding is the changing force-deflection response under repeated load cycles that has been observed during in-house testing. There is not an accepted material model to represent this complicating load cycle changing behavior in an analysis model.

Custom formulated polymers exhibit a nonlinear material response that can be modeled using an experimentally determined stress-strain curve in a finite element analysis. In-house testing has demonstrated repeatable behavior when the test specimen was subjected to multiple load-unload cycles which makes the component response more predictable. The combination of a relatively simple, repeatable material response makes these custom polymers an ideal material to use in the design and fabrication of crane rail pad. Various pad profiles can be configured to produce optimized stiffness properties for different facility applications.

History of the use of polymer compounds for resilient rail support components

Polymer compounds have been widely and successfully used for the manufacture of resilient rail support systems in both railroad and crane rail installations for many years. Molyneux has successfully used these compounds for both continuous and discontinuous rail support systems. DSP pad is a continuation of this use, with the additional element of custom design of the pad to suit particular applications.

MOLYNEUX CAN CUSTOM DESIGN DSP PAD TO SUIT SPECIFIC PROJECT REQUIREMENTS

The predictable response characteristics of DSP pad allows Molyneux to formulate and design DSP pad to create the required compression modulus specified by the project engineer(s) to suit specific project requirements. The compressive properties of the crane rail pad, including pad thickness, must be carefully considered to minimize peak stresses within acceptable displacement tolerances for the overall system. Crane installations impart time-varying dynamic loading on the facility which must be considered to prevent fatigue damage to the facility or operating personnel. The compliance of the resilient pad acts as a mechanical filter to reduce the amplitude of any impact or dynamic loading transmitted to the facility. Inappropriate or inadequate uses of rail pads can exacerbate fatigue damage. The design objective of selecting rail pad is to maximize separation of the crane excitation frequencies from the facility response frequencies thus minimizing the transfer of dynamic forces [4]. This design rule of thumb applies to both harmonic and impact loadings imparted to the system. Correct rail pad selection for a railway system attenuated dynamic bending strains in the concrete sleepers by more than 50 % [5]. On the other hand, selecting a resilient pad that resulted in synchronizing the excitation and response frequencies would produce the highest dynamic loading possible on the facility.

The lowest natural frequency for a port crane was measured to be 1 Hz and the highest measured frequency was the sixth mode with a frequency of 6 Hz [6]. An overhead crane with a 5000 kg load was analyzed to have a fundamental (i.e., lowest) frequency of 3.28 Hz with multiple modes of response below 20 Hz [7]. Test and analysis of moving cranes in an automated facility indicates crane-induced vibrations in the 15 – 35Hz range where the dominant mode of 25 Hz was determined to be sensitive to rail irregularities [8]. The above examples represent low, medium and high frequencies of response for different types of crane installations with potentially different compliance requirements for the resilient pad to produce acceptable facility designs.

As seen above, different crane installations have different excitation and response frequencies. It is imperative that a selection of resilient crane rail pads is available to enable tuning of the system response to minimize transmitted stresses within allowable displacement limits. To this end, Molyneux Industries offers a variety of polymer compound crane rail pad solutions to provide a targeted appropriate customized compressive modulus.

[1] https://rahco-rubber.com/materials/nbr-nitrile-rubber/.
[2] http://dx.doi.org/10.4236/mnsms.2016.62004.
[3] M. Rackl, "Curve Fitting for Ogden, Yeoh and Polynomial Models," Ostbayerische Technische Hochschule Regensburg Mechanical Engineering Department, May 31, 2015
[4] https://www.chaocompute.com/wp-content/uploads/2020/07/Dynamics-of-Structures-Clough-Penzien.pdf.
[5] https://ro.uow.edu.au/engpapers/493.
[6] W. Zhang and O. Postolache, "Parametric model updating with frequency and MAC combined objective function of port crane structure based on operational modal analysis," Open Phys. 2019; 17:69–76.
[7] T. Haniszewski, "Strength of Overhead Travelling Crane with Use of Finite Element Method," Transport Problems, Volume 9, Issue 1, 2014.
[8] S. H. Ju, et. al., "Investigation of vibration induced by moving cranes in high-tech factories," Journal of Low Frequency Noise, Vibration and Active Control, 2020, Vol. 39(1), pp. 84–97