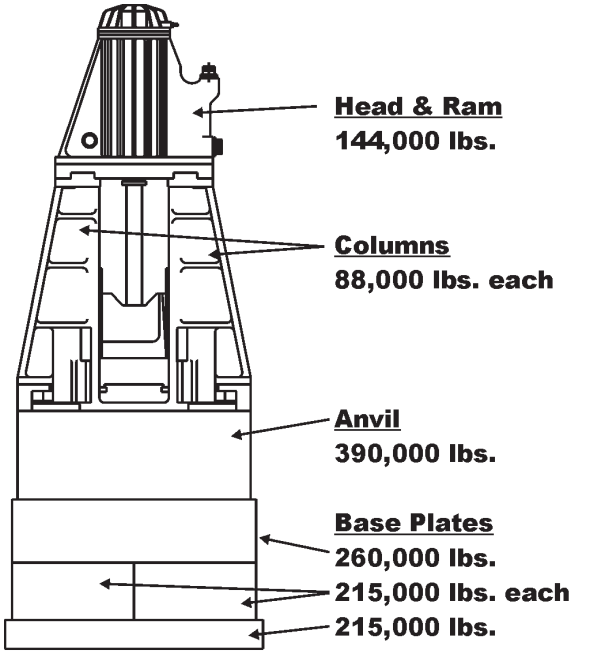
Erie 50,000 lb. Steam Hammer Installed on Vibro/Dynamics® MRM™ Isolation Elements

Elastomer Shock Isolation System Performs Beyond Expectations

Kropp Forge - Cicero, IL is a leading North American aerospace forger, known for its expertise with difficult-to-forge materials like titanium, high temperature nickel and stainless based alloys. A key machine in their extensive line of equipment is a 50,000 lb. Erie steam powered forging hammer. One of the largest of its kind, this unique piece of equipment gives Kropp Forge the ability to produce large, intricate, exceptionally durable high-stress forgings used in critical components for military aircraft and vehicles, construction, mining, helicopter rotors and more.

Weighing more than 1.6 million pounds, this enormous hammer is estimated to be capable of generating 550,000 ft/lbs (750 kilojoules) of energy. Operating a piece of equipment of this magnitude requires unique manufacturing expertise. Large parts, made from exotic alloys and a specific grain flow, with dependable strength consistency and reduced weight are examples of the capabilities of this hammer.

Kropp Forge originally installed (2) of these forging hammers in the early 1950's. The two hammers were installed side-by-side in pits with 42' x 36' x 23.5' deep foundations weighing more than 5.5 million pounds each. One of the hammers was later removed and replaced with a 40,000 lb. CECO steam hammer.



Hammer leaning to the left and front due to foundation failure

In 2002, the Erie 50,000 lb. hammer began to exhibit significant movement during operation. The hammer also appeared to be tilting sideways and forward several degrees.

An examination of the pit floor at the hammer sub plate confirmed the hammer had shifted unevenly. One corner was noticeably lower. A wet, mud-like, rocky material was being extruded from below the hammer sub plate and accumulating at one end.

Vibro/Dynamics was one of several companies contacted by Ajax Technologies (*a sister company in the Park-Ohio organization*) for assistance. Engineers from Vibro/Dynamics met with Kropp Forge and Ajax Technologies personnel within several days of being contacted, to assess
the installation.

Historical records and interviews with Kropp personnel revealed that a variety of materials have been installed underneath the hammer over the years in an attempt to prevent the hammers from destroying the supporting foundation.

The earliest methods used multiple layers of massive oak timbers. Later methods attempted to combine timbers with layers of pad material, which were then replaced in the 1990's with alternating layers of pad material and steel plates.

The most recent system (*alternating layers of laminated fabric pad material and steel plates*) was installed on top of a mixture of concrete and grout poured into the original pit to compensate for a height difference between the timber/pad system and the new pad/plate system. The material extruded from beneath the hammer was examined and found to be a mixture of concrete, grout, pad material, and water.

Tilted sub-plate with foundation mass oozing from underneath

The original foundation design and subsequent modifications were carefully examined. The installation of the CECO 40,000 lb. hammer in the adjacent pit was also studied. The findings indicated the additional concrete added at the bottom of the original pit had deteriorated and failed due to a combination of the high level of transmitted shock and vibration, insufficient strength, pit flooding, and the new concrete not being securely anchored to the original foundation.

A long-term, successful installation of a piece of equipment of this magnitude presents a variety of unique challenges. In addition to its massive static weight, each blow of the hammer generates an enormous amount of shock and vibration. Tremendous heat, steam and water are always present in varying degrees, stressing all components to their limits. The combination of an extremely harsh environment and the tremendous forces exerted on the installation system make successfully installing this steam hammer one of the most challenging applications.

Vibro/Dynamics engineering staff carefully analyzed the operating and structural characteristics of the hammer installation, using proprietary computer modeling software to predict the magnitude of the forces generated by the operation of the hammer.

The engineering analysis identified the following key factors required to design a successful, long-lasting, high-performance, hammer installation system:

1. The ability to accurately computer model the forces generated by the hammer.
2. The ability to accurately predict the isolation system's response to the hammer's forces
3. Design and apply the isolation system so its components operate at a low working stress.
4. Design the isolation system for severe and "worst case" operating and environmental conditions.

To meet these requirements, Vibro/Dynamics engineers designed the first high-performance, unitized elastomeric isolation system - the MRM™ Isolation Element, specifically designed for forging hammer installations.

The modular resilient cushions are the heart of the MRM System. Unlike sheets of pad material, each module is molded individually to tightly controlled stiffness and damping specifications. All modules are made using modern, high quality polymers, specially compounded for severe manufacturing environments.

The modules can be molded in different stiffnesses, load capacities, durometers and thicknesses, and also molded, bonded or unbonded, to a steel plate. All of these variables are used to achieve the proper performance characteristics required for a successful hammer installation.

The modules are then rigidly fastened to a series of interlocking plates and assembled into a one-piece, unitized construction, called an MRM Isolation Element. The number of modular layers and columns is configured for each application.

Heavy threaded bolts keep the layers together and provide a means to easily lift and install each Element using hoist rings. This greatly simplifies and speeds the placement and positioning of the entire isolation system, compared to manually placing and positioning individual pads, and plates, layer after layer.

Case History

Taking the design a step further, Vibro/Dynamics engineers built in additional protections against “worst case” scenarios. In addition to the interlocking bolts and pins used to maintain the position of the individual components, when multiple Elements are used, side buttress bumpers are used to maintain the position and spacing of the elements beneath the hammer.

The entire 1.61 million pound hammer was installed on (16) pre-assembled MRM Isolation Elements. Each Element was individually packaged and shipped by truck on simple skids.

Once on-site, the shipment of Elements was placed next to the open hammer pit. Each Element was numbered, corresponding to the installation diagram, making it simple to determine the placement of each Element.

Hoist rings were attached to the lifting bolts on each Element, and then each Element was simply lowered into the pit and placed directly on the concrete foundation. Installation was quick and easy!

MRM Isolation Elements being lowered into pit using hoist rings

MRM Isolation Elements being placed into pit

The following additional precautions were taken to prevent the elements from shifting under any unanticipated operational conditions:

- 8” x 8” oak beams were placed around the pit perimeter and between the MRM Elements to secure the positioning of the elements.
- A series of flat bars and plates were welded across the elements, tying the entire system together.

The hammer was then stacked and assembled on the MRM system. Installation was fast and smooth.

Vibro/Dynamics Engineering department had calculated the expected isolation performance difference between the previous installation method and the MRM System. When compared to the previous installation method it was predicted that Vibro/Dynamics MRM System would:

- Isolate approximately 31% more shock vibration.
- Increased the bearing area on the foundation surface by 205%.
- Reduced dynamic force transmission to the foundation by 77%.

Stacking the Steam Hammer

When the 50,000 lb. hammer was installed nine years ago, neighbors more than a block away had reported vibration from the operation of the 50,000 lb. hammer. The installation on the Vibro/Dynamics MRM System was completed on a Friday afternoon, with production setup planned over the weekend. After working in his office across the yard for several hours on the following Monday morning, the President of Kropp Forge phoned down to the Production floor to ask why the 50,000 lb. hammer wasn't running. The production supervisor responded it had been running all morning. Approximately a month after the 50,000 lb. hammer had been in full production, a manager at a printing company across the street ran into the President of Kropp Forge and asked when he'd get his big hammer running.

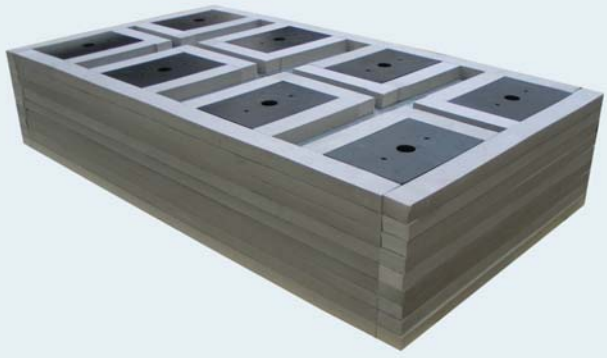
In summary, the unique design and features of the MRM™ Isolation System resulted in superior shock isolation, and a faster, easier installation. The combination of using elastomers with proper stiffness and damping, applied at minimal stress levels, will provide a long-lasting, trouble-free installation.

Vibro/Dynamics has manufactured and supplied custom engineered installation and isolation systems for a wide range of industrial machinery since 1965.

Installation of a 50,000 lb. Erie Steam Hammer Complete!

MRM™ Isolation Elements possess the following key characteristics:

- **Superior dynamic response to shock forces.**
  Vibro/Dynamics expertise in engineering elastomers makes it possible to install a system that will achieve a low dynamic natural frequency (less than 8 Hz) for maximum isolation and minimal motion, resulting in isolation effectiveness approaching that found in viscous spring isolators.
- **Predictable stiffness characteristics.**
  Vibro/Dynamics advanced MTS dynamic testing machine provides precise, detailed data on the characteristics of the modular cushions, allowing accurate prediction of system performance.
- **Increased durability and longer life.**
  Made from advanced elastomers specially compounded for maximum performance. MRM Systems are applied at a low working stress level for maximum durability and minimal fatigue.
- **Faster, easier installations.**
  MRM Isolation Elements are custom designed and sized for each installation. The Elements are simply lowered into the pit as units. No layout, arranging, or stacking of individual pads is required!



MRM Isolation Elements are Custom Engineered and Sized
(Model MRM8x9-1-G shown)

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