Farrat Isolevel
Foundation Shock and Vibration Isolation Systems for Structures, Machinery and Equipment
Reasons for using isolated foundations

- Increasing machine frame stiffness to maintain alignment during changes in applied static and dynamic loads.
- Minimising changes in level due to alterations in static load distribution.
- Increasing inertia mass of the machine and reducing vibration through mass damping.
- Lowering the centre of gravity to improve stability.
- Distributing static and dynamic loads over a greater ground area.
- Isolating low frequency of shock and vibration using more elastic vibration isolators than could be used between machine and foundation.
- Low frequency disturbing vibration requires low frequency, high deflection vibration isolators. On machinery requiring low operating motion amplitudes an isolated foundation is essential if low frequency vibration isolation is required.

Vibration Control/Isolation
Vibration Control involves the correct use of a resilient mounting or material in order to provide a degree of isolation between a machine and its supporting structure. A condition should be achieved where the amount of vibration transmitted from, or to, the machine is at an acceptable level.

To achieve efficient vibration isolation it is necessary to use a resilient support with sufficient elasticity so that the natural frequency \( f_n \) of the isolated machine is substantially lower than the disturbing frequency \( f_e \) of vibration. The ratio \( f_e/f_n \) should be greater than 1.4 and ideally greater than 2 to 3 in order to achieve a significant level of vibration isolation.

Damping provides energy dissipation in a vibrating system. It is essential to control the potential high levels of transient vibration and shock, particularly if the system is excited at, or near, to its resonant frequency.

Active Shock and Vibration Isolation
A foundation block for a dynamic machine should be isolated in order to reduce the effects of vibration and shock on nearby machines, people and the building structure. Controlling the source of a structural disturbance is known as active isolation.

Applications include: isolation of foundations for: power presses, pumps, drop hammers, forging machines, metal forming and cutting machines, compressors, gensets, engines and test rigs, printing machines and rolling roads.

Passive Shock and Vibration Isolation
When it is not possible to prevent or sufficiently lower the transmission of shock and vibration from the source a resiliently supported foundation block can be used for the passive isolation of sensitive equipment.

Applications include: isolated foundations for: machining centres, grinding machines, measuring and inspection equipment, laser cutters and microscopes.
### Undamped systems:

\[
T = \frac{1}{1 - R^2}
\]

### Damped systems:

\[
T = \frac{1 + \frac{R^2}{Q^2}}{1 - \frac{R^2}{Q^2}}
\]

\[
R = \frac{f_e}{f_n}
\]

\[
Q = \frac{1}{2 \frac{C}{C_c}}
\]

Transmissibility \( T \) can be read from diagram 3.2 or calculated as follows:

\[
f_{nd} = \frac{1}{2\pi} \sqrt{\frac{K_{td}}{M}} \text{ Hz}
\]

**Fig 3.1**

- Out of balance
- Bent shaft
- Misalignment

### Sources of vibration in rotating machines

<table>
<thead>
<tr>
<th>Source</th>
<th>Disturbing Frequency ( f_e ) Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary out of balance</td>
<td>1 x rpm x 0.0167</td>
</tr>
<tr>
<td>Secondary out of balance</td>
<td>2 x rpm x 0.0167</td>
</tr>
<tr>
<td>Shaft misalignment</td>
<td>2 x rpm x 0.0167</td>
</tr>
<tr>
<td>Bent Shaft</td>
<td>( 2 x \text{rpm x } 0.0167 )</td>
</tr>
<tr>
<td>Gears (N = number of teeth)</td>
<td>( N \times \text{rpm x } 0.0167 )</td>
</tr>
<tr>
<td>Drive Belts (N = belt rpm)</td>
<td>( N, 2N, 3N, 4N \times 0.0167 )</td>
</tr>
<tr>
<td>Aerodynamic or hydraulic forces</td>
<td>( N \times \text{rpm x } 0.0167 )</td>
</tr>
</tbody>
</table>

**Fig 3.2**

- For natural rubber and coil spring isolators static and dynamic spring constants are the same.

### Typical support natural frequencies (\( f_n \))

<table>
<thead>
<tr>
<th>Structures</th>
<th>Natural Frequency ( f_n ) Hz</th>
<th>Isolator Frequency ( f_{ni} ) Hz</th>
<th>Isolator type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspended concrete floor</td>
<td>10-15</td>
<td>3-5</td>
<td>Helical, Air Springs</td>
</tr>
<tr>
<td>Ground Floor</td>
<td>12-34</td>
<td>6-8</td>
<td>Helical, Air Springs, Elastomeric</td>
</tr>
<tr>
<td>Soft Clay</td>
<td>12</td>
<td>6-8</td>
<td>Helical, Air Springs, Elastomeric</td>
</tr>
<tr>
<td>Medium Clay</td>
<td>15</td>
<td>6-8</td>
<td>Elastomeric Isolators</td>
</tr>
<tr>
<td>Stiff Clay</td>
<td>19</td>
<td>8-10</td>
<td>Elastomeric Isolators</td>
</tr>
<tr>
<td>Loose Fill</td>
<td>19</td>
<td>8-10</td>
<td>Elastomeric Isolators</td>
</tr>
<tr>
<td>Very dense mixed grain sand</td>
<td>24</td>
<td>10-12</td>
<td>Elastomeric Isolators</td>
</tr>
<tr>
<td>Limestone</td>
<td>30</td>
<td>10-12</td>
<td>Elastomeric Isolators</td>
</tr>
<tr>
<td>Hard Sandstone</td>
<td>34</td>
<td>10-12</td>
<td>Elastomeric Isolators</td>
</tr>
</tbody>
</table>

**Fig 3.3**

- Farrat are certified to TUC UKQA ISO 9001/2000
Reasons for isolating the effects of shock

Shock is created by impact of one mass against another e.g. during operation of power presses, forging machines, drop hammers etc. The shock impulse caused by the impact travels through the machine structure as a deflection wave. If the machine is rigidly connected to its foundation this deflection wave enters the foundation and the surroundings. The shock will generally cause the affected masses to vibrate at their own natural frequencies.

Reduction in shock severity by use of suitable isolators is achieved by the isolators storing the energy of the shock through isolator deflection and subsequent release in a smoother form over a longer period with lower overall amplitude.

A shock pulse may contain frequency components from 0-\infty. It is therefore not possible to avoid resonance with the isolator/mass. If however the duration of the shock pulse is less than one half period of the isolation system resonance may not be serious.

Figure 4.1
Shows the output force (into the supporting floor) v time levels from a machine produced shock wave. In case 1 the machine under consideration is connected directly to the supporting floor. Case 2 typifies a machine installed on spring or elastomeric isolators in conjunction with a foundation block. It can be seen that the same amount of energy is transmitted in both instances. However in case 2 the energy is transmitted over a much larger time scale resulting in a substantially lower peak force. In reality the force transmitted will present itself as noise and structure borne vibration detectable by humans, it is therefore desirable in most instances to keep the peak value of transmitted force as low as possible by using on spring or elastomeric isolators between the machine and foundation or an elastically supported foundation block.

Figure 4.2
Shows a machine/structure that is rigidly connected to its foundation. The peak force into the structure is very high and of relatively short duration. Essentially all the force that occurs in the machine is transferred to the structure with the exception of that which is absorbed by the machine.

Figure 4.3
Illustrates the use of elastomeric or spring isolators between the machine and the supporting foundation. In this scenario with the correct isolator specification the peak force transmitted to the supporting foundation is significantly reduced resulting in reduced structure borne noise and transmitted vibration.

Figure 4.4
Illustrates the use of spring or elastomeric isolators supporting a foundation block. In this instance the peak force transmitted is reduced to virtually zero. The foundation block increases the system mass and reduces machine vibration and movement through mass damping.
High precision machine foundation vibration isolation

**Description**
ISOMAT foundation isolators used in conjunction with FVF Farrat Base Void Filler and LVI and/or ISF Sidewall Vibration Isolation materials provide highly predictable performance characteristics over many years of service.

**ISOMAT is produced in three rubber types**
- **IM CR** Neoprene for high elasticity, moderate damping and self extinguishing properties. Conditional oil and chemical resistance
- **IM NR** Natural Rubber for maximum elasticity and low damping (passive isolation) Poor oil and chemical resistance
- **IM BR** Nitrile Rubber for excellent combination of elasticity, damping and excellent oil and chemical resistance.

**Working Temperature Range:** °C: -30 to +120
**Creep:** Very Low

**Building materials class:** B2

Complete chemical resistance tables available on request.
Farrat would advise on most suitable ISOMAT grade for each application and provide full specification, predicted natural frequencies, damping, layout drawings and installation instructions.

**Description of Diagram**
1) Polymeric Sealant (eg Sikaflex Pro-3WF) or rubber sealing strip to prevent moisture ingress.
2) Top strip Vidam VM or ISF.
3) Reinforced concrete foundation block.
4) Sidewall Isolation: ISF, FVF 15-50 or LVI.
5) JLT Joint line tape to all joints.
6) Reinforced impermeable concrete forming tank
7) Damp proof membrane DPM. Minimum 1000gsm.
8) ISOMAT Isolators.
9) Base void filler, FVF-10-50.
10) Consolidated hardcore to firm ground.

* Reinforced concrete foundation blocks and associated structures to be designed by qualified consulting engineers and constructed by contractors of proven ability and experience.

<table>
<thead>
<tr>
<th>Product</th>
<th>Thickness (mm)</th>
<th>Comp. Modulus (Ec N/mm²)</th>
<th>Isomat Units</th>
<th>Other sizes available to suit application</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>150</td>
<td>200</td>
</tr>
<tr>
<td>ISOMAT IM CR 40</td>
<td>25  50</td>
<td>2.7  2.7</td>
<td>0.35  0.35</td>
<td>kN</td>
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<tr>
<td>ISOMAT IM NR 45</td>
<td>25  50</td>
<td>3.7  3.7</td>
<td>0.45  0.45</td>
<td>kN</td>
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<tr>
<td>ISOMAT IM BR 40</td>
<td>25  50</td>
<td>3  3</td>
<td>0.4  0.4</td>
<td>kN</td>
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<td>ISOMAT IM BR 50</td>
<td>25  50</td>
<td>3.7  3.7</td>
<td>0.5  0.5</td>
<td>kN</td>
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<tr>
<td>ISOMAT IM BR 70</td>
<td>25  50</td>
<td>6  6</td>
<td>1.2  1.2</td>
<td>kN</td>
</tr>
</tbody>
</table>
FAVIM FVM-100 Full Area Shock and Vibration Isolation Material

Full area vibration damping and sound deadening materials for foundations, plinths and floating floors can be applied to either a concrete base or consolidated hardcore.

Applications include: Machinery, HVAC, lifts and elevators, workshops, pumps, compressors and generators, industrial storage and working areas, expansion joints, helicopter pads.

Ideally suited for medium pressure applications.

Construction: Recycled rubber particles with a polyurethane PUR binder.

Properties:
- Mildew and moisture proof
- Permanently elastic / Low long term creep
- Temperature range °C: -30 to +110
- Density: 550 kg/m³

Building materials class: B2

Standard Sheet: 1.25m x 1.0m, 1.0m x 1.0m, 1.0m x 0.5m.

Other sizes, pads and strips available on request.

Description of Diagram
1) Polymeric sealant or sealing strip (Not supplied by Farrat).
2) Reinforced impermeable concrete to sides and base of pit. (Fig 8.2) Thickness and concrete specification to be determined by ground and loading conditions.*
3) Farrat LVI or ISF side wall vibration isolation material, spot bonded to pit walls using WB Adhesive.
4) Damp proof membrane DPM. Minimum 1000gsm.
5) Steel cage reinforced concrete foundation block designed to support imposed dynamic and static loads and suitable for elastic support.*
6) JLT Joint line tape to all joints.
7) Favim 100 full area vibration isolation material to the pit base.
8) Reinforced concrete pit base.* (Fig 8.2)
9) Consolidated hardcore base.

Favim can be applied either direct to a consolidated hardcore base or a reinforced concrete pit base depending upon the site conditions.

### Favim 100
Full area vibration isolation material

<table>
<thead>
<tr>
<th>Product</th>
<th>FVM 100-12</th>
<th>FVM 100-25</th>
<th>FVM 100-50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edc (MPa)</td>
<td>Slp Edc (mm Hz)</td>
<td>Slp Edc (mm Hz)</td>
<td>Slp Edc (mm Hz)</td>
</tr>
<tr>
<td>25</td>
<td>2.57</td>
<td>43</td>
<td>30</td>
</tr>
<tr>
<td>30</td>
<td>2.63</td>
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<tr>
<td>100</td>
<td>2.71</td>
<td>23</td>
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</tr>
</tbody>
</table>

Dynamic vertical natural frequency

\[ f_{vd} \text{ Hz} = \frac{1}{\sqrt{N}} \times \frac{\text{Edc} \times \text{Slp Edc}}{} \]

Static deflection

\[ \delta \text{ mm} = \text{N x deflection for one layer} \]

Specific spring constant

\[ K \text{ N/mm/mm²} = \frac{\text{Kss} \text{ (for one layer)}}{\text{N}} \]

Spring constant

\[ K \text{ N/mm} = \frac{\text{Area mm² } \times \text{Kss}}{\text{N}} \]

Vertical natural frequency

\[ f_{vd} \text{ Hz} = 15.76 \times (1/\text{N}) \times \sqrt{\text{Kss}} \]

Number of layers

\[ N \]

* Reinforced concrete foundation blocks and associated structures to be designed by qualified consulting engineers and constructed by contractors of proven ability and experience.

<table>
<thead>
<tr>
<th>Product</th>
<th>Thickness mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVM 100-12</td>
<td>12.5</td>
</tr>
<tr>
<td>FVM 100-25</td>
<td>25</td>
</tr>
<tr>
<td>FVM 100-50</td>
<td>50</td>
</tr>
</tbody>
</table>

Other thicknesses available on request.
ISOLAY isolated foundation for CNC Machining Centre

CNC machining centre on ISOLAY isolated foundation

ISOMAT isolated foundation for large Cerutti printing press

Cerutti Printing Press on ISOMAT isolated foundation

ISOMAT isolated foundation for Rhodes 2500 kN Power Press

Rhodes 2500kN Power Press on ISOMAT isolated foundation

ISOMAT/FVF isolated foundation for metal recycling and crushing machine

Metal recycling and crushing machine on ISOMAT/FVF isolated foundation
Fig. 14.1
In the case of spring and air mounts it is advisable to have an access gap around the foundation for maintenance reasons.

Fig. 14.2 a/b
Where a machine has a high center of gravity it is usually desirable to keep the centre of gravity as low as possible to avoid instability of both machine and foundation.

For this reason a stepped foundation block can be employed. By reducing the vertical distance between the anti vibration mount and the combined machine/foundation centre of gravity the stability of the entire system is dramatically increased.

Fig. 14.3 Floating floor, Isolay or Favim

Fig. 14.5
Where forging hammers and other such shock creating machinery is used it is advisable to put vibration isolation systems both directly under the machine and beneath the foundation block.

This has the effect of minimising the shock wave that is transmitted through the surrounding floor, thus reducing noise and structure borne vibration.
Information in this brochure is for guidance only and in the interests of product development may change.