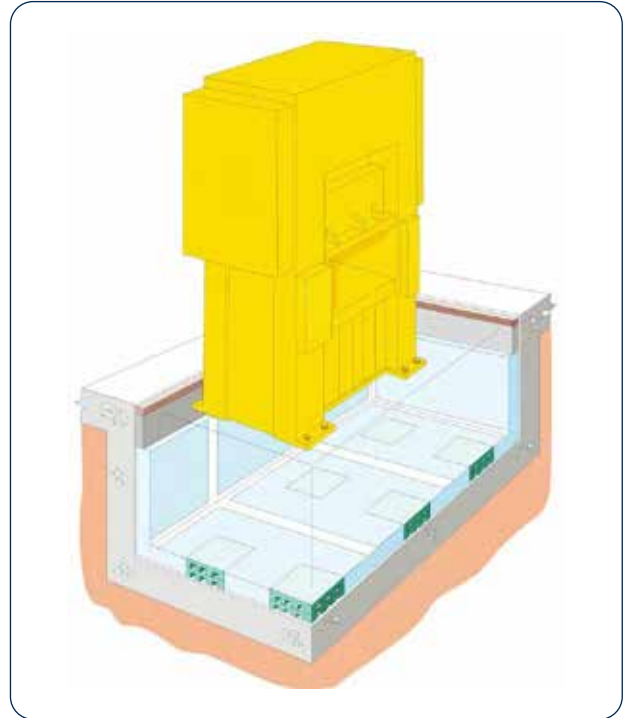


Isolated Foundations

Protecting your Investment & Maximising Productivity

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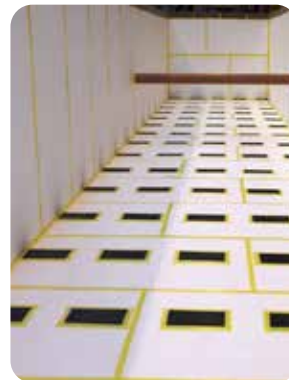
1.0 Introduction

1.1 Farrat Industrial Heritage

Farrat's heritage of engineering isolated foundations dates back to the 1960s. Since then, we have developed vibration isolation solutions for clients around the world across construction, industrial and power generation sectors.

Equipment manufacturers are increasingly designing machinery to work faster and with more precision, whilst reducing weight and cost. Farrat Isolated Foundations are used in many applications to ensure the operating conditions - in terms of vibration levels - are controlled to within equipment specifications, to maximise productivity and to conform to H&S and local authority requirements.

Whether you are relocating existing machinery, installing new equipment or are involved in detailing foundations, Farrat have the knowledge and experience to provide the most suitable Isolated Foundation solution.



Typical Applications

- ▶ Printing Presses
- ▶ Cupping Presses
- ▶ Power Presses
- ▶ Roll Grinders
- ▶ Recycling Centres
- ▶ Forges
- ▶ Long-bed Machinery
- ▶ Metrology & Inspection
- ▶ CMM

1.2 Farrat Isolated Foundations

Isolated Foundations (IFDs) either protect sensitive machinery from surrounding vibrations (passive isolation) or reduce vibrations and prevent them from migrating to the surrounding foundations (active isolation).

How are Isolated Foundations constructed?

IFD's comprise of a concrete inertia block, to which equipment or machinery is rigidly connected. Specialist Vibration Isolating Material, provided by Farrat, surrounds the inertia block to prevent vibration from either entering or leaving, depending on the particular application.

What different configurations are there?

Although there are multiple variants, there are two main themes of isolation: **full isolation** and **lateral isolation**.

With full isolation, both the base and walls of the inertia block are surrounded with Vibration Isolating Material, whereas for lateral isolation, only the walls are surrounded.

How does the Vibration Isolating Material work?

There are specific material properties determined by specialist in-house test equipment at Farrat - that allow us to determine the transmissibility. This is also affected by the exciting frequency, natural frequency, mass and the isolation efficiency given under load conditions, among other factors.

What does the inertia block do?

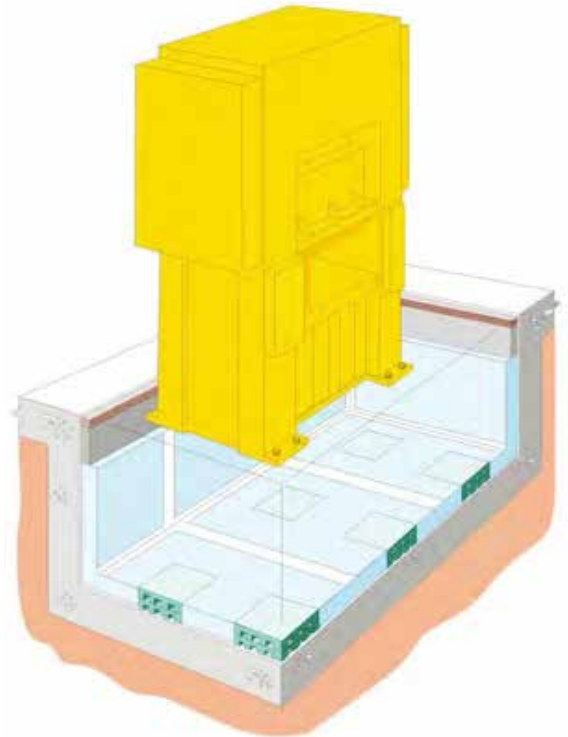
- ▶ The inertia block adds mass, which significantly reduces the vibration levels relative to the vibratory force. This is known as "mass damping"
- ▶ The inertia block adds stiffness, thus maintaining alignment during changes in static and dynamic loads. This can be particularly beneficial for long-bed machinery, modular machines or high-precision equipment.
- ▶ The inertia block also reduces the centre of gravity (CoG), which can be very beneficial for equipment with a high CoG.
- ▶ Farrat can provide guidance when determining the Inertia block size for a particular application.

***For information on specific applications, download our range of Application Design Guides from: www.farrat.com/applications**

Additional Resources:

- ▶ Printing Press Design Guide
- ▶ Power Press Design Guide
- ▶ Roll Grinder Design Guide
- ▶ Pumps & Compressors Design Guide

Fig 1.1 Typical IFD Construction



- ▶ Water Turbines
- ▶ Pumps & Compressors
- ▶ Weaving Machines
- ▶ Large Machining Centres
- ▶ Oil & Gas
- ▶ Dynamic Test Rigs
- ▶ Manufacturing Facilities

2.0 How Farrat Deal with Enquiries

Farrat have over 50 years' experience in providing vibration isolation solutions for machinery and equipment. This section provides the considerations and information required to enable Farrat to provide the most cost-effective Isolated Foundation solution for each enquiry.

For **lateral isolation**, Farrat have several materials available as detailed in Section 6. If in doubt please contact Farrat.

For **full isolation**, the key factors for vibration isolation are:

1. Total static mass of the machine and equipment, including tool and component mass
2. Dimensions and mass of the machine, equipment and the proposed inertia block
3. Required dynamic natural frequency
4. Required level of damping

2.1 Considerations

The first two points can generally be determined quite easily. Farrat can advise on the most suitable damping levels / materials for a given application. Other factors to consider include the environmental compatibility and in particular, the compatibility of the isolating materials with oils and lubricants.

As seen in Section 3, the vibration isolation for cyclical vibration is dependent on the ratio of the exciting frequency to the natural frequency - it is therefore relatively easy to determine the required natural frequency for a required level of isolation. For the isolation of impact machinery, the theory is more complex as there are many more variables. In these cases, we advise you to contact the Farrat Technical Team to discuss your application / requirements.

2.2 Applications - Type & Level of Isolation

2.2.1 Active Isolation

APPLICATION	DYNAMIC FORCE	LEVEL OF ISOLATION	TYPE OF ISOLATION	GENERAL TYPE (see page 12)
Metal Forming (presses / forging)	Impact / Cyclical	Full	Active	1
Dynamic Test Rigs	Impact / Cyclical	Full / Lateral	Active	1
Pumps	Cyclical	Full	Active	1
Water Turbines	Cyclical	Base Only	Active	1.3
Weaving Machines	Cyclical	Full	Active	2

2.2.2 Passive Isolation

APPLICATION	DYNAMIC FORCE	LEVEL OF ISOLATION	TYPE OF ISOLATION	GENERAL TYPE (see page 12, 22)
Machining - Machine Centres		Lateral	Passive	Lateral
Machining - Long Bed		Lateral	Passive	Lateral
Roll Grinding		Full	Passive	1, Spring
CMM / Metrology / Inspection		Full	Passive	1, 2
Printing Press		Full	Passive	1

2.3 Why Choose Farrat?

Our engineering capabilities enable us to help you choose the right products to develop the optimum industrial vibration control solution for your specific application.

Solutions for Industry and Power Generation

Industrial Vibration Control (IVC)

- ▶ Vibration, noise and shock have significant effects on the performance of industrial and power generation equipment and their surroundings and establishing workable solutions can often be complex. Farrat's rich and varied history, coupled with cutting-edge and ever-improving techniques, makes us the ideal choice for resolving vibration, noise and shock problems.
- ▶ Our durable range of industrial vibration control solutions have been developed over time using a combination of experience and customer feedback to ensure that we are constantly innovating and problem solving, however bespoke the requirement.
- ▶ We support OEM's and end users throughout the process, from fact-finding through to concept and detailed system design to installation.

The Farrat IVC range of solutions includes FSL Coil Spring Isolators, Isoblocs and Anti-Vibration Materials, Washers & Bushes.

To view the range, please visit www.farrat.com.



Standards Compliance

Elastomeric Compounds & Isolators

Our compounds conform with the requirements and testing procedures set out in BS 6177:1982 and BS EN 1337-3:2005.

Quality Assurance

Farrat operates an ISO 9001:2008 approved Quality Assurance System and an ISO 14001:2004 Environmental Standard.

Industry Memberships

Farrat are proud to be sponsoring members of the Institute of Acoustics (IoA).

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Global Experience

Working closely with a trusted global network of industrial distributors and original equipment manufacturers (OEM's), we have provided solutions to all manner of industrial applications, including:

- ▶ Full Automotive Production Lines
- ▶ Individual Machine Tools
- ▶ HVAC Equipment
- ▶ Power Presses
- ▶ Roll Grinders
- ▶ Printing Presses

Our Technical Team are passionate about "creative Engineering", seeking technical excellence and innovation on every project to meet complex project requirements.

If you are unsure of which solution is best for you, our team will advise and guide you throughout each stage of the process.

3.0 Applications & Project References

Global solutions exported from Farrat's UK manufacturing facility.

3.1 Canning - Bodymakers / Cupper Presses

Farrat have over 47 years experience designing and supplying Isolated Foundations for both bodymakers and cupping presses, supplying multiple production lines globally, including Europe, China, The Middle East and India. Materials used for cupping presses are: NBR ISOMAT Pads, Voidfiller & Vidam. For bodymakers we use Vidam & Voidfiller



Stolle, Hungary
Equipment Type: Cupper Press



Stolle, Hungary
Equipment Type: Bodymaker

3.2 Metrology

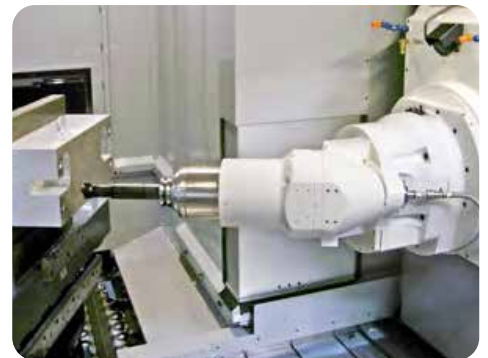


AFRC, Strathclyde University
Equipment Type: Delta Gantry CMM
*Case study on page 34

3.3 Machining



BAE, Samlesbury
Equipment Type: Starrag Eco F



Rolls Royce, Ansty
Equipment Type: Makino Machining Centre

3.4 Steel / Paper - Roll Grinders



GE Energy
Equipment Type: Herkules Grinder



Voith Paper, International
Equipment Type: Roll Grinder
*Case study on Page 26



Union Electric, Gateshead
Equipment Type: Churchill Roll Grinder
*Case study on Page 28

3.5 Oil & Gas

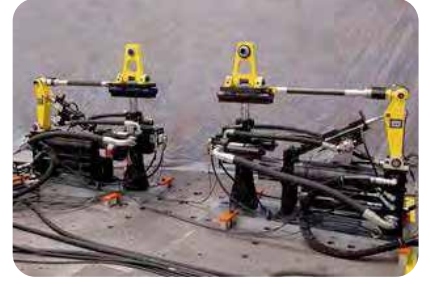


Sahil & Shah, Abu Dhabi
Equipment Type: Compressors
*Case study on Page 24

3.6 Automotive - Dynamic Test Rigs



Llanelli, Wales
Equipment Type: Dyno Roller Block



Triumph Motorcycles
Equipment Type: 4-Axis Road Simulator

3.7 Forging



Kimber, Birmingham
Equipment Type: Massey 7 Tonne Drop Forge

3.8 Printing Presses



Daily Mail Press, Didcot
Equipment Type: Cerutti Flexo Press
*Case study on Page 30



Kaleva Printing, Finland
Equipment Type: Cerutti Flexo Press
*Case study on Page 32

3.9 Metal Presses



Equipment Type: Rhodes 350T Power Press

3.10 Recycling



Equipment Type: Metal Vehicle Crusher

4.0 Vibration Control - Basic Theory

Vibration isolation reduces the level of vibration transmitted between a machine, building or structure and another source.

Vibration can come from multiple sources, such as an imbalance of rotating machinery, impact from a metal stamping press and reciprocating engines and compressors - which have inherent imbalance. When sensitive equipment requires isolating, even low levels of vibration from sources such as overhead cranes, stacker trucks and accidental dropping of heavy objects can become a problem.

Vibration isolation is a very complex subject, particularly when the non-linear properties of elastomers are taken into account. Therefore, solutions are derived by using a combination of theory, knowledge and practical experience.

Generally speaking, there are two main sources of excitation for vibration: cyclical and impact. OMAT isolators and therefore minimising any transmission to the surroundings.

4.1 Cyclical Vibration

Where the exciting vibration is cyclic, then vibration isolation theory can be used to determine the level of isolation. Fig 4.1 demonstrates the relationship between the exciting and natural frequencies, damping ratio and transmissibility. The level of isolation is the inverse of transmissibility.

$$R = \frac{\text{Frequency of disturbing vibration } f_e}{\text{Natural frequency of isolator } f_n} = \frac{f_e}{f_n}$$

As seen in Fig 4.1, vibration isolation is achieved with R values greater than 1.4, however to achieve realistic isolation, the R value should be at least 2. This is exemplified in Fig 4.3, by comparing R values of 1.5 and 2.0 for C/Cc of 0.1. The isolation provided for an R value of 1.5 is 19%, whereas an R value of 2.0 provides 64% isolation.

As can be seen in Fig 4.1, when R = 1, reverberation occurs, which magnifies the exciting vibration - this is to be avoided at all costs. So, for a material with minimal damping, the amplification of the original vibration level can be 10 or more times the original vibration levels.

The natural frequency of the ground also has to be considered to ensure the isolator frequency does not coincide with the natural frequency of the ground.

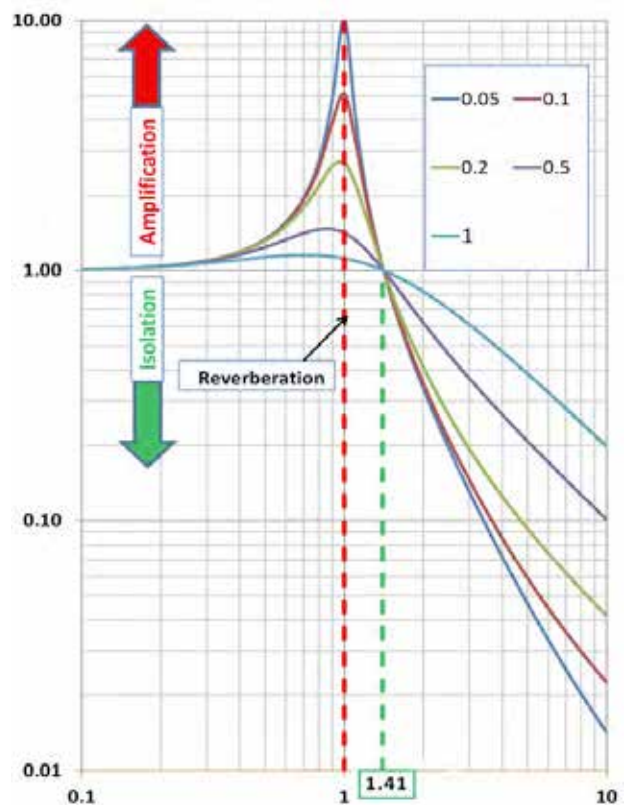
4.1.1 Exciting Frequency (fe)

For rotating machinery this is usually the rotational speed (in Hertz), but there may also be multiples of the speed if blades, lobes or gears, etc, are attached to the rotating shaft.

$$\frac{60 \text{ rpm} = 1 \text{ Hz}}{\text{Therefore, for a 2-pole motor the frequency is 50 Hz.}}$$

rpm = revolution per minute

Fig 4.1 Key Factors in Achieving Vibration Isolation



4.1.2 Natural Frequency (fn)

Vibration isolation only becomes effective when the exciting frequency is greater than the natural frequency; therefore, when a machine increases to working speed, there will be an instance when resonance occurs and damping becomes an important requirement to limit the level of vibration.

The natural frequencies for common structures are shown in Fig 4.2, for typical isolator types.

Fig 4.2 Frequencies for Common Structures

TYPICAL SUPPORT NATURAL FREQUENCIES (Fn)			
STRUCTURES	NATURAL FREQUENCY	ISOLATOR FREQUENCY	ISOLATOR TYPE
Suspended concrete floor	10 - 15	3 - 5	Helical, Air springs
Ground floor	12 - 34	6 - 8	Helical, Air springs, Elastomeric
Soft clay	12	6 - 8	Helical, Air springs, Elastomeric
Medium clay	15	6 - 8	Elastomeric
Stiff clay	19	8 - 10	Elastomeric
Loose fill	19	8 - 10	Elastomeric
Very dense mixed grain sand	24	10 - 12	Elastomeric
Limestone	30	10 - 12	Elastomeric
Hard sandstone	34	10 - 12	Elastomeric

4.1.3 Relationship Between Vibration Isolation and Damping Ratio

As shown in Fig 4.1 and Fig 4.3, increased damping provides a means of limiting the vibration level with the compromise of limiting the vibration isolation.

Fig 4.3 Damping Ratio and Vibration Isolation

DAMPING C/CC	FREQUENCY RATIO (R) Fe/Fn							
	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
0.05	20	66	80	87	91	93	94	95
0.10	19	64	79	85	89	91	93	94
0.15	17	62	76	83	87	90	91	93

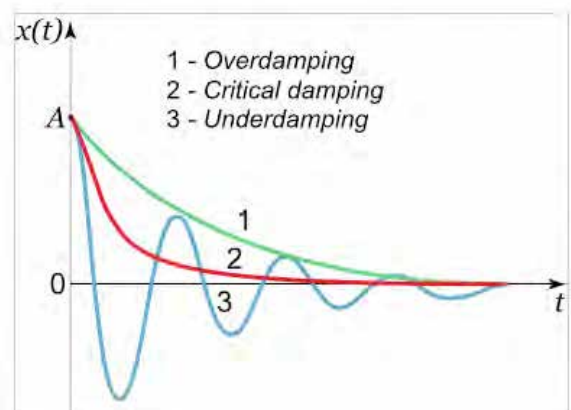
PERCENTAGE ISOLATION EFFICIENCY

4.1.4 Damping Ratios

The damping ratio C/C_c is determined for each material by testing.

The C_c is the critical damping, which is defined by Line 2 in Fig 4.4, where typical damping for common materials is defined by Line 3. The greater the ratio, the fewer oscillations required before equilibrium is achieved.

Fig 4.4 Damping Ratios



5.0 Impact and Shock Isolation - Basic Theory

Shock is created by impact of one mass against another, e.g. during operation of power presses, forging machines and drop hammers.

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, the deflection wave enters the foundation and the surroundings; with the shock causing the affected masses to vibrate at their own natural frequencies.

5.1 Isolating Impact or Shock Vibration

A reduction in shock severity is achieved by the use of suitable isolators, which work by storing energy from the shock through isolator deflection and subsequently releasing it in a smoother form over a longer period with lower overall amplitude.

A shock pulse may contain frequency components. It is therefore not possible to avoid resonance with the isolator/mass.

Fig 5.1 shows the output force (into the supporting floor) vs. time for a machine-produced shock wave.

In Case 1, the machine under consideration is connected directly to the supporting floor, as shown in Fig 5.2. Case 1 shows a high level of force over a relatively short duration.

Case 2 typifies a machine installed on spring or elastomeric isolators in conjunction with a foundation block, as shown in Fig 5.4.

It can be seen that the same amount of energy is transmitted in both instances. In Case 2, however, the energy is transmitted over a much larger time scale resulting in a substantially lower peak force.

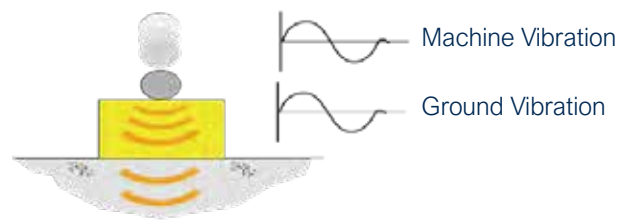
Fig 5.1 Output Force vs. Time Levels From a Machine Produced Shock Wave



1. Rigidly Connected

- ▶ Fig 5.2 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.
- ▶ The force that occurs in the machine is transferred to the structure with the exception of that which is absorbed by the machine.

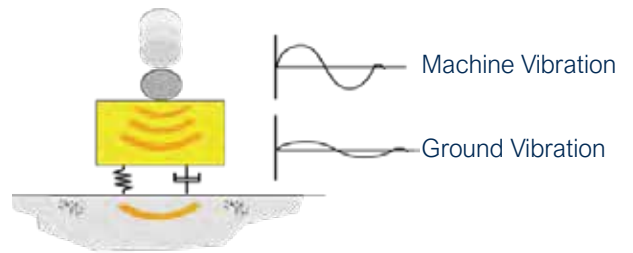
Fig 5.2



2. Using Isolators

- ▶ Fig 5.3 demonstrates the use of elastomeric or spring isolators between the machine and the supporting foundation.
- ▶ 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.

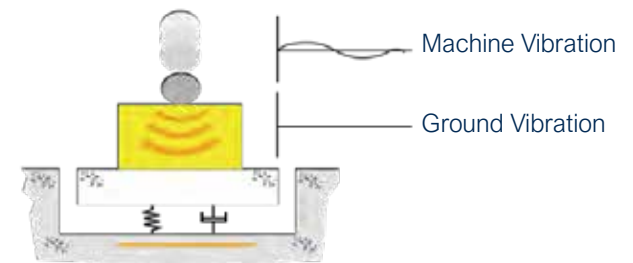
Fig 5.3



3. Using Isolators and Inertia Block

- ▶ Fig 5.4 shows 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.

Fig 5.4



6.0 Isolated Foundation Configurations

Farrat Isolated Foundations combine the use of high performance vibration isolation materials, mass damping and rigid, uniform fixing of the equipment to its foundation.

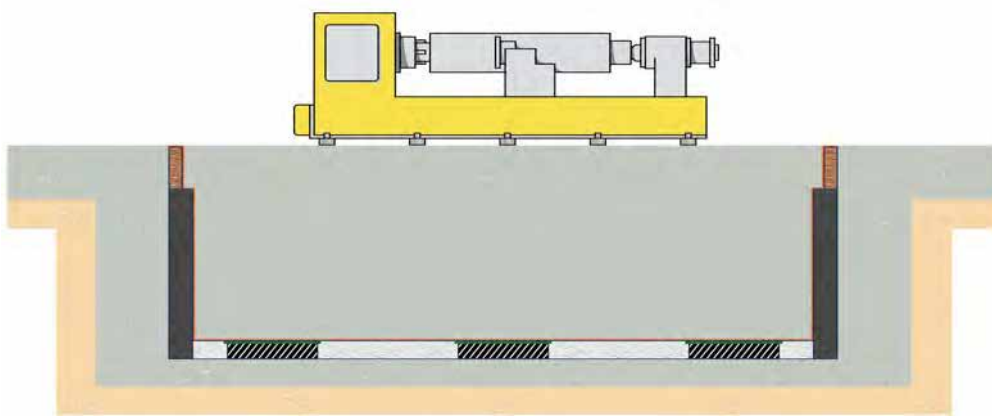
There are two main types of vibration isolation systems:

- ▶ Lateral isolation (walls only)
- ▶ Full isolation (base and walls)

6.1 Full Isolated Foundations

Full Isolated Foundations are typically used where vibration isolation is paramount and therefore requires isolation from the base of the inertia block in addition to the walls. There are a variety of construction types for this system depending on the application, construction and budgets - the most common construction variants are detailed in Types 1 - 3 below (Figs. 6.2, 6.3 and 6.4).

Fig 6.1



Key

- Concrete
- ISOFOAM
- ISOMAT
- Void Filler
- Vidam or ISOFOAM
- DPM (min 1,000 gs/m²)
- Surrounding Ground
- Full Area Base Isolation
- Plywood or Cement Board
- FSL Spring Isolator / Damper

Fig 6.2 **Type 1** For inertia blocks > 1 m high using ISOMAT Pads. See ISOMAT Pads range on Page 13.

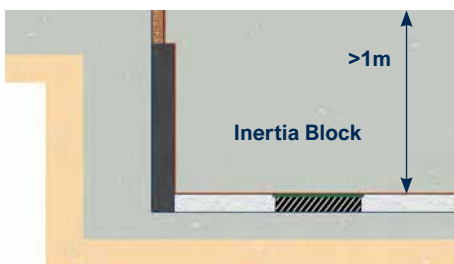


Fig 6.3 **Type 2** For inertia blocks < 1 m high using ISOMAT pads. See ISOMAT Pads range, on Page 13.

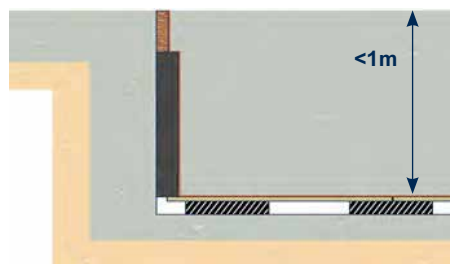


Fig 6.4 **Type 3** For inertia blocks needing full area base support. See full area materials on Page 18



Fig 6.5 **Type 4** For inertia blocks that require spring isolators. See FSL Spring Mounts on Page 21.

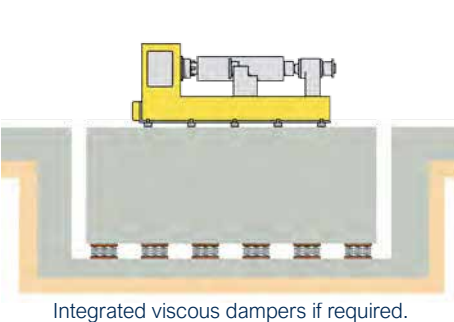
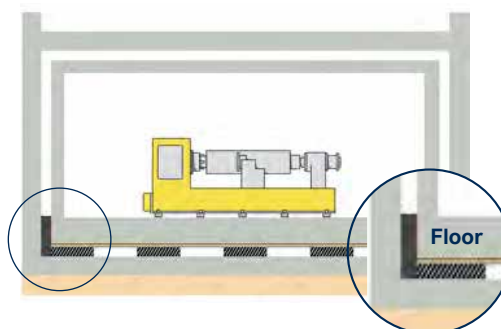


Fig 6.6 **Type 5** For full room isolation (Box in Box). See ISOMAT Pads range on Page 13.



Typical Applications

Types 1-3

- ▶ Presses
- ▶ Forges
- ▶ Pumps

Types 4 - 5

- ▶ Grinders

7.0 Farrat Materials and Products

Farrat have been supplying anti-vibration materials since the 1960s. Our anti-vibration materials & products are distributed worldwide across a wide range of industries and we are proud of the high performance that these materials have provided our customers in their applications.

7.1 Base Isolators

Base Isolators support the mass of the inertia block and machinery whilst providing vibration isolation. Farrat’s knowledge and understanding has been critical when determining the most-appropriate materials and products.

7.1.1 ISOMAT Pads

ISOMAT foundation Isolators are the cornerstone of Farrat’s Isolated Foundation solutions. ISOMAT Pads, with their unique profile coupled with a selection of our elastomers, and thicknesses with extensive testing and experience provide highly predictable performance characteristics over many years of service. ISOMAT is produced in three elastomeric types, as shown in Fig 7.1.



ISOMAT Pads are manufactured by Farrat from 1 m x 0.5 m sheets. For IFD’s, the standard thickness is 50 mm, with 20 mm, 25 mm and 37 mm variants also available. Additional performance can be achieved by stacking pads to achieve a greater thickness, but this is usually not required. The pad sizes are selected to achieve the maximum yield.

The pad reference is the material code + thickness + hardness, where the available rubber hardness is indicated in the table above, e.g. IMBR70-50.

For further details on ISOMAT Pads, download the ISOMAT datasheets [here](#).

Fig 7.1 ISOMAT Pad Properties

MATERIAL CODE	COMMON NAME	GENERAL PROPERTIES & USES	DAMPING FOR SHORE HARDNESS				
			40	44	45	50	70
IMBR	Nitrile	For an excellent combination of elasticity, oil resistance & high damping.				9%	10%
IMCR	Neoprene	For high elasticity, moderate damping and good oil and chemical resistance.			5%		
IMNR	Natural Rubber	For maximum elasticity and low damping (passive isolation). Poor oil and chemical resistance.		2%		3%	

Features and Benefits:

ISOMAT

- ▶ Five material grades / hardness to suit a wide range of applications / load ranges
- ▶ Can accommodate offset centre of gravity (CoG)
- ▶ Can achieve accurate natural frequencies, irrespective of loading

High-quality compounds and manufacturing methods:

- ▶ Low stiffness/high resilience allowing natural frequencies as low as 6 Hz
- ▶ Long service life (50 years+) without deterioration or stiffening
- ▶ Efficient use of material, providing high cost-effectiveness
- ▶ Low ratio of dynamic to static stiffness and low creep rate

7.2 Base Isolator Selection (ISOMAT)

For inertia blocks less than 1 m deep, a slightly different construction is utilised and smaller ISOMAT Pads are generally used.

This is shown as Type 2 in Section 6.1. For this design, please provide Farrat with your requirements so we can offer our best solution.

For inertia blocks greater than 1 m deep (Type 1, Section 6.1), due to the many variants, in order to achieve the best performance / cost ratio, we would suggest that you contact the Farrat Technical Team for a final selection. However, for a general understanding of the selection process we have provided summarised technical details and selection method.

The charts overleaf provide a simple means of determining which pad material and size would be the most suitable to achieve a given dynamic natural frequency.

The charts show performances based on 15% strain. IMBR50 is also shown at 8% strain to indicate the change in performance. Generally, strains between 8% and 15% are the most common.

Example ISOMAT Pad Selection

A machine with a mass of 28 tonnes is to be supported by an inertia block 6 m x 6 m x 1 m deep, with a mass of 88 tonnes. Therefore, the total mass of machine and inertia block is 116 tonnes. This equates to 1,140 kN.

The required dynamic natural frequency is 8 Hz, with good damping to achieve the required isolation. The machine is in a workshop environment, so the material has to be compatible with lubricating oils.

Farrat Solution:

The first step is to determine the most suitable pad material and size. By referring to Fig 7.4, to achieve 8 Hz, with good damping, the most suitable pad size is 121, using IMCR45-50, and, by referring to Fig 7.3, the pad size is 495 x 245 mm.

The next step is to determine how many pads are required. By referring to Fig 7.5 and 7.5.1, for a size 121 pad using IMCR45-50, we can determine the load per pad. In this case it is 57 kN.

Now, as the total load is 1,140 kN, the number of pads required is $1,140 / 57 = 20$ pads. If the centre of gravity (CoG) is central then these would be equally spaced under the inertia block. If the CoG is offset, then the pads would be equally distributed around the CoG.

As for the type of construction, as the inertia block depth is 1 m by referring to page 12, the most suitable type is Type 1, as shown in Fig 6.2, as this can use Voidfiller - the most cost-effective solution.

Fig 7.2 Example IFD Pit Using ISOMAT



ISOMAT Part Reference Example

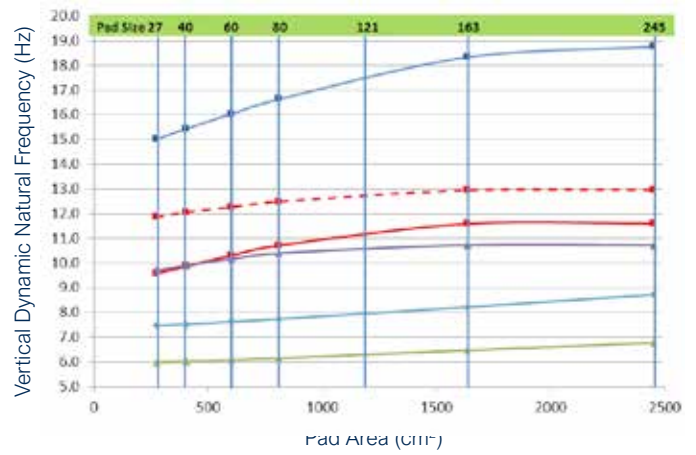
EXAMPLE: IMBR70-50-121

ISOMAT Pad, 70 = shore hardness of Nitrile,
50 = thickness, 121 = size of pad.

Fig 7.3 ISOMAT Pad Dimensions

ISOLATOR SIZE	L (cm)	W (cm)	AREA (CM ²)
27	165	165	272
40	165	165	404
60	245	245	600
80	330	245	809
121	495	245	1,213
163	495	330	1,634
245	495	495	2,450

Fig 7.4 Performance for 50 mm Thick ISOMAT



KEY

- IMBR70-50
- IMNR50-50
- IMBR50-50 8%
- IMCR45-50
- IMBR50-50
- IMNR44-50

*This is at 8% strain. All others are at 15% strain.

Fig 7.5 ISOMAT Pad Performance Showing 15% Strain

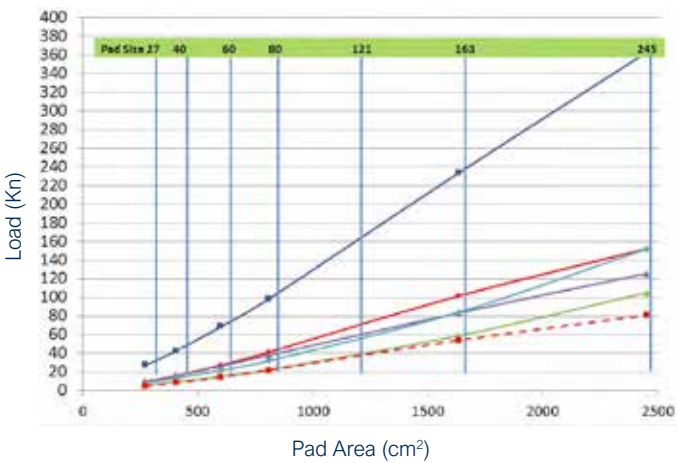
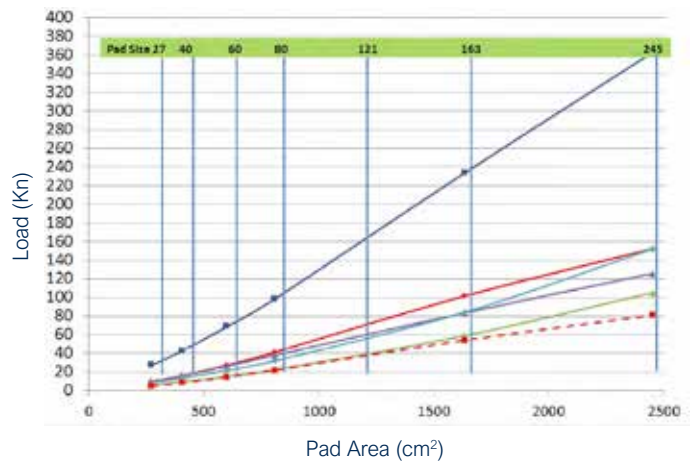


Fig 7.5.1 Zoom of Fig 7.5 (as indicated in blue box)



7.2.1 Base Voidfiller



Voidfiller

Farrat Voidfiller is a cost-effective material used predominantly in Type 1 foundations (where the inertia block is greater than 1 m deep), to fill the area between ISOMAT Pads.

This material supports the wet concrete until it hardens, then over a few hours, creeps under the load to allow the ISOMAT Pads to take the full load and perform.

For further details on Voidfiller, contact our [Technical Team](#).

7.3 ISOMAT Isolated Foundation Installation Guidance

7.3.1 “Types 1 & 3” Construction Types

STEP 1

- ▶ Lay strips of the base Voidfiller (white) around the periphery on the floor, ensuring no gaps between the strips or the walls.
- ▶ Then, adhere the ISOFOAM (black) and top strip to the walls, on top of the Voidfiller, using Farrat-supplied adhesive.
- ▶ This operation is very simple and quick using Farrat's latest adhesive roll, which can be applied in a few minutes per sheet.

STEP 2

- ▶ Lay the base Voidfiller (white) on the floor, then cut holes according to the outline drawing provided by Farrat to accommodate the ISOMAT base isolators (green).
- ▶ No adhesive is required at this stage, and again, this is a relatively simple process.
- ▶ The yellow tape is a sealing tape provided by Farrat to seal any small gaps between the sheets and the isolators.

STEP 3

- ▶ Apply the clear damp-proof membrane (DPM) and seal with tape. The pit is now ready for the rebar cage (if required).
- ▶ The base isolators have a steel top plate (green), designed to support the weight of the rebar. Do not support the rebar on top of the Voidfiller!
- ▶ Where rebar cage is constructed outside of the pit, then we suggest pouring 25 - 50 mm of concrete (blinding) first, then construct the cage and pour the rest of the block.
- ▶ The first 200 - 300 mm of concrete should be poured and allowed to cure before the remaining concrete is poured. This initial concrete layer provides the rigid base to ensure the base isolators support the full mass of the inertia block.



NOTE: The Voidfiller is sacrificial to prevent the concrete being supported directly by the sub-base.

7.3.2 “Types 2 & 5” Construction Types

STEP 1

Bond the isolation strips to the perimeter wall (usually ISOFOAM)

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STEP 2

Place the isolators at 600 - 610 mm centres, depending on the plywood / cement board sheet size. Typical sizes in UK are 2,440 mm x 1,220 mm, or 2,400 mm x 1,200 mm.

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STEP 3

Place covering sheets onto the isolators and screw into place by screwing into some of the corner isolators.

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STEP 4

Lay DPM into the covering sheet and above the wall isolation strips. Overlay by 300 mm and seal with Farrat-supplied sealing tape.

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STEP 5

Lay reinforcement mesh (if required) on spacers to prevent damage to DPM.

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STEP 6

Pour concrete slab.

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7.4 Full Area Isolation Matting

Farrat's wide range of full area isolation materials cover a wide spectrum of performance and price, covered by four material grades and three standard thicknesses of 12.5 mm, 25 mm and 50 mm.

Three of the material grades are Verlimber, which is a range of high-grade vibration isolation, high-quality polyurethane using an innovative blown expansion method. The three grades offer a wide choice of performance and thickness - ensuring the most cost-effective solution - and are used where high levels of isolation are required.

The remaining material is Favim, which is a medium performance, cost-effective material manufactured from high-quality recycled rubber and foam granulate with polyurethane bonding agent. Favim has been used for many years in general industrial workshop environments.

7.4.1 Verlimber Pads & Favim Pads



Verlimber

Although Verlimber is classed as a "full area" material, we also provide this material as pad design as shown in Section 6.1 (Type 2), due to its high load capacity.

The charts provide a simple guide to help select a particular material for a given application.

For full material properties please see Farrat's Verlimber Datasheets, which are available for download on our website [here](#).



Favim FV10

Favim FV10 is produced from the highest-quality recycled rubber granulate and polyurethane bonding agent in tightly controlled, state-of-the-art manufacturing processes. Favim can be laid without bonding directly onto a consolidated hard-core base where it will, to an extent, compensate for surface irregularities.

This "full area" material can be supplied as sheets or bespoke pads and strips.

For more information on Favim FV10, please refer to the datasheet [here](#).

Verlimber and Favim Selection Method:

To use the selection method, two inputs are required:

1. Pressure from the inertia block & equipment
2. Dynamic natural frequency required to achieve the vibration isolation (see page 8)

By referring to both Fig 7.6 and Fig 7.7, the most-appropriate materials can be readily identified. Fig 7.6 provides a simple means of determining the pressure acting on the material based on the concrete depth alone. The mass of the machine needs to be considered in addition.

Fig 7.7 shows the pressure range for each material regardless of the thickness. From the materials suitable for the pressure, Fig 7.8 allows the most suitable material to be selected with regard to the Isolating performance.

Note: Farrat recommend consulting the relevant material's datasheet for clarification of selection.

Fig 7.6 Depth to Mass of Inertia Block

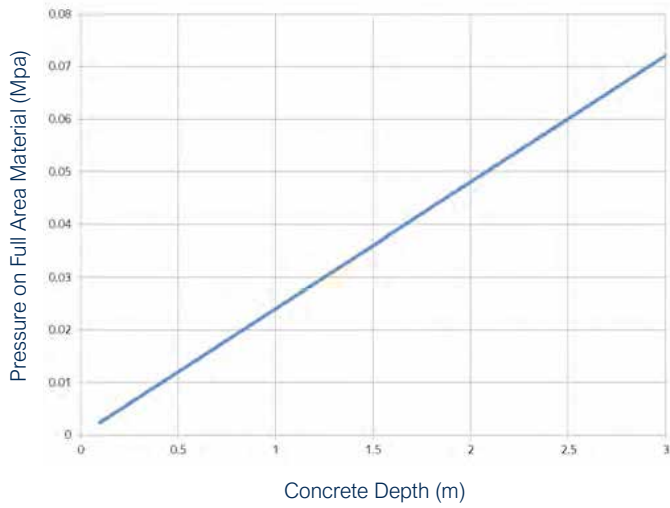


Fig 7.7 Pressure Ratings for Verlimber and Favim

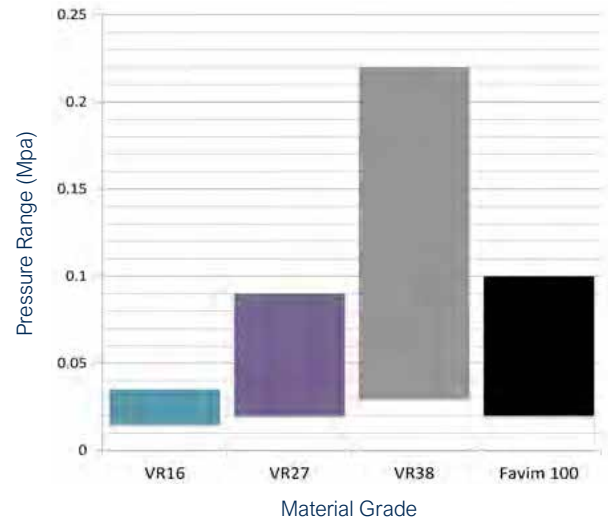


Fig 7.6 Depth to Mass of Inertia Block

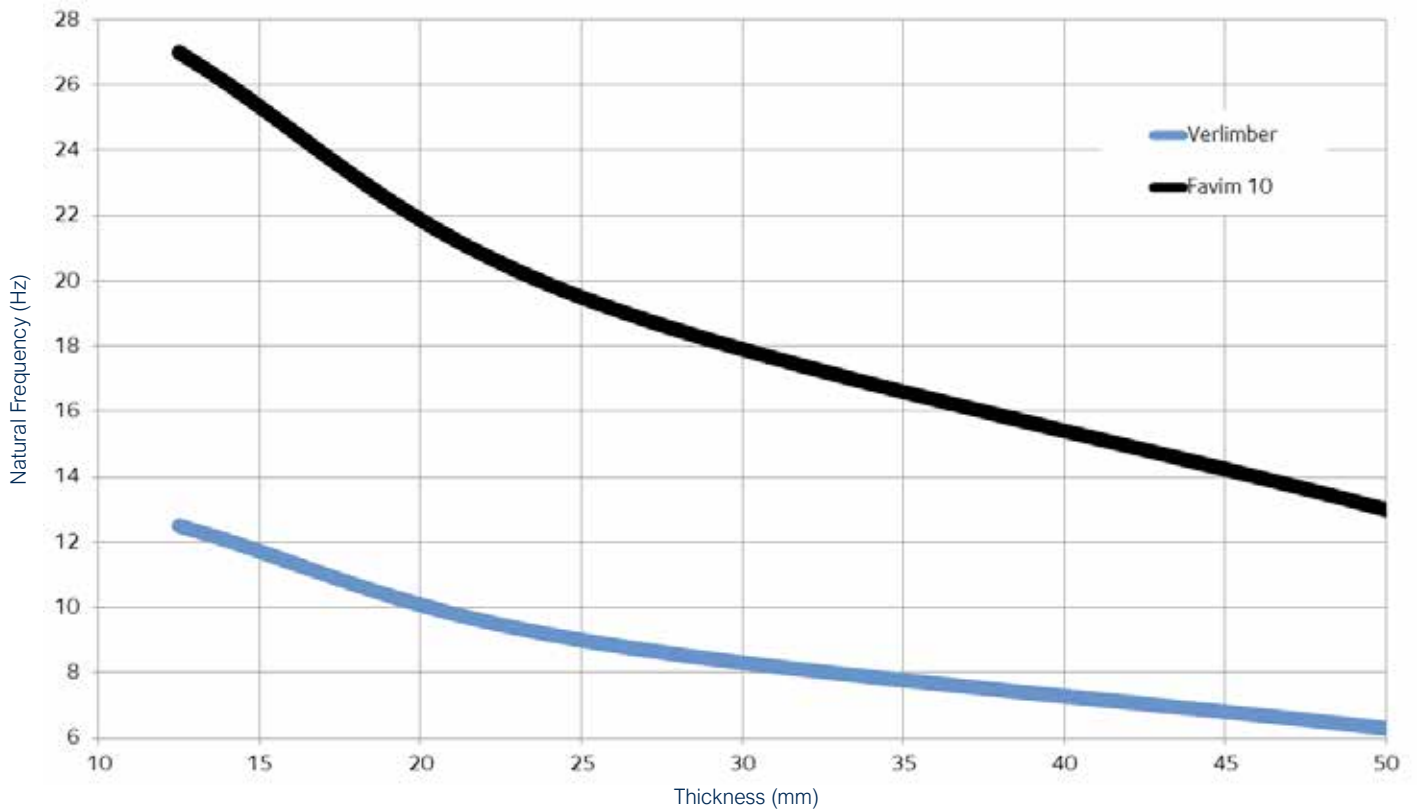


Fig 7.9 IFD Full Area Isolation Matting for a Water Turbine



7.6 FSL & FSLV Spring Isolators

Where natural frequencies are required below 7 Hz (limitation of elastomeric materials), then Farrat's standard range of spring isolators and dampers enable natural frequencies as low as 3.2 Hz to be achieved. Farrat also design bespoke spring units for specific requirements, including frequencies lower than 3.2 Hz.



FSL & FSLV Coil Spring Isolators

Farrat heavy duty structural coil spring isolation systems provide low-frequency vibration isolation for large structures and industrial equipment. FSL coil spring isolation systems are used to provide both active and passive vibration isolation with natural frequencies down to 3 Hz to isolate disturbing frequencies as low as 6 Hz. Where a system is likely to pass through or near to resonance, or where shock vibration is encountered, then it is recommended that the FSLV products are used, which incorporate a viscous damping unit. The standard range of Spring Isolators are detailed in Fig 7.13.

For further details on FSL & FSLV Isolators, download the datasheet [here](#).

Fig 7.13 Farrat Standard Range of Spring Isolators

Part Reference		Length (mm)		Width (mm)	Spring Rate (kN/mm)	Load per unit (kN)		Natural Frequency (Hz)		(Hz) Isolator Height (mm)			Damping Ratio* Un-C/Cc
Un-damped	Damped	FSL	FSLV			Max	Min	at Max Load	at Min Load	Free	Max Load	Min Load	
FSL 1-4	FSLV 1-4	500	500	305	3.4	85	28	3.2	5.5	165	140	157	0.15
FSL 1-6	FSLV 1-6	720	720		5.1	128	42						
FSL 1-8	FSLV 1-8	940	850		6.8	170	56						

Fig 7.14 FSL Coil Spring Isolation System for Structures & Sensitive Equipment

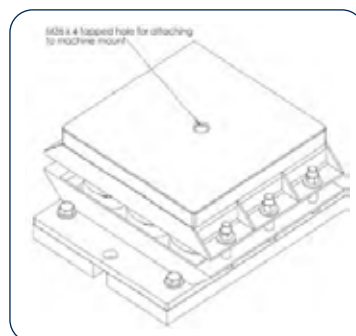


Fig 7.15 FSLV Combined Spring/Damper Unit



7.7 Bespoke Isolators

Depending on the needs of the project. Farrat can design and manufacture bespoke isolators to meet specific customer and project requirements.



7.8 Side Wall Isolation

These materials prevent vibrations from transmitting through the foundation walls (lateral isolation).

7.8.1 ISOFOAM



ISOFOAM has been Farrat's wall isolation material for many years, whether it is for a full isolation system or just lateral isolation. ISOFOAM comes in several grades, selected based on their capacity to withstand the pressure imparted by the wet concrete during the construction. ISOFOAM 120 is the standard grade as it is most cost-effective, and covers most depths of up to 1.5 m in one pour. The standard thickness is 50 mm, but other thicknesses can be provided, depending upon the application.

For further details see Farrat's ISOFOAM datasheet [here](#).

Fig 7.16 Concrete Hydrostatic Pressure for Rate Rise and Depth

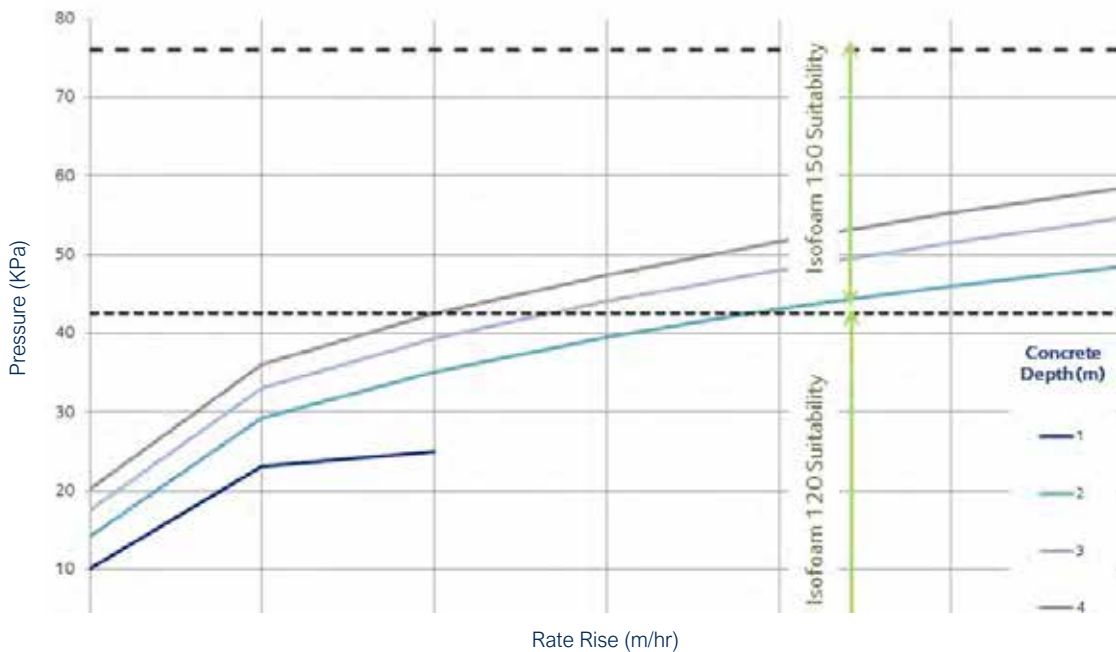


Fig 7.17 Typical ISOFOAM Grades Within a Laterally Isolated IFD

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Construction Method:

- ▶ A selection of ISOFOAM grades are available depending on the depth of the pit.
- ▶ Farrat ISOFOAM or Vidam is used for the top strip. Allow between 20 and 30 mm above for the polymeric sealant.
- ▶ The foundation block & side walls are in accordance with the structural engineers requirements for load-bearing capacity.
- ▶ The damp-proof membrane prevents wet concrete from bridging the isolation.
- ▶ If the concrete rise rate can be controlled, then to ensure ISOFOAM 120 is used (as the more cost-effective solution), refer to Fig 7.17, which provides guidance on the rate of rise.

7.8.2 Top Strip

The top strip has a “tear strip”, which once the concrete is set, allows the top 20 mm to be pulled out to enable the application of sealant.

Fig 7.19 Farrat ISOFOAM Side Wall Isolation



Fig 7.18 Farrat ISOFOAM or Vidam Top Strip detail

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Fig 7.20 ISOMAT IFD with ISOFOAM Top Strip



Fig 7.21 ISOMAT IFD with Vidam Top Strip



8.0 Case Study

8.1 Sahil & Shah Full Field Development Project, Abu Dhabi

Client: Tècnicas Reunidas & Intec Plantas Industriales, S.A.

Equipment: Nuovo Pignone High- & Low-Pressure Compressors

Challenge

Spanish design company Tècnicas Reunidas (part of Initec Plantas Industriales group of companies) approached Farrat with a view to providing both products and specialist engineering consultancy support as a part of a \$3.5 billion engineering, procurement and construction project - Sahil & Shah Full Field Development Project for Oil and Gas. The client had not previously considered vibration control; therefore, the design was very closely monitored and controlled due to the critical requirements of the equipment.

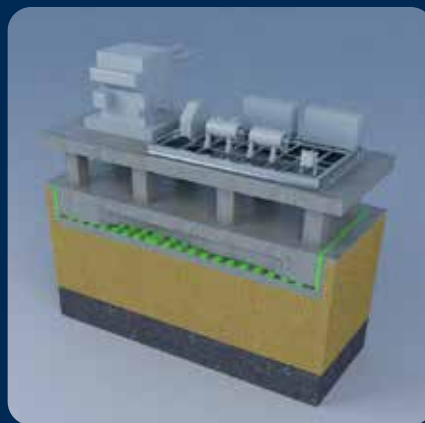
There were some key questions posed by the design process. A series of compressors were to be constructed on desert sand of roughly 5 metres depth, meaning that vibration had to be minimised in order to prevent the installation sinking. Further challenges came in the form of the high-temperature operating conditions and the complex load distribution of off-centre rotating equipment such as the large electric motor and associated compressor equipment skid.

The compressors needed to be located 3.7 metres above ground level to meet up with the pipelines and were being installed in a location subject to an ambient temperature of 58 °C within an open shelter. We were also required to advise on management of the installation process - being undertaken by unskilled labour and in a remote location in the middle of the desert, 200 km south of Abu Dhabi.



Farrat's technical expertise and their close communication at all stages of the project ensured a successful solution to our unique challenges.

Félix Ustáriz
Civils & Structures Manager,
Initec Plantas Industriales, S.A.



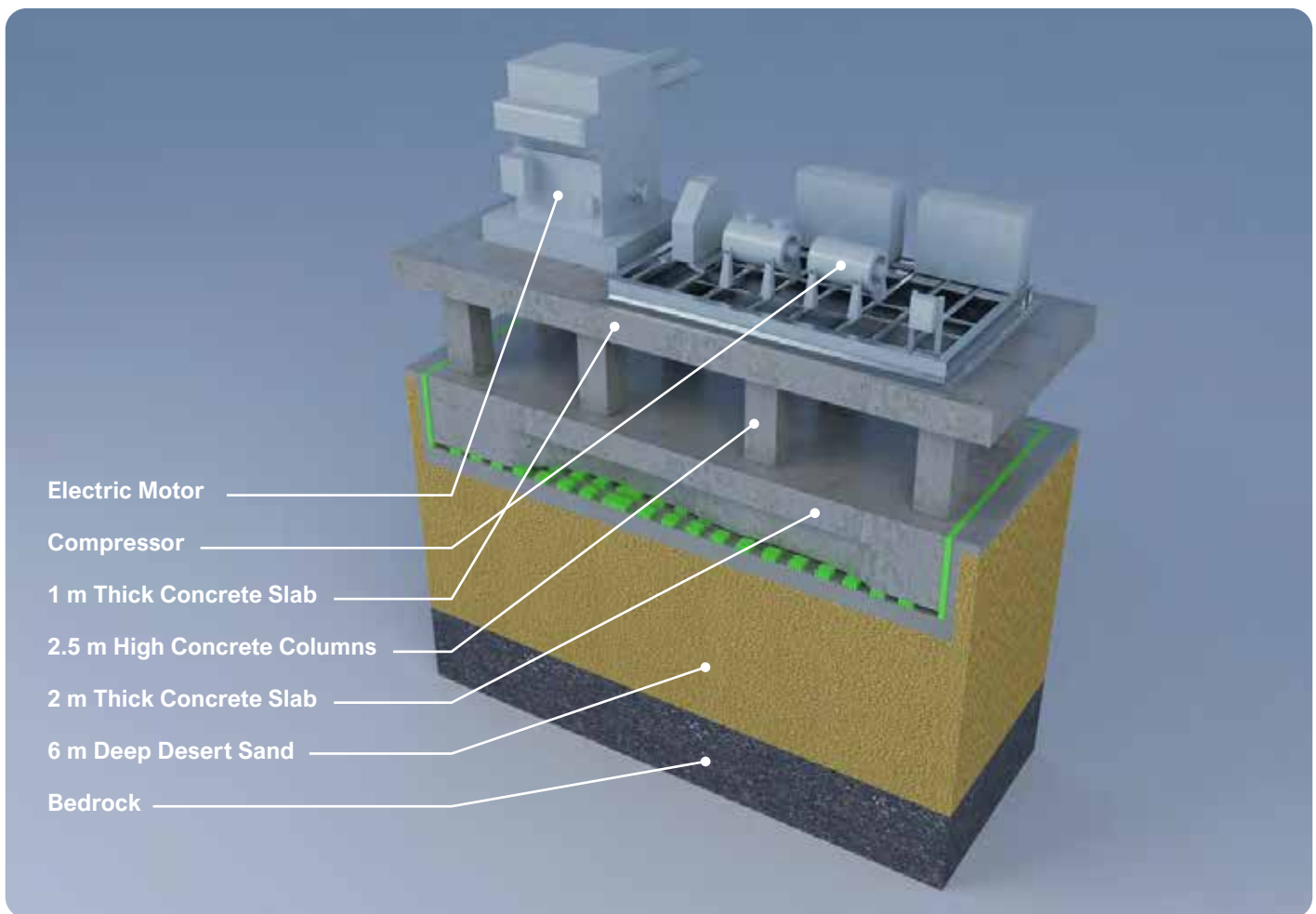
Solution

By the very nature of their high speed and powerful operating requirements, pumps and compressors can cause significant noise and vibration disturbance. On such a high-cost project, it was vital that Farrat guide the client, who had limited experience of isolated foundations, throughout the process.

We provided highly detailed information as well as developing detailed static and dynamic performance calculations of the isolated foundation system. We then developed a detailed budget to include all materials for the execution as well as the works supervision on site. We were guided by very strict delivery demands, which we had to fulfil in order to get the items delivered to Abu Dhabi, and we ensured the utmost in flexibility to the client's needs when it came to supervising the installation.

Key Facts

- ▶ System natural frequency: 8 Hz
- ▶ System Deflection: 6 mm
- ▶ Number of isolators supplied: 348
- ▶ Total machine and foundation mass: 1,112,000 kg



Case Study

8.2 Voith Paper

Client: Voith Paper

Structural Engineer: CCL Engineering

Equipment: Waldrich-Siegen Roll Grinder

Challenge

Voith Paper, a division of Voith GmbH, is a leading supplier in the international paper industry, supporting all aspects of the paper making process from fibres to end products. The company has global revenues in excess of £1.7 billion and one third of global paper production is performed on Voith Paper production systems.

Voith was keen to move and install a very large reconditioned Waldrich Siegen roll grinder from Korea to Voith Paper in Manchester - the main purpose of this unit would be to grind paper machine rolls for one of the world's largest paper mills. As the client was initially unsure if vibration isolation was required, Farrat suggested Univib undertake a survey which verified that there were low levels of vibration in the ground.

Whilst the actual vibration levels were low it was decided that it would be worth investing in a 7 Hz vibration control system as a precautionary measure in case of vibrations from overhead cranes, future developments and adverse impacts from dropping components.



Farrat were extremely supportive in terms of survey, product supply and their guidance of the installation process.

Steven Walls
Facilities Manager, Voith Paper



Solution

Farrat engineered an holistic solution to the identification and mitigation of shock and vibration on this project. In conjunction with the structural engineer, we decided that an ISOMAT Isolated Foundation system would provide the ideal combination of vibration isolation, damping and sensible cost in order to respond to the client's unique requirements. This solution combines an ideal blend of vibration isolation and damping as well as being maintenance free and extremely durable in terms of ongoing performance.

Farrat also provided calculations to predict deflections during construction and operation as well as dynamic natural frequency and foundation movement due to changing load conditions.

After being supplied with the complete system, including more than 100 isolators, the client completed the installation themselves, quickly and efficiently based on Farrat's instructions.



Key Facts

- ▶ 2.75 to 1 ratio of total machine + component + foundation / machine + component mass
- ▶ 100 ISOMAT IMCR70-50 Isolators



Case Study

8.3 Union Electric

Client: Davy Roll (Union Electric)

Structural Engineer: CCL Engineering

Equipment: Churchill Roll Grinder

Challenge

Part of Union Electric Steel, Davy Roll is a major European supplier of cast rolls to the global metalworking industry, with a capacity in excess of 20,000 tonnes per annum. The company approached Farrat with the objective of moving a Churchill roll grinder from Midland Roll in Crewe to Davy Roll in Gateshead. The engineer, who had already designed several foundations for the client, contacted us with a view to designing a bespoke isolation system.

Roll grinders present a unique set of challenges as they are not only high precision machines but they are also large-volume equipment - a single unit often measures up to 10 metres in length with mass up to 400 tonnes. The machines are long and thin; they have a fixed headstock, but the tailstock location will vary depending on the length of roll.

There are two key aspects to the unit: a roll bed to carry components; and a wheel head bed, on which the grinding head traverses along the roll. The machines are generally installed in areas where there is significant risk of shock and vibration but they are simultaneously required to have lengthy periods of uptime. Any disturbances can potentially lead to a reduction in accuracy and so the effective control of shock and vibration is vital.



Farrat provided vital expertise that helped us to get the most out of this high-value equipment.

John Caffrey
Facilities Manager, Union Electric



Solution

Farrat proposed an ISOMAT Isolated Foundation system where the isolators could be evenly spaced, taking the load pattern of the machine into account under the machine, which meant the foundation design could be simplified with a lower stiffness than if it were to be installed on coil springs. The SOMAT Isolated Foundation system essentially involves the creation of a reinforced concrete foundation pit which is then fully lined with Vibration Isolating Materials. A reinforcement cage is then placed into the pit and it is filled with concrete to create an isolated inertia block onto which the machine can be placed.

The aim of this solution was to minimise the effects of any changes in load and centre of gravity whilst still providing a highly effective vibration isolation system. The ISOMAT Isolated Foundation system also had the benefit that it provided a sealed isolated floor so the void could not become contaminated.

A very stiff machine-to-foundation connection was critical to the overall operation of the machine and also to obtaining the maximum benefit from mass damping effect of an isolated foundation block. This was demonstrated at a later date, as the client was having problems with reverberations in the machine bed caused by a lack of support stiffness from the levelling screw supports.

Farrat supplied wedge levelling elements as intermediate supports - resolving the problem.



Key Facts

- ▶ System dynamic natural frequency: 9 - 10 Hz
- ▶ 120 ISOMAT IM-BR-50-50 Isolators

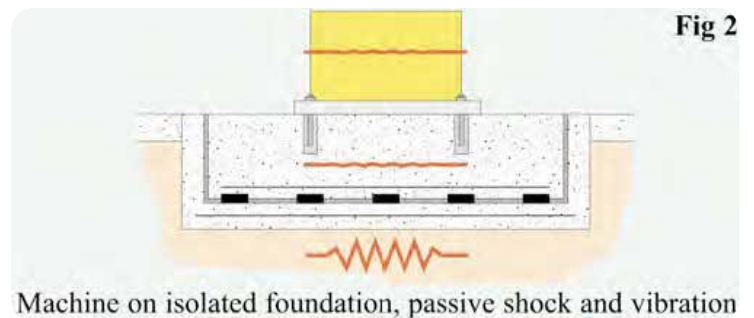
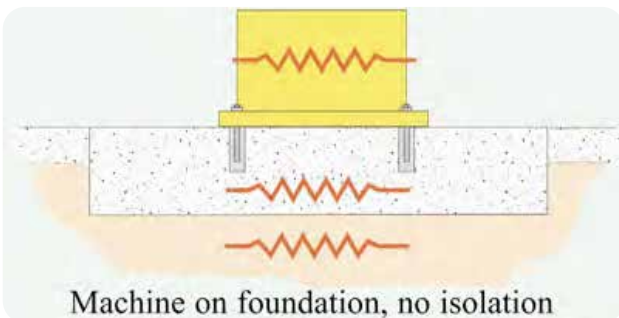


Fig 2

Case Study

8.4 Daily Mail Printing Press

Main Contractor: Bowmer & Kirkland

Structural Engineer: URS Scott Wilson

Equipment: Cerutti Flexo Printing Press

Challenge

This project followed the successful £82 million completion of a new state-of-the-art printing facility at Didcot for Harmsworth Quays Printing Ltd on behalf of the Daily Mail. The printing and production operation incorporated a Cerutti Flexo printing press producing newspapers in colour with non-rub-off ink.

The new press site was to be set in ten acres and would house four S4 Cerutti flexographic presses, which can print up to 80,000 copies an hour. Once fully operational, the centre would be printing 3.2 million copies a week of the Daily Mail and Mail on Sunday, and 350,000 copies of regional titles. Printing presses offer a unique challenge as they simultaneously operate at high speeds and also need to achieve a high level of precision in the print output.

The client and their structural engineers were worried about the vibration from the Great Western main railway line adjacent to the building and vibration from the printing press itself affecting the offices built alongside. An additional challenge was the mass of the printing press in question, which had a total weight, including printing press, folding units and reel stands, of 3,721,056 kg.



You can stand with one foot on the foundation and the other on the floor next to it and notice the absolute reduction in vibration.

**Design Manager,
Bowmer & Kirkland**

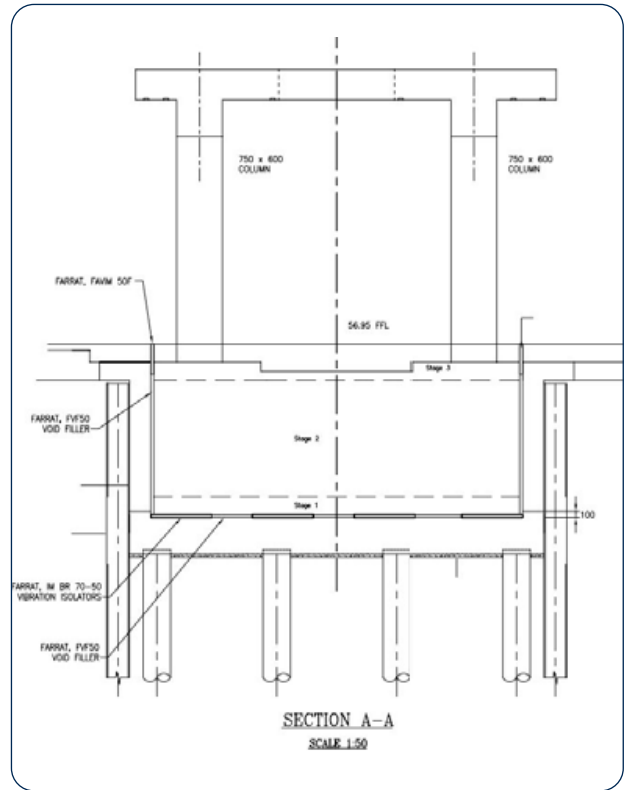


Solution

Printing presses are highly complex structures made up of numerous internal rotating parts, each of which could produce out-of-balance forces. As a result, Farrat prioritised the identification of the operating speeds and resonant frequencies from within the machine before a suitable isolation system could be designed as it was critical to avoid any of these disturbing frequencies. A full analysis of the machine structure was established by taking a 3D model of structure from the press manufacturer. Based on the findings of the analysis, Farrat designed a bespoke ISOMAT Isolated Foundation system with a dynamic natural frequency of 10 Hz with approximately 10% damping.

The foundation, which formed the backbone of the machine, was then designed. This needed to be 94 metres long and 6 metres wide but the depth was still to be determined. Such large printing presses are tall, narrow structures where the reel stands are at ground level and the press, which contains most of the weight, is supported by columns built off the isolated foundation block. In this case a 2.8 metre deep block was designed to provide sufficient stiffness for the modular machine as well as to lower its centre of gravity.

To complete the process, Farrat manufactured the isolation system, which was then installed under close supervision.



Key Facts

- ▶ 200 IMBR70-50 1000 x 500 ISOMAT Isolators
- ▶ Favim 100-50 top strip
- ▶ FVF10-50 base void former
- ▶ FVF15-50 void former for the walls
- ▶ Order value: £85,000



Case Study

8.5 Kaleva Printing, Finland

Main Contractor: YIT Construction

Structural Engineer: Pöeyry Civil Oy

Equipment: Manroland Colorman Printing Press

Challenge

Kaleva Printing House is the head office of the newspaper Kaleva, the main newspaper of Northern Finland. Parent company Kaleva Oy (Ltd) is the largest diversified multimedia company in Northern Finland and the fourth largest daily newspaper in Finland with a circulation of 78,216 and 192,000 readers. The group's main operations are the publishing and printing of daily and free-distribution newspapers, as well as production of digital services. In addition, the group offers sheet printing, advertising and distribution.

Pöeyry Civil Oy was commissioned to design the foundation for a large Manroland newspaper printing press at a new print facility in Oulu in the north of Finland. Pöeyry was concerned about the vibration from the printing press adversely affecting the offices built alongside. The company was already aware of Farrat's expertise and the benefits of the ISOMAT Isolated Foundation system for this type of project and so proceeded to design a system based on Farrat's literature. However, they would require remote assistance and guidance in the final, critical stages of the procurement and installation process.



Despite being based in another country, Farrat provided a highly efficient and clearly defined solution.

Teuvo Tuomine
Vice President, Pöeyry Civil Oy



Solution

The key issue to avoid with this type of application is low-resonance -frequency effects between the press and the surrounding floor, building structures and subsoil. Based on specific experience from previous projects, Farrat designed an ISOMAT Isolated Foundation system with a dynamic natural frequency of 10 Hz with approximately 10% damping. This system offers a simplified foundation design as well as being economical and easy to install.

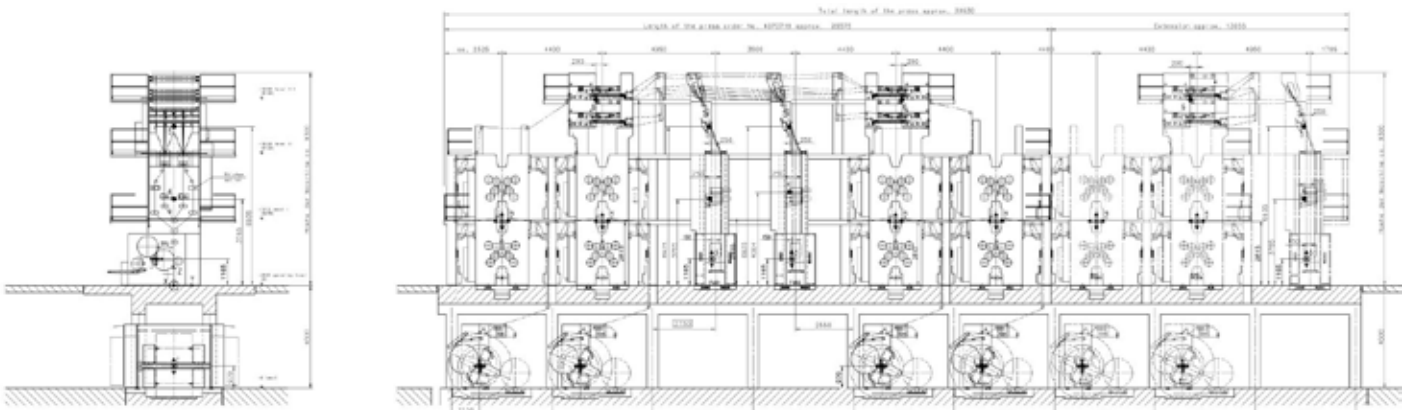
The foundation, which formed the backbone of the machine, was subsequently designed. It needed to be 42 metres long and 5 metres wide, but the depth was still to be determined. Such large printing presses are tall, narrow structures where the reel stands are at ground level and the press, which contains most of the weight, is supported by columns built off the isolated foundation block. In this case, a 2.8 metre deep block was designed to provide sufficient stiffness for the modular machine as well as to lower its centre of gravity.

Farrat worked with a local agent in Finland to provide local expertise and support on both the supply and installation of the Farrat system - leading to a successful installation by the client.



Key Facts

- ▶ The total weight of the printing press, folding units and reel stands was 791,500 kg
- ▶ Order value: £46,000
- ▶ 208 ISOMAT isolators as well as ISOFOAM top strips and FVF void formers



Case Study

8.6 AFRC/Strathclyde Uni

Main Contractor: ROC

Structural Engineer: The Structural Partnership

Equipment: Hypostyle Architects

Challenge

Farrat were tasked with providing a floating floor for a precision coordinate measuring machine (CMM) at the cutting edge Advanced Forming Research Centre on the Strathclyde University campus. The university is a leading international centre for engineering research and is the result of a cross-sectoral collaborative partnership between leading academic institutions.

The machine, used for performing demanding measuring tasks in laboratory and production environments, is extremely heavy with only three support feet each loaded with 17 kN point loads - which would in turn cause high pressure loadings on the floating slabs. There would also be other equipment of varying loads to go on the slab and the layout was regularly altered leading up to the final layout. All of this contributed to a fairly demanding design and installation process.



On what was a highly bespoke job, we appreciated the high level of technical proficiency demonstrated by Farrat.

John Mitchell
Team Leader / Technical Manager,
ROC Building Ltd



Solution

Working in close partnership with all parties including the Structural Engineer, Architect and Main Contractor, Farrat came up with a solution which would meet the specific challenges posed by this unique R&D laboratory application.

In the end it was decided to split the slab to provide appropriate load bearing on one slab with an imposed loading of 8kN/m² where the CMM was to be located and imposed loading of 3kN/m² for other equipment on the second slab.

AcouStruct installed the dry systems, then handed over to the client to install the mesh and pour the concrete slab.



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Key Facts

- ▶ Slab thickness: 123 mm
- ▶ Natural frequency: 10 Hz



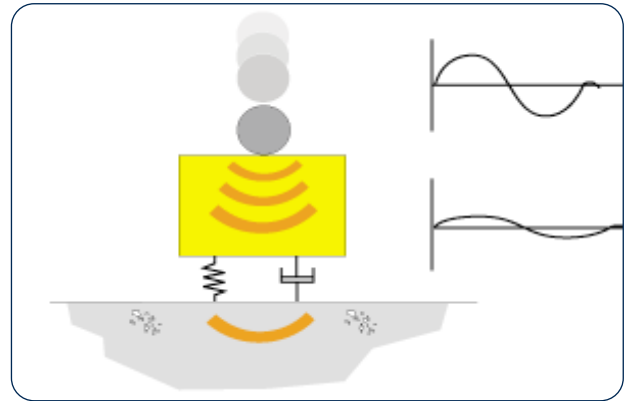
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Additional Farrat Solutions

Industrial Vibration Control (IVC)

Our rich and varied history, coupled with cutting edge and ever-improving techniques, makes us the ideal choice for resolving vibration, noise and shock problems. We support OEMs and end users throughout the industrial vibration control process, from fact-finding to concept and detailed system design to installation.

Products engineered and manufactured by Farrat for Industrial Vibration Control include: Isolated Foundations, Isoblocs, FSL Isolators and Anti-Vibration Materials, Washers & Bushes.



Support & Levelling of Industrial Machinery

Whether you are relocating existing machinery, a machine manufacturer, or simply require a better solution for your existing installation, Farrat can help. We have been designing and manufacturing high-performance machine mounts and machinery installation systems since the 1960s.

We offer a portfolio of standard products which are used in a very wide range of industrial and power generation applications all around the world. In addition to the standard products, we can design and manufacture bespoke solutions as well as source non-Farrat products to meet the precise requirements of the specific application and its environment.



View our full range online at: www.farrat.com