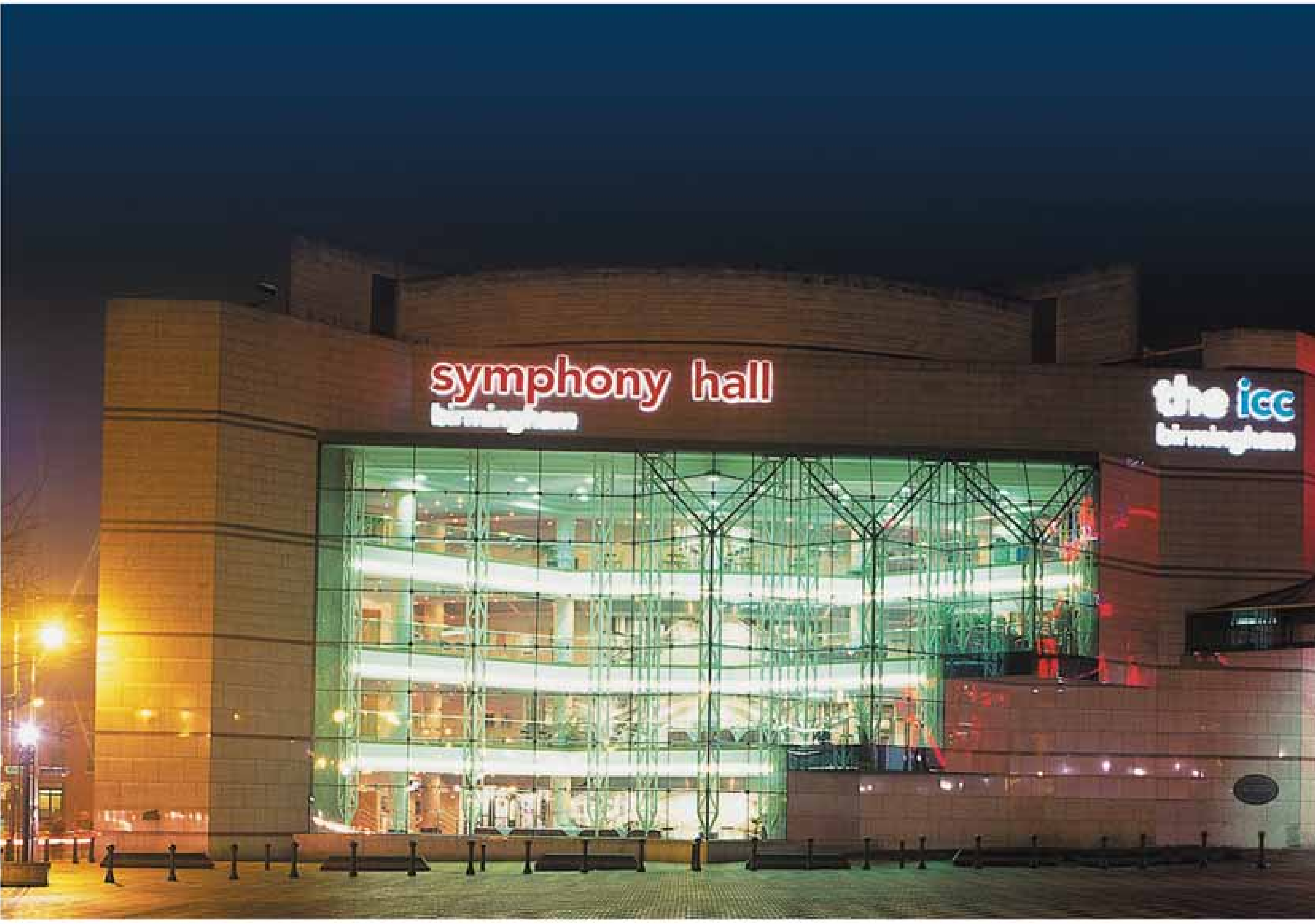
ANDRE

Structural Bearings for Seismic, Vibration and Acoustic Isolation



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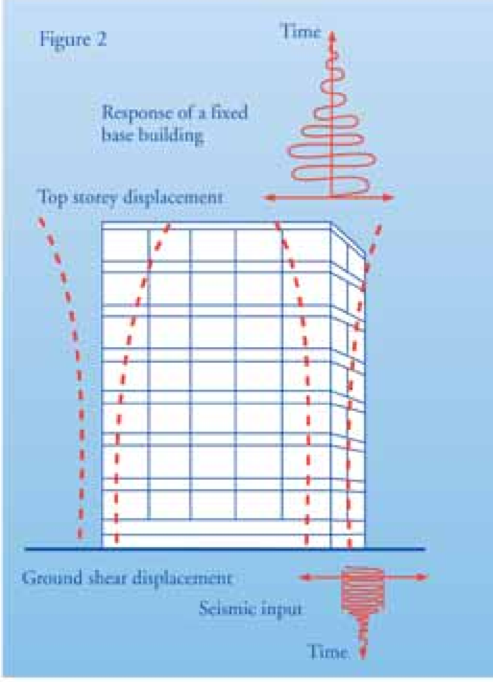
ENGINEERED SYSTEMS

Profile

The Andre brand of structural bearings was first developed in the 1950's to support bridges. Initial projects completed included Pelham Bridge in Lincoln and the Hunts Kennel Highway Bridge in the United Kingdom. From these early beginnings Andre further developed laminated natural rubber bearings to support and isolate buildings.

Andre was the first company in the UK to isolate buildings from vibration. Albany Court apartment block in London became the world's first building to use Andre laminated natural rubber bearings, for vibration isolation from St. James Park Underground Railway Station.

Today, Andre designs and manufactures elastomeric steel composite bearings to support and isolate a variety of buildings. Recent projects include vibration isolation of the Metropole Hotel in London, acoustic protection of The Royal Concert Hall in Covent Garden and seismic protection of buildings such as The Los Angeles Cathedral (Our Lady of the Angels) and 911 Emergency Operations Centres in the USA.



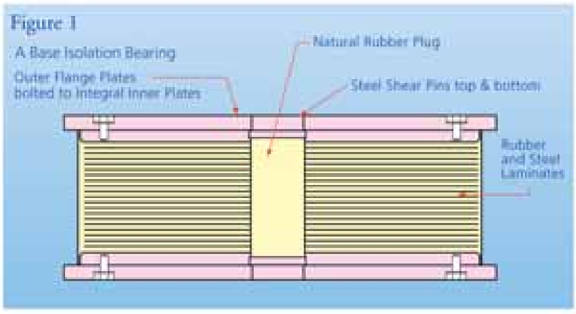
Isolation Principles

The isolation of a building is achieved using composite bearings that are usually manufactured of rubber and steel, placed between the ground and the structure to be protected. As the bearings are designed to be flexible they greatly reduce the transmission of vibration from any disturbance to the structure. The bearings do not however absorb the energy of the disturbing vibrations from the ground, but prevent energy transfer by mismatching the frequencies between the ground borne vibration and the structure.

Isolation Bearings to operate efficiently must:-

- Support the weight of the building and its contents.
- Confer a horizontal natural frequency on the building that is below the ground borne dominant forcing frequency (Seismic isolation).
- Confer a natural frequency on the building that is below the ground borne dominant forcing frequency (Vibration isolation).
- Provide a restoring force to return the building to its at rest position (Seismic isolation).
- Reduce the transfer of resonant vibrations.
- Have proven longevity in service.
- Provide long term stability against the effects of ageing.
- Accommodate large horizontal displacements of a building in relation to the ground while still safely supporting the building (Seismic isolation).

Andre High Damping Rubber Base Isolation Bearing installed under a ground floor beam of a 911 Emergency Operations Centre.



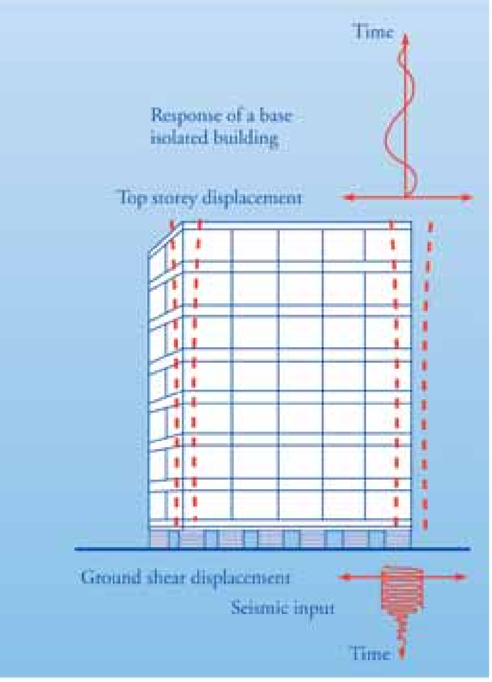
Andre High Damping Rubber Bearings under shear test on a 4000 ton bi-axial test machine.

Bearing Design

Laminated natural rubber bearings comprise of a number of rubber and steel layers as shown in Figure 1. The thickness and the number of rubber layers influence the horizontal and vertical stiffness characteristics of the bearing and its load carrying capability.

Bearings designed specifically for seismic isolation need to have a high vertical stiffness. This is achieved using comparatively thin layers of rubber. The horizontal stiffness and the displacement capacity of each bearing is determined by the overall combined height of the rubber layers.

In comparison, bearings designed for vibration isolation need to deflect vertically by several millimetres and are therefore designed with thicker rubber layers.



Seismic Protection

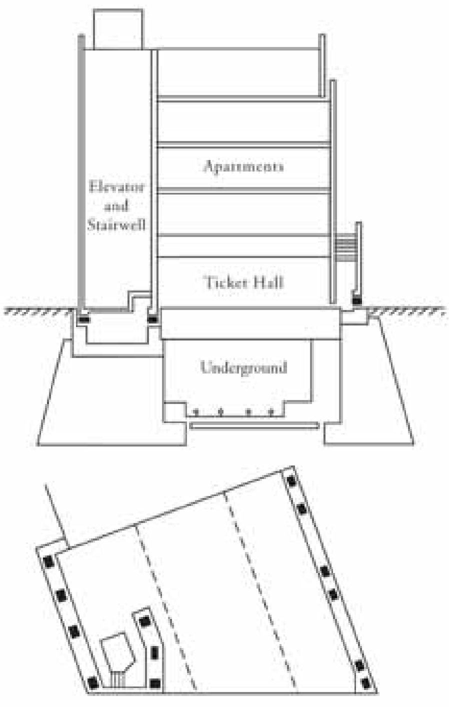
A typical seismic response in ground consisting of rock or firm soil shows that maximum horizontal damage will occur within a structure that has a horizontal natural frequency of between 2 Hz to 5 Hz. Many stiff, medium-sized structures have natural frequencies in this region and therefore resonate in sympathy with a seismic event with accelerations in the ground amplified through the structure.

If the structure is modified so that its natural frequency of horizontal vibration is reduced below 1 Hz the damage caused by a seismic event is greatly reduced. The behaviour of a fixed base and base isolated typical five-storey shear wall structure to a large seismic event is shown in Figure 2.

Modification of a structure to tune its dynamic performance is achieved with the introduction of either Andre high damping natural rubber bearings or a hybrid arrangement of Andre resilient natural rubber bearings, steel hysteretic dampers or Andre slider bearings that are positioned between the ground and the structure.

As a seismic isolation system, Andre slider bearings when used in conjunction with Andre resilient natural rubber bearings are becoming increasingly recognised as an effective system, particularly suited to lightly loaded buildings. The slider bearing not only supports the building but acts as a friction-damping device providing supplemental system damping.

Figure 3



Vibration and Acoustic Protection

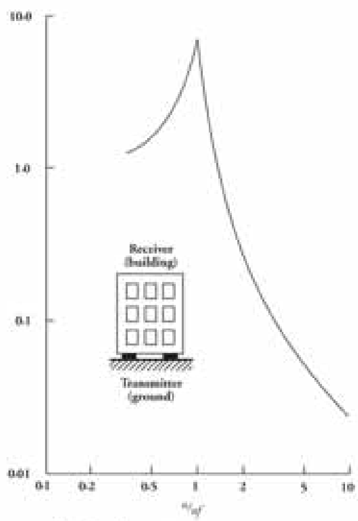
Figure 3 depicts an apartment block built over an underground railway station. The transmission of the vibration into the building from passing trains is significantly reduced with the installation of the isolation scheme shown.

Bearings of this type are designed and manufactured to confer a natural frequency to the isolated structure as low as 3 Hz with typical frequencies generally in the range of 8 Hz to 10 Hz. Base isolation of this type provides approximately 90% of isolation from disturbing frequencies above 30 Hz.

A high level of isolation against a given disturbing frequency requires the isolated structure to operate at a lower natural frequency. The ratio of disturbing frequency to natural frequency is referred to as the frequency ratio. The higher the frequency ratio the more effective the isolation efficiency.

The effectiveness of base isolation bearings is generally presented in the form of a transmissibility response which for Andre resilient natural rubber bearings is detailed in Figure 4. This shows how the transmissibility or the ratio of the vibration amplitude on the protected side of the bearing to that of the disturbing vibration, varies with frequency ratio. A frequency ratio approaching unity or resonance is to be avoided, as source vibrations will be significantly amplified into the structure.

Figure 4



n = forcing frequency
nf = natural frequency of isolated structure

Andre vibration isolation bearings have the capability of operating as effective isolators under compressive stresses in excess of 12 MPa. Space efficient bearings, as shown in Figure 5 can therefore be offered.

Figure 5

Andre Resilient Natural Rubber Bearings installed under The Disney Concert Hall, Los Angeles.


Figure 6


Figure 7


Figure 8

BNFL Nuclear Waste Pipeline, Sellafield
Kang Nam Tower, Seoul, Korea
Los Angeles Cathedral, (Our Lady of the Angels) - Figure 6
Barbican Centre, London
Hearst Memorial Mining Building, University of California
Birmingham Symphony Hall, England
Computer Data Centre, Utah
Benaroya Concert Hall, Seattle - Figure 7
Docklands Light Railway, London
Kazanci - Gumosova Anatolian Bridges, Turkey
911 Emergency Operations Centre, San Francisco
Thames Barrier, London
LAC+USC Diagnostic and Treatment Centre. Los Angeles
Faslane Submarine Ship Lift, Scotland
Glasgow Concert Hall, Scotland
Belfast Concert Hall, Northern Ireland
Rosyth Royal Naval Dockyard, Scotland
BNFL Nuclear Waste Container Vessel, Sellafield
Lion Plaza, Threadneedle Street, London
911 Emergency Operations Centre, Utah
AOL Time Warner Centre, New York
Disney Concert Hall, Los Angeles - Figure 8
Royal Opera House, Covent Garden, London - Figure 9
First American Corporation, Santa Ana, California
Hoag East Tower, Irvine, California


Figure 9

ISO 9001,
ISO 14001 & SCC*
DNV
REGISTERED

Trelleborg

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