KINETICS Noise Control

Address: 6300 Irelan Place, Dublin, Ohio 43017
Phone: 800.959.1229
Fax: 614.889.0540
Web: www.KineticsNoise.com
Email: ArchSales@KineticsNoise.com

Seismic Restraint of Isolated Floors Subject to IBC 2006 & 2009

Angela Waters, PE[1]

Introduction

Isolated floors are used to limit the transmission of noise or vibration through a building. This requires that isolated floors be designed to permit horizontal and vertical movement independent of the main building structure. This movement has to be relatively unrestrained in order for the isolated floor to perform optimally. This unrestrained movement creates a challenge when the isolated floor is also required to be seismically restrained; now the isolated floor system has to be relatively unrestrained and seismically restrained at the same time. How is this accomplished?

In order to provide seismic restraint while at the same time maintaining optimal isolation of the floor system, all vertical and horizontal forces (including seismic and wind) must be taken into account when specifying the proper isolators and restraints for a project. Kinetics Noise Control offers a diverse line of isolators and restraints that will meet the challenges of a seismically restrained isolated floor system

Isolated floors are not part of the main horizontal or vertical force resisting structural system of the building and thus are considered to be architectural components. The applicable building codes refer to these as nonstructural components. *ASCE 7-05 Chapter 13*[2] governs the restraint design for these nonstructural components and is the applicable standard for isolated floors within projects that are subject to the *IBC 2006 & 2009* editions[3]. Table 13.2-1 of ASCE 7-05 specifies the requirements for isolated systems.

The code and applicable standards define instances in which the governing load combination for a particular isolated floor may or may not be established by a seismic load combination. An example of this would be an exterior, isolated, roof top slab that could well be governed by wind loading instead of seismic loading. In a case such as this, although the wind load combination may govern, the detailing requirements of all the applicable code sections (including seismic) are still required.

Seismic Load requirements are based on the Seismic Design Category of the specific building project. Common practice is for the assigned Seismic Design Category to be identified on the first sheet of the Structural Drawings for the building project. The Seismic Design Category is a classification that is assigned by the Structural Engineer of Record for the project based on the building's Occupancy Category, the building project's geographical location in regard to seismic activity, and the soil quality upon which the building is built.

[1] Angela Waters is the Structural Engineering Manager at Kinetics Noise Control in Dublin, Ohio. She holds a B.S.C.E. from the Ohio State University and is a licensed professional engineer in the state of Ohio.

[2] *The American Society of Civil Engineers Minimum Design Loads for Buildings & Other Structures 7-05; 2006*

[3] *International Building Code 2006& 2009 editions; International Code Council, Inc.; January 2006 & February 2009*

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The term Occupancy Category is not the same as Seismic Design Category. Occupancy Category is a classification that describes the intended purpose of the building as that purpose relates to the risk to human life. Table 1-1 of ASCE 7-05 presents the Occupancy Category description for different types of buildings.

Another term that is necessary to define in order to understand how ASCE 7-05 applies exemptions and requirements to nonstructural components is the term Component Importance Factor. Component Importance Factor is not necessarily the same as the (building) Importance Factor. The term Component Importance Factor applies to a specific component and only has a value of 1.0 or 1.5. Section 13.1.3 of ASCE 7-05 defines when a component has a Component Importance Factor of 1.0 or 1.5.

The (building) Importance Factor applies to the entire building and is based on the building's Occupancy Category, as shown in Section 11.5.1 of ASCE 7-05. A building's Importance factor, in regards to seismic loading, can be 1.0, 1.25, or 1.5.

Building Code Requirements

Isolated Floors:

ASCE 7-05 mandates that any nonstructural component that either directly supports life safety systems, or has the potential to damage a component that supports life safety systems is required to be seismically restrained. Many examples of these two different scenarios can be found in buildings such as hospitals. It is obvious that hangers that support the medical gas pipe are required for life safety. In order to prevent failure of the hangers and ultimately the medical gas pipe, the pipe is required to be seismically restrained. Less obvious is that if this medical gas pipe were to be sleeved through an isolated floor, lateral motion of the floor would have to be controlled during a seismic event to avoid any consequential damage to the medical gas pipe. Thus the isolated floor requires seismic restraint as well. This example emphasizes the importance of the design professionals conveying accurate information to Kinetics Noise Control and their representatives.

Critical Hospital Buildings fall into Occupancy Category IV. Occupancy Category IV buildings are those that are expected to maintain operation during and immediately after an Earthquake because the risk to human life, in the event of a failure, is considerable. The Engineer of Record uses the Occupancy Category classification as an input when determining the Seismic Design Category for the project.

Below are the qualifications by Seismic Design Categories wherein isolated floors are exempted from restraint.

Seismic Design Category A

1. All isolated floors in any project in this Seismic Design Category are exempt.

Seismic Design Category B

1. Isolated Floors are exempted in Seismic Design Category B as long as the isolated floor cannot affect the performance of any components with a Component Importance Factor of 1.5.

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Seismic Design Categories C, D, E, & F

1. There are **not** any exemptions for Isolated Floors in Seismic Design Categories C, D, E, and F.

Products by Kinetics Noise Control for the Seismic Restraint of Isolated Floors:

Kinetics Noise Control offers two major types of isolated floors that provide vibration and noise isolation. Both of the two major systems can be seismically restrained.

One of the systems is called the Lift Slab. This isolated floor system basically consists of an array of isolators that are installed in steel housings that become integral with the isolated concrete slab. The Lift Slab, or Jack up Slab system and the installation of such isolated floors are detailed thoroughly in a white paper by Kinetics Noise Control[4]. These isolated floors can either be seismically restrained by perimeter restraints or interior restraints.

Perimeter restraints are commonly used when the building structural system (not by Kinetics Noise Control) either provides a structural wall system or a curb, see Figure 1. If a client wishes to use perimeter restraints and the building structure does not provide a perimeter for the isolated floor, angles can be anchored to the building structure to provide a perimeter, as shown in Figure 2. When the perimeter restraint system is selected, neoprene pads are placed along the perimeter between the isolated floor and the perimeter structure provided by the building. Kinetics PPI (Perimeter & Penetration Interface) is placed between the isolated floor and the perimeter structure, wherever the neoprene pads are not located, to provide a resilient isolation joint.

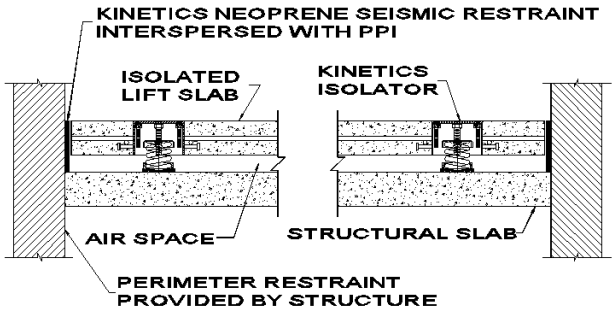

Figure 1: LIFT SLAB W/ PERIMETER RESTRAINTS PROVIDED BY STRUCTURE

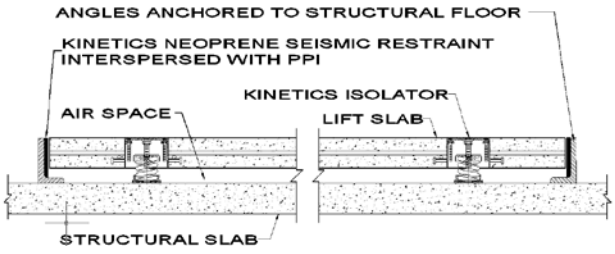

Figure 2: LIFT SLAB W/ PERIMETER RESTRAINTS PROVIDED BY ANGLES

The other type of system that Kinetics Noise Control offers for the seismic restraint of isolated Lift Slabs is an internal restraint system. Often times, it is not desirable to anchor structural angles to the building

[4] Sherren, Richard & Golden, Matthew; High Performance Floating Floors, A white paper of Kinetics Noise Control Inc., 6300 Irelan Place, Dublin, OH 43017, Last Date Revised – 14 May 2010

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structure to provide a perimeter for restraint purposes, and the client prefers an alternative. Internal restraints provide such an alternative. With internal restraints, the outer housing of the restraint is connected to the Lift Slab, while the inner housing of the restraint is connected to the structural slab, as shown in Figure 3. These restraints have neoprene pads between the housings. Internal restraints can also be utilized to prevent buckling of the isolated floor. The buckling characteristics of the floor should be evaluated by the Structural Engineer of Record.

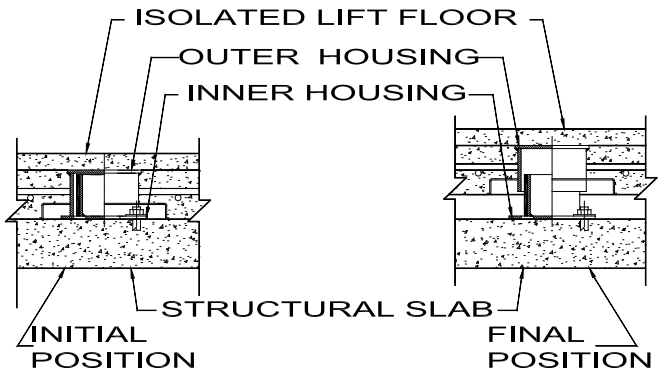

Figure 3: LIFT SLAB INTERNAL SEISMIC RESTRAINTS

The second type of isolated floor is the Lost Formwork Floor or Roll-Out Isolation Floor. The Lost Formwork Floor is titled such because the plywood or steel deck that is used to form the isolated concrete floor remains in place, but is not contributing to the structural performance of the floor once the concrete floor cures.

The Lost Formwork Floor consists of an array of Kinetic Noise Control KIP isolator pads that are embedded in a roll of loose fibrous batting. This roll with the isolator pads provides the support for one layer of 1/2" plywood (the formwork). In some applications, ¾ " plywood or two layers of plywood are used to create the formwork. In other cases, corrugated metal decking may be secured to FIC, a channel system with restrained KIP isolators. Either of the two structures described above provides the formwork for the concrete floor that is then poured to the specified thickness. The formwork becomes a "lost form" once the concrete floor cures.

The seismic restraint options for the Lost Formwork Floors are similar to those options for the Lift Slabs. Perimeter restraints, as described previously, can be used if either the building structure provides a structural perimeter such as a wall or a curb, or angles are anchored to the building structure to provide a perimeter. These options are shown in Figures 4 & 5.

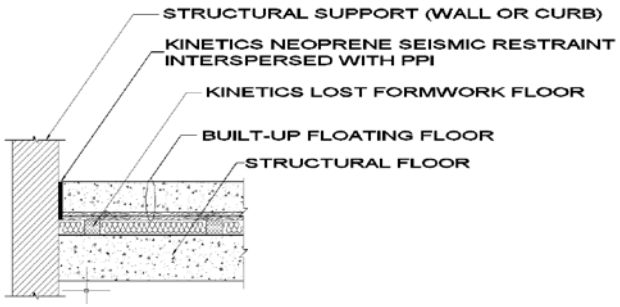

Figure 4: LOST FORM WORK SLAB W/ PERIMETER SEISMIC RESTRAINT BY STRUCTURE

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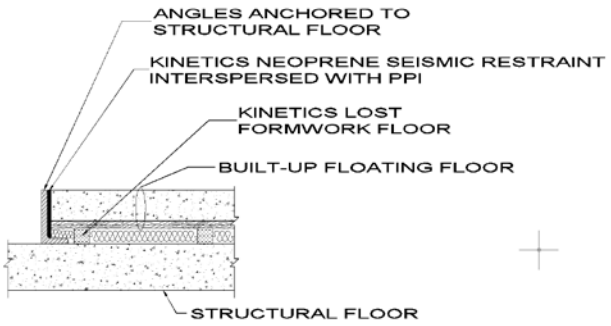

Figure 5: LOST FORM WORK SLAB W/ PERIMETER SEISMIC RESTRAINT BY ANGLES

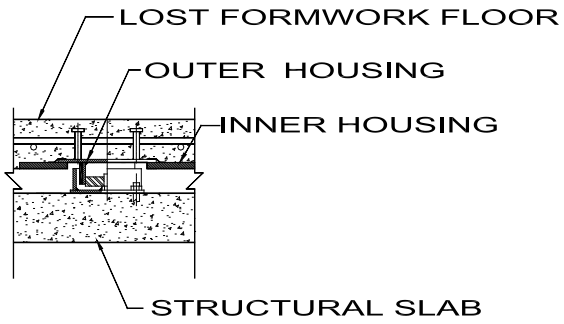

Figure 6: INTERNAL SEISMIC RESTRAINT FOR ISOLATED LOST FORM WORK FLOOR

If the building structure does not provide a structural perimeter and anchored angles to the structure are not desirable, internal restraints can be used to seismically restrain the isolated Lost Formwork Slab. Internal restraints are also used when the Structural Engineer of Record is concerned about the buckling potential of the isolated floor.

The internal restraints are placed before the floor is formed with the plywood or the corrugated metal decking. The inner portion of the restraint is connected to the structural slab, while the outer portion of the restraint is connected to the Lost Formwork Floor, i.e. the isolated floor, see Figure 6. Just as the internal restraints for the Lift Slab utilized neoprene pads between the inner and outer portions, so do these internal restraints.

In Conclusion:

Kinetics Noise Control is pleased to offer this diverse group of products. The products that we have discussed in this paper meet the code requirements that we have also summarized here. These systems provided by Kinetics Noise Control enable our clients to meet the seismic restraint requirements of the governing building code, as well as control the transmission of unwanted sound & vibration.