S05: JAEE Special Session
S05-01:
Spectacular Projects of Base-Isolated Buildings

MIDDLE-STORY ISOLATED STRUCTURAL SYSTEM OF HIGH-RISE BUILDING

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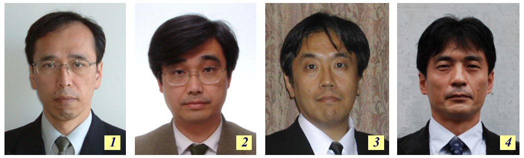

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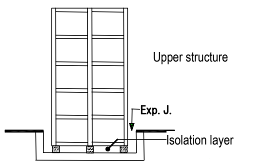
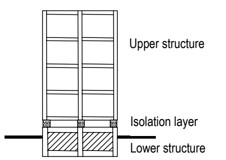
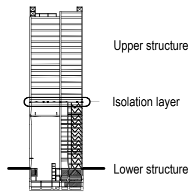
1. INTRODUCTION

This paper discusses three key issues:

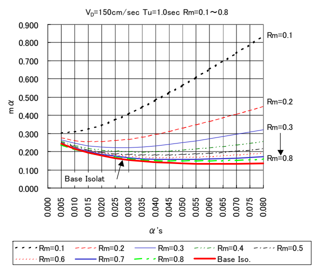
- Characteristics of high rise buildings with middle-story isolated structural system.
- Response properties and design method for high rise buildings employing a middle-story isolated structural system.
- Examples of high rise buildings adopting a middle-story isolated structural system.

2. CHARACTERISTICS OF HIGH RISE BUILDINGS WITH MIDDLE-STORY ISOLATED STRUCTURAL SYSTEM

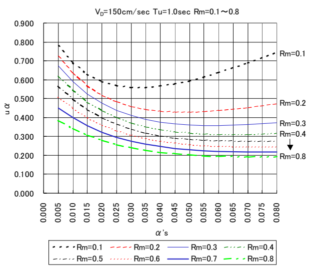
Characteristics of each structure

Foundation base isolation structure	Generally adopted middle-story isolated structure	Middle-story isolated structure with untuned mass damper effect
		
• It is possible to reduce the seismic input to the upper structure, so comparatively free structural planning is possible. • An expansion joint is needed around the building, which has a large impact on architectural planning. • It is necessary to make the upper structural form virtually the same, so it is difficult to adjust the structural form to suit the use.	• The seismic forces in the upper structure supported by the isolation layer are small, and the structural form is not chosen, so a high degree of freedom in architectural and structural planning is possible. • The lower structure must provide stiffness and resistance as foundations, so normally an RC structure with sufficient seismic shear walls is used.	• The upper structure has high seismic resistance as a seismically isolated structure, and a high degree of freedom in architectural and structural planning is possible. • As a result of the mass damper effect, the response of the lower structure is also reduced and the seismic performance is increased, so a high degree of freedom in architectural and structural planning is possible. • It is possible to adopt different structural forms for the upper and lower structures, so it is possible to adjust the structural form to suit the use.

3. RESPONSE PROPERTIES AND DESIGN METHOD FOR HIGH RISE BUILDINGS EMPLOYING A MIDDLE-STORY ISOLATED STRUCTURAL SYSTEM



Response maximum shear force coefficient in isolation layer $_m\alpha_{max}$



Response maximum base shear coefficient of lower structure $_u\alpha_{max}$

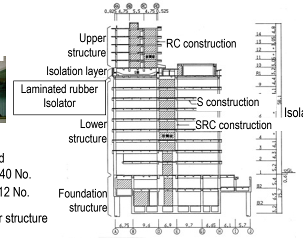
R_m: upper structure mass / total mass above ground
α'_s: damper yield force / total mass above ground

Maximum predicted response value in each part when the velocity conversion value of the energy that contributes to damage is V_D=150cm/sec

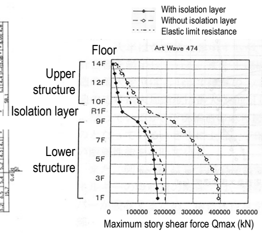
4. EXAMPLES OF HIGH RISE BUILDINGS ADOPTING A MIDDLE-STORY ISOLATED STRUCTURAL SYSTEM

Example 1 – "Iidabashi First Building, First Hills Iidabashi" in which the optimum structure and framing forms for each use were stacked vertically

External and internal views of Iidabashi First Building, First Hills Iidabashi

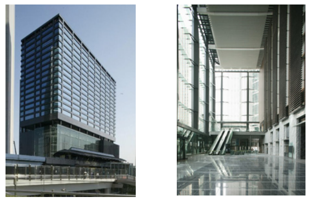


Framing elevation (in short direction)



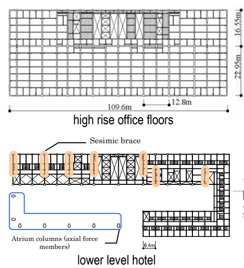
Result of Dynamic Response Analysis

Example 2 Application to "Shiodome Sumitomo Building", a high rise building having a large atrium in the lower levels

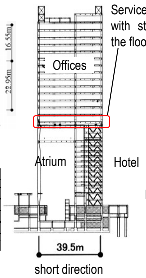


Natural rubber laminated rubber isolators 1000 - 1300 φ : 41 No.
Lead dampers: 100 No., steel rod dampers: 14 No.
Rm (mass of upper structure / total mass above ground) = 0.68
α's (damper yield force / total weight above ground) = 0.033

Building external view, Atrium internal view

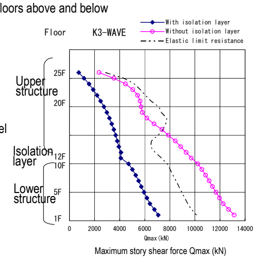


Framing plan



Framing elevation

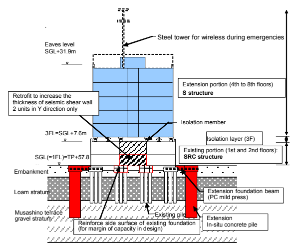
Intermediate isolation layer
Services switching floor with stiff strong slabs on the floors above and below



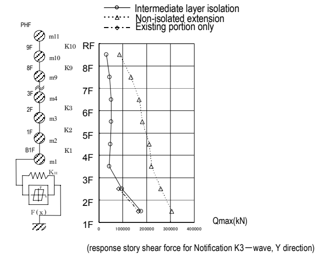
Result of Dynamic Response Analysis

Example 3 – application to the expansion of the upper part of an existing building to form a high seismic performance disaster prevention center "Musashino City Disaster Prevention and Safety Center"

Building external view



Outline of the structure



Result of Dynamic Response Analysis