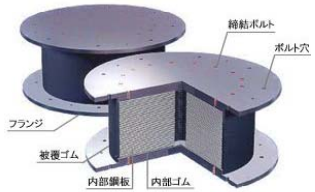
Seismic Response Control of Wooden House with Joint Oil Dampers Placed on Sliding Base

Background of Development

Ordinary Base Isolation



● Rubber Bearing

● Sliding base

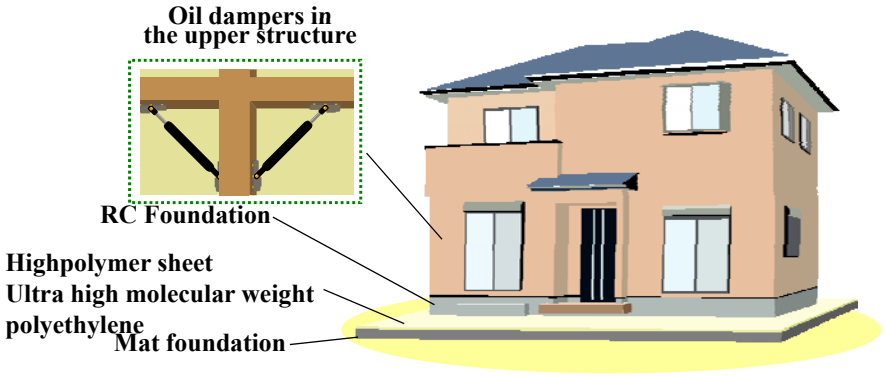
Max. Acceleration could be less than 2-300cm^2

Mainly applied to Large Scale Apartment Houses

Application to detached house is limited

➡ **Needs for simple and less expensive system is which is much more effective than seismic response control, but not so much as base isolation though.**

Concept of a house on the sliding fundation

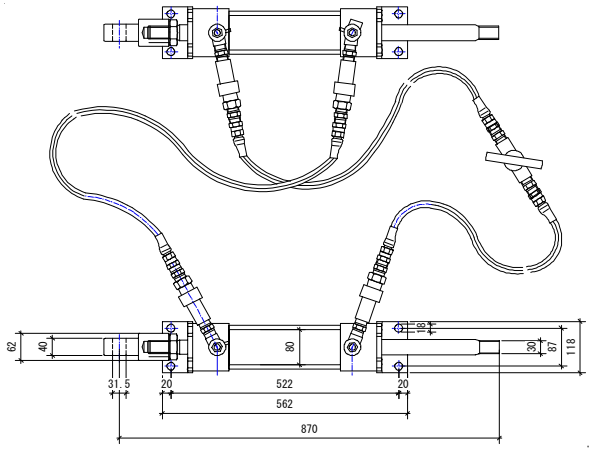


For minor ground motion, oil damper works

For strong ground motion, seismic force will not transmitted

Torsion and residual displacement will be dealt with by linked oil dampers(usually unnecessary)

Linked Oil Damper

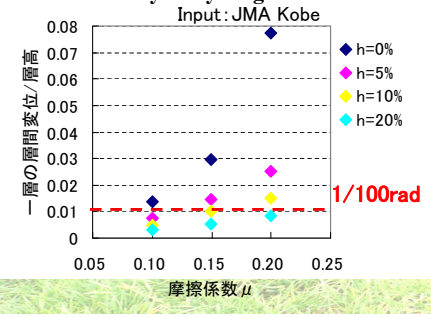


Identification of Proper Friction Coefficient

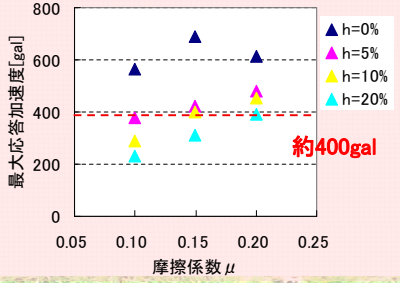
Requirements:
①No need of large scale repair even after intense ground motion
②avoid excessive amount of sliding

Friction Coefficient (μ) should be less than 0.2

- Maximum Relative displacement divided by story height

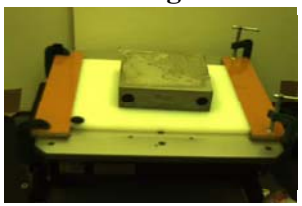


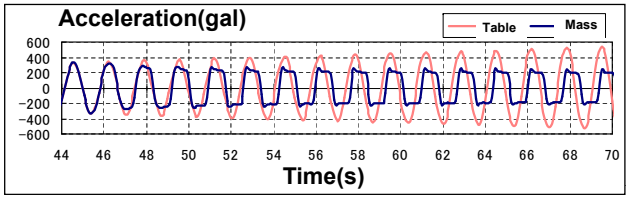
Maximum Acceleration at the top



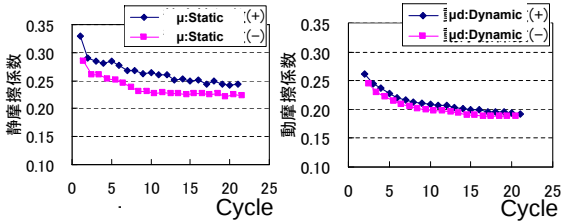
Search for the Combination of Materials to Yield μ=0.2

- Shaking table test





Acceleration Time History



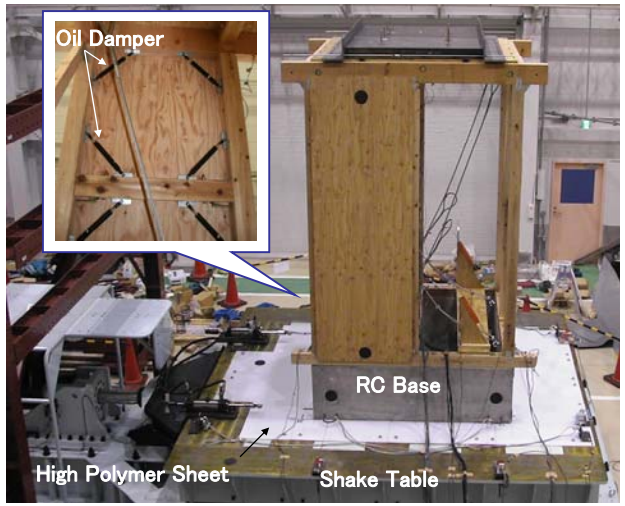
μ（Static ave.)=0.25
μd(Dynamic ave.)= :0.2

Shaking Table Test of Full-Scale Wooden House on Sliding Foundation

Structural Elements

RC Base

Finish of the Base Back



実験システムとダンパの配置

Test Results

- **Input ground motions**

KOBE 30%→KOBE 60%→ KOBE 60%→ KOBE 100%→ KOBE 100%

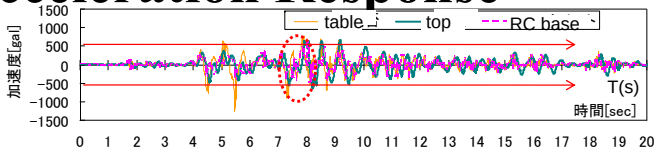
With Oil Dampers
Max. Displacement= 282mm

Without Oil Dampers
Max. Displacement= 291mm

Reduction of Acceleration Response

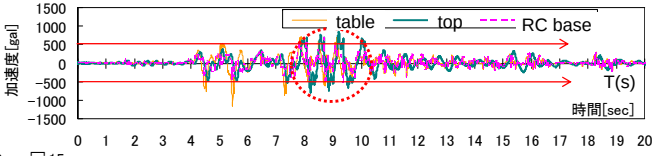
With dampers

Kobe100%

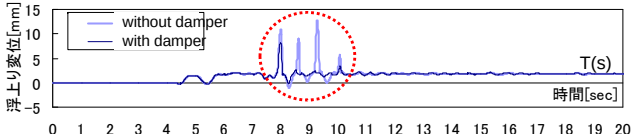


Without dampers

Kobe100%



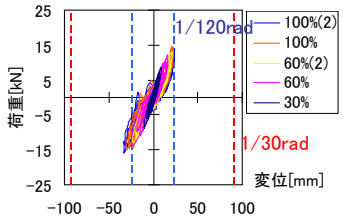
Greater acceleration is caused by up-lift



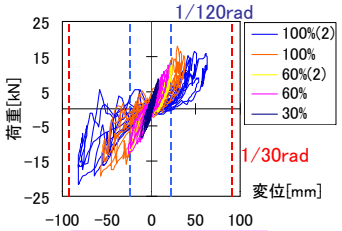
➡ We can remove undesirable acceleration increase by up-lifting by additional damping and less aspect ratio, which makes it possible to reduce max. acceleration to about 400 gal.

Usefulness of Oil Dampers to Minimize Deterioration of Structure

- **Load-deflection Relation**

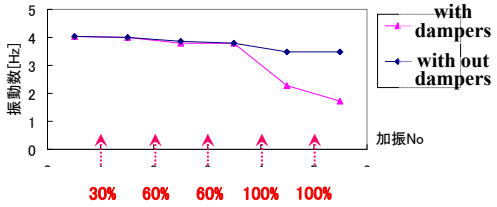


With dampers



Without dampers

- **Natural Circular Frequency**



- Sliding base is effective because there is no serious damage even after 60% Kobe is input twice

- Use of the oil damper is effective, because structural damage never proceeds even after 100% Kobe is input

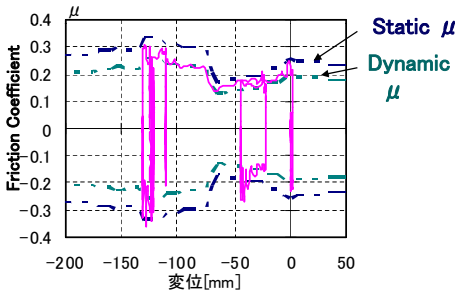
Seismic Response Analysis of Wooden House with/without Oil Dampers Placed on the Sliding Base

Simulation of the Shake Table Test

Analytical Model

Analytical Model for Sliding Base

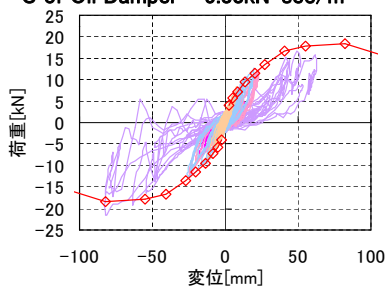
Irregular Distribution of both static and dynamic friction coefficient is taken into account.



μ of sliding base

Analytical Model for upper wooden house

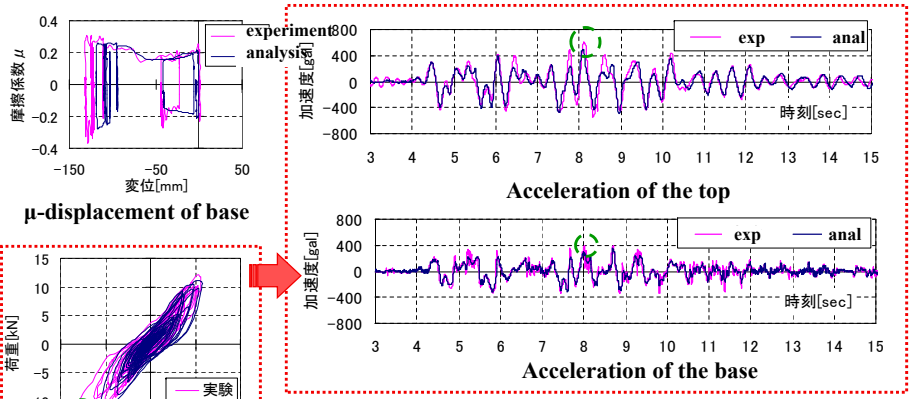
Extended NCL model is used
First mode Natsural period=0.25s
Damping factor =3%(in proportion to initial stiffness)
C of Oil Damper = 5.33kN･sec/m



Load-deflection relation of wooden house

Comparison between Analytical and Experimental Results

(Kobe30%→) Kobe60%

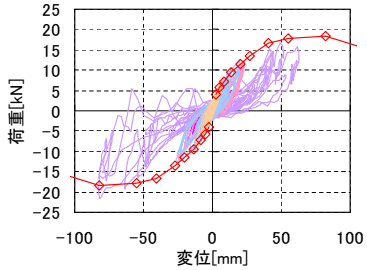


On the whole, analytical results coincides fairly well with the test.

Comparison with the case of with Fixed Base

Analytical Conditions:

Friction Coefficient : μs=0.267, μd=0..205
T1:0.249 s h:3%(in proportion to initial stiffness)
C of Damper::5.33kN･sec/m
Input Excitations:
kobe30%→kobe60%→kobe60%→kobe100%

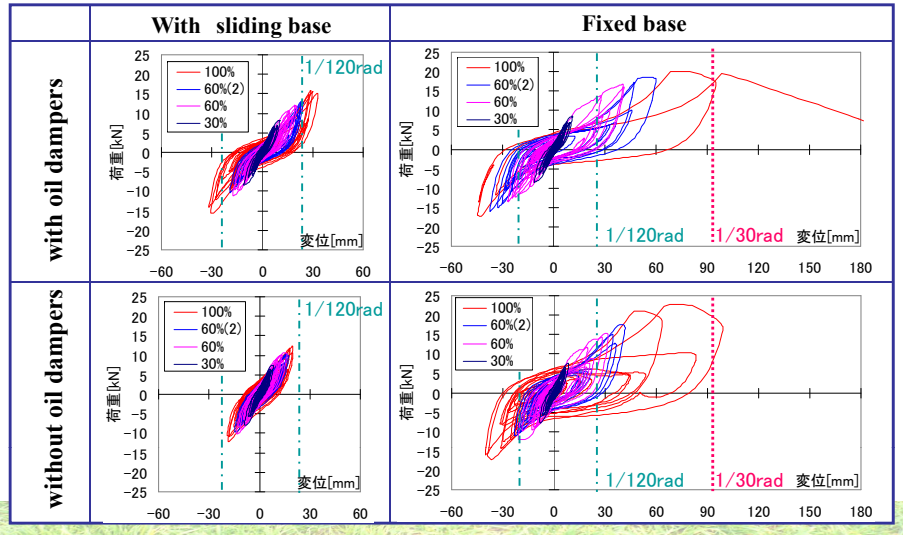


Load-deflection Relation

Wooden House with Sliding Base

Analytical Results

Load-deflection Relations



Conclusions

- Proper value for friction coefficient is found to be 0.2, which can be realized by the contact surface of relatively strong concrete and ultra high density poly-ethelene.

- Application of sliding base makes it possible for wooden houses to resist intense earthquake ground motion keeping its maximum acceleration within 500gal and maximum story deflection angle within about 1/100.

- Real seismic performance of the proposed sliding base structural system can be simulated quite accurately by analysis.

➡ **Sliding base structural system is quite promissing!!**

End of Lesson Five
Part two