STUDY ON THE LARGE SCALE DISPLACEMENT VIBRATION TEST FOR THE 1/25 SCALE MODEL OF THE 17-STORIED BUILDING J. N. R.

by

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ABSTRACT. The first part of this paper refers to the observation of the mode and coefficient of the normal function of elastic vibration has a good coincidence with theoretical value, and no torsional vibration is observed under the adequate shear wall distribution.

The second part explains about the observation of the model top displacement is the smallest at the hard type, the second at the lower frame soft, the third at the upper frame soft, and the largest at the soft type.

The third part of this paper refers to the observed natural period of the model is lenthened 1.5 - 2 times after the 2g shaking acceleration test than that of 0.1g, and the ductility factor of the large scale vibration test is 3 - 4 times of the elastic limit, but the damage is insignificant.

In the final part of the paper, it is discussed that the value of non linear response analysis has a good coincidence with observed data, under the assumption of equivalent bending-shear vibration system which has the same natural period with that of the tested model.

INTRODUCTION. In order to keep safety for the planned tall building structure, a large scale displacement vibration test was projected by author and other research members of J. N. R., for the purpose of observation if any torsional vibration occurs at the type of building plan, and to investigate response values on different types of vertical stiffness distribution of structure and of earthquake patterns.

The steel model scale is 1/25 (height 2.9m, width 1.4 x 2.9m, weight 8 ton); stiffness series are hard, partial soft; and acceleration steps from 0.1g, 0.5g, to 2g.

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Selected model plan series are 1) the plain square type and 2) the design hoped Z type plan; and adopted earthquake patterns are acceleration type as follows:

EL CENTRO U.S.A.	1940	NS	330 gal
TAFT U.S.A.	1952	EW	160 gal
TOKYO 101 SAITAMA JAPAN	1952	EW	80 gal

and several observed earthquake ground motion acceleration patterns at the just point of the construction for this building.

EXCITOR

Vibration energy	Oil pressure type actuator (5 ton x 4).
Capacity	Maximum output pawer (20 ton-g). Maximum model base size (3 x 2.5 m).
Frequency range	0.05 - 50 c/s.
Amplitude range	0 - 12 cm (at 0.05 - 1 c/s frequency).
Input wave pattern	Acceleration, velocity, or displacement control is usable.
Maker	Mitsubishi shipbuilding-works Co. Ltd. (see Fig. 1)

MODEL DETAILS

Frame members and connections	material	steel plate (0.88 - 1.16mm thick).
	columns	box type (28 - 32mm square section).
	beams	I-type (frange 12 - 20mm width and web 30 - 32mm height).
	connections	welding connection (partially rivetting type is used).

Plan type, size and weight		square type plan	Z-type plan
	height	2,870 mm	2,870 mm
	width	1,153x692mm	2,880x1,360mm
	weight	2,410 kg	8,430 kg

Floor mass distribution	lead plate (10mm thick-equivalent with actual floor mass distribution).
Shear wall	asbestor plate (8.6mm thick - fixed by screw bolt and adhesive bond material). (see Fig. 2)

TESTING METHOD AND THEORETICAL ASSUMPTION

Mode and coefficient of the normal function

Mode of the 1st degree and 2nd degree are observed by sine wave stationary base vibration, and are theoretically assumed from observed coefficient of the normal function. (see Fig. 3)

Torsional vibration

Test points are selected on the top of the Z-type model at the right side, left side and centre of the model plan, and observed each displacement phase and amplitude. (see Fig. 4)

Stiffness distribution and response displacement

Five test points are selected from the top to the base of the square type model, and frame stiffness distribution types are determined by vetical shear wall distribution as follows:
1) hard type (shear wall placed all stories -- 1 - 17 floor);
2) partial soft type (upper frame soft -- shear wall 1 - 6 floor, and lower frame soft - shear wall 2- 17 floor). (see Fig. 5)

Change of natural period under repeated earthquake vibration

Input earthquake vibration energy is regulated from 0. 1g to 2g acceleration and repeatedly imposed with each time free vibration test for observation of the change of natural period; and observed if any damage is occurring. (see Fig. 6)

Large scale response displacement and its theoretical assumption

At the large scale vibration, model stiffness reached in the non linear vibration range; and in that case theoretical values are assumed and compared with observed model top response displacement as follows:
response calculated as bending-shear stiffness system under upside-down triangular type lateral force distribution which has the same natural period with that of tested model. (see Fig. 7)

CONCLUSION

Mode and coefficient of the normal function

Fig. 3 shows a good coincidence between observed and calculated value of the mode of 1st degree and 2nd degree.

Torsional vibration

Fig. 4 shows no torsional vibration is observed by the large scale vibration in this Z-type plan under the adequate shear wall distribution.

Stiffness distribution and response desplacement

Fig. 5 shows that observed model top displacement is the smallest at the hard type, the second at the lower frame soft, the third at the upper frame soft, and the largest at the soft type.

Change of natural period under repeated earthquake vibration

Fig. 6 shows that observed natural period is lengthened 1. 5 - 2 times after the 2g shaking acceleration test than that of 0. 1g, and the ductility factor of the large scale vibration test is 3 - 4 times of the elastic limit, but the damage is insignificant.

Large scale response displacement and its theoretical assumption

Fig. 7 shows the value of non linear response analysis has a good coincidence with observed data, under the assumption of equivalent bending-shear vibration system which has the same natural period with that of the tested model.

ACKNOWLEDGEMENTS.

The writer wishes to thank Dr. Hajime Umemura, Professor of Faculty of Engineering, University of Tokyo, and Dr. Yutaka Osawa, Professor of Earthquake Research Institute, University of Tokyo, and other many co-operaters of the Japanese National Railways and of Mitsubishi ship building-works Co. Ltd. , for their kind suggestion and excellent support in carrying out this vibration test.

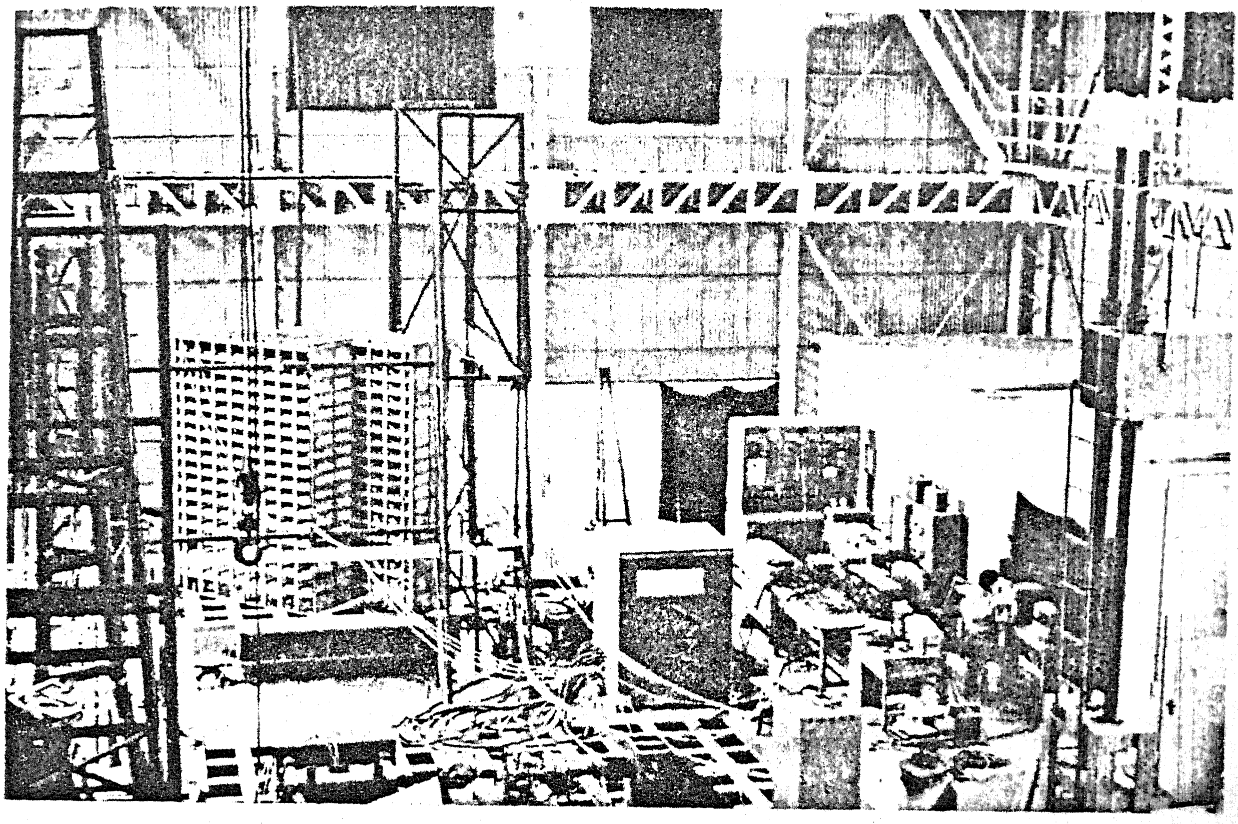

Fig. 1 Excitor and model

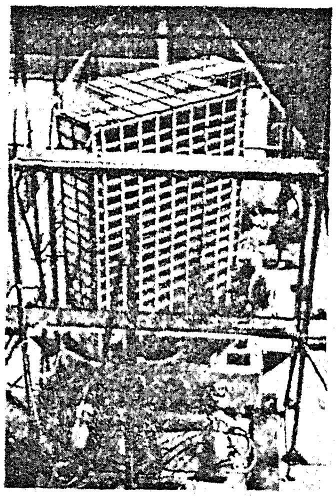

Fig. 2 (a) Z-type plan model

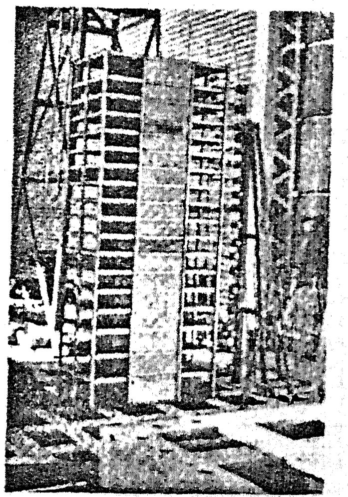

Fig. 2(b) Square plan model

Fig. 3 Observed Mode and Calculated mode

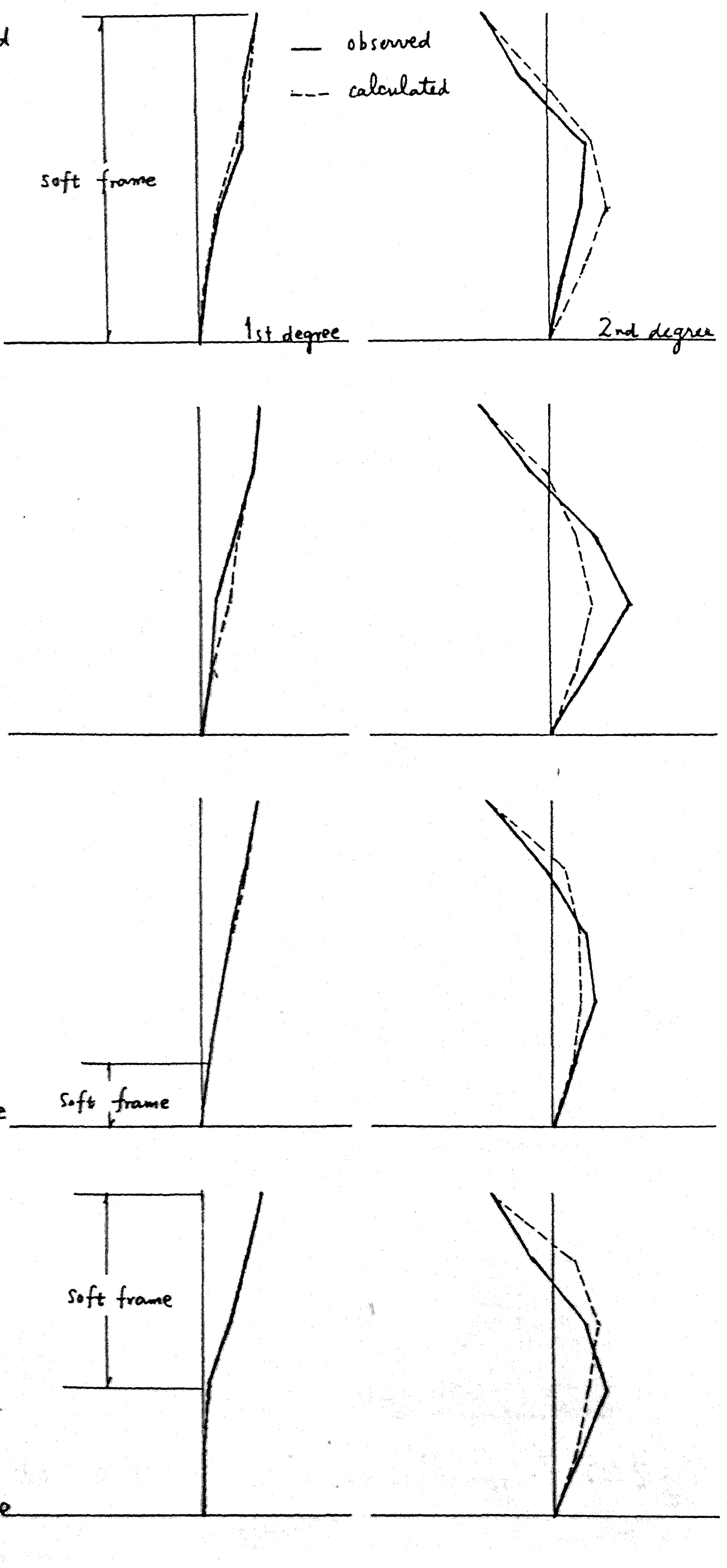

Fig. 3 (a) Soft type

Fig. 3 (b) Hard type

Fig. 3 (c) Lower frame soft type

Fig. 3 (d) Upper frame soft type

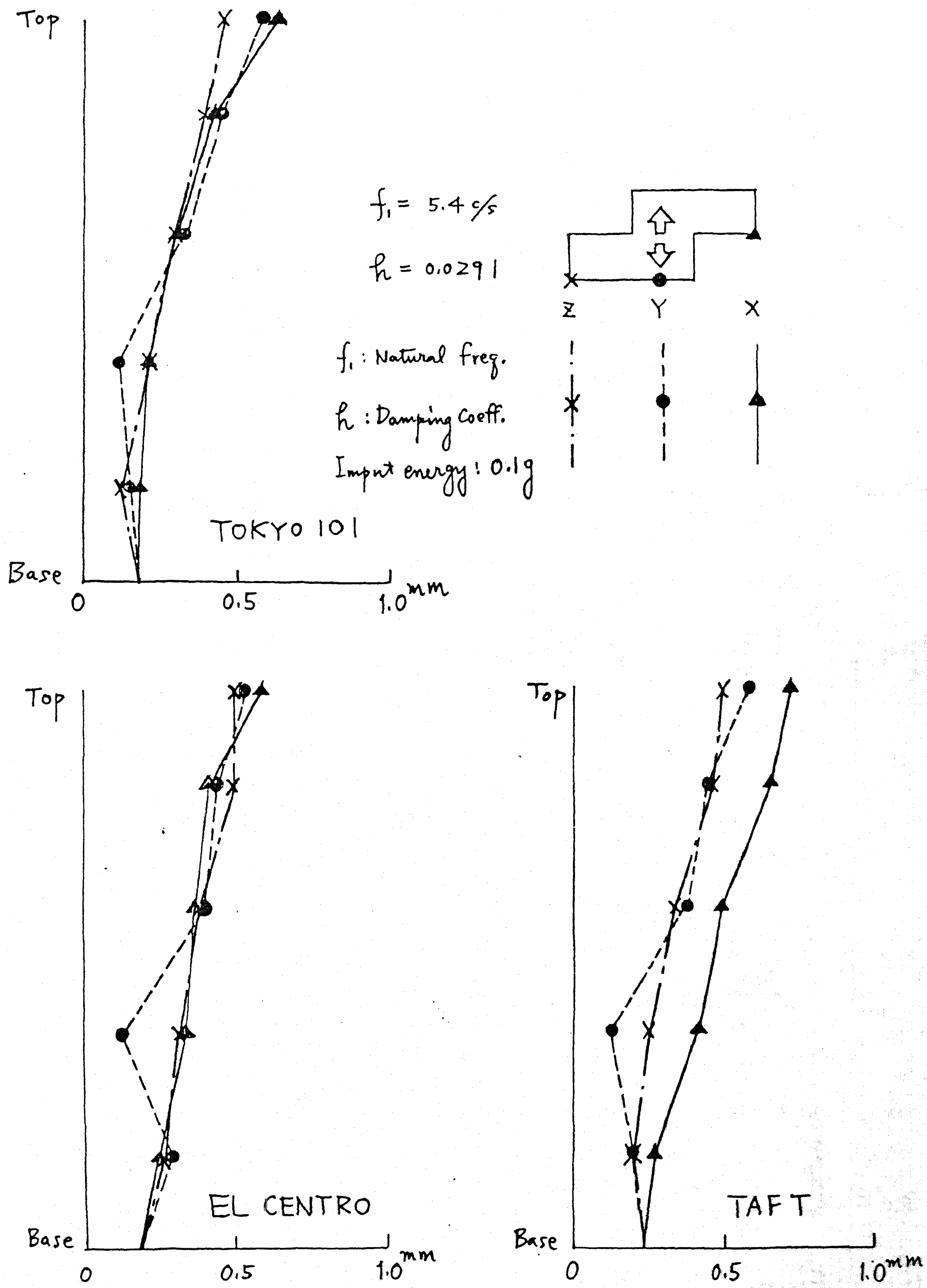

Fig. 4 Z-type model response displacement

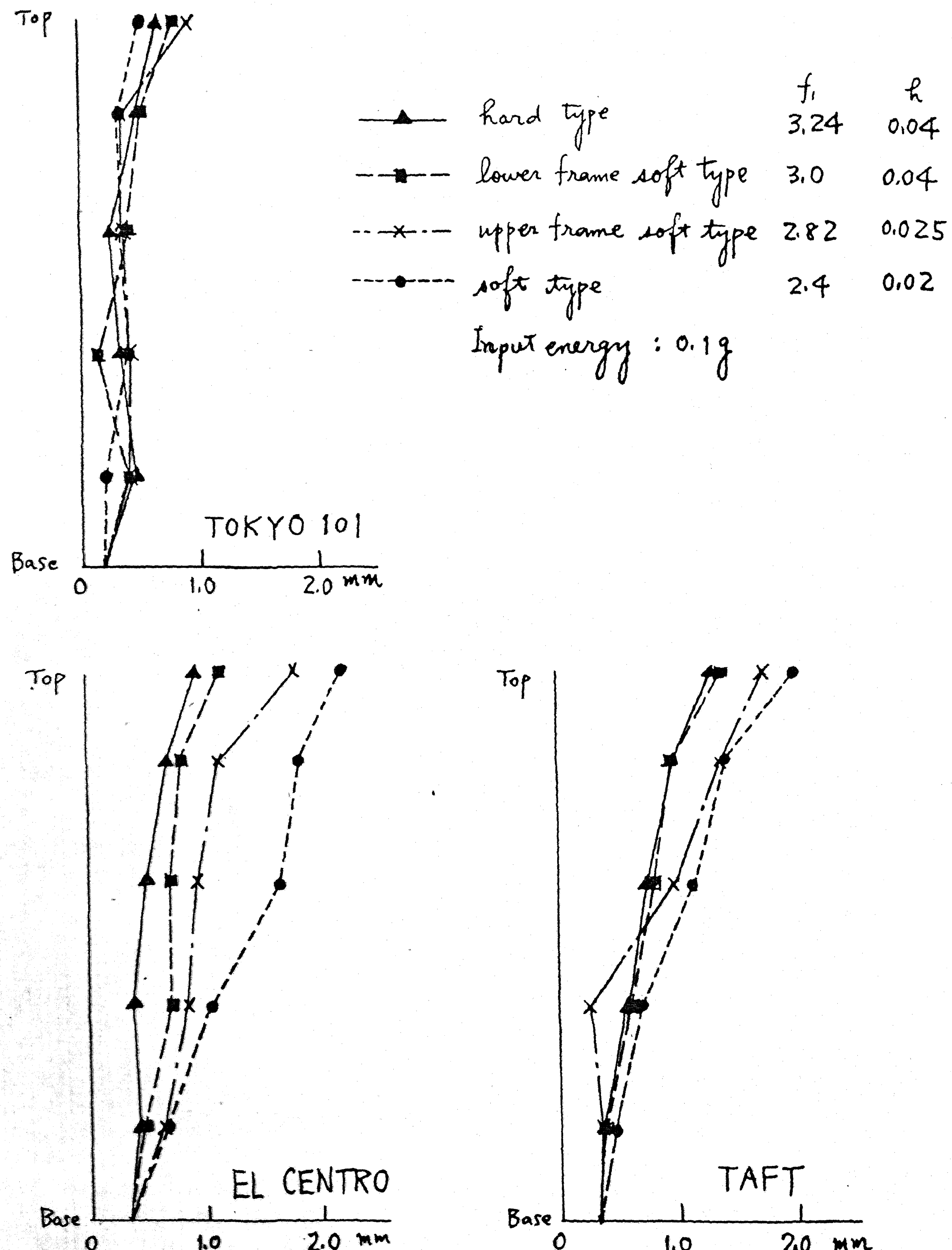

Fig. 5 Square type model responce displacement

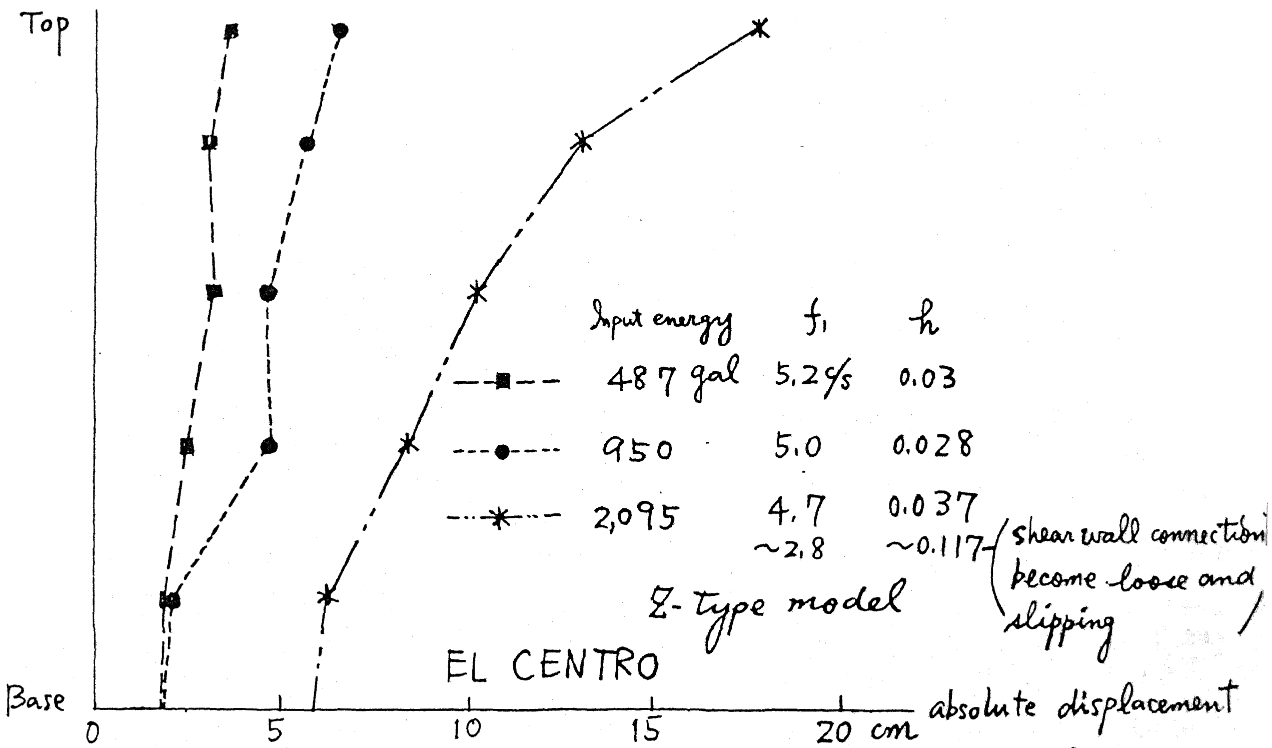

Fig. 6 Observed response displacement under large scale base acceleration

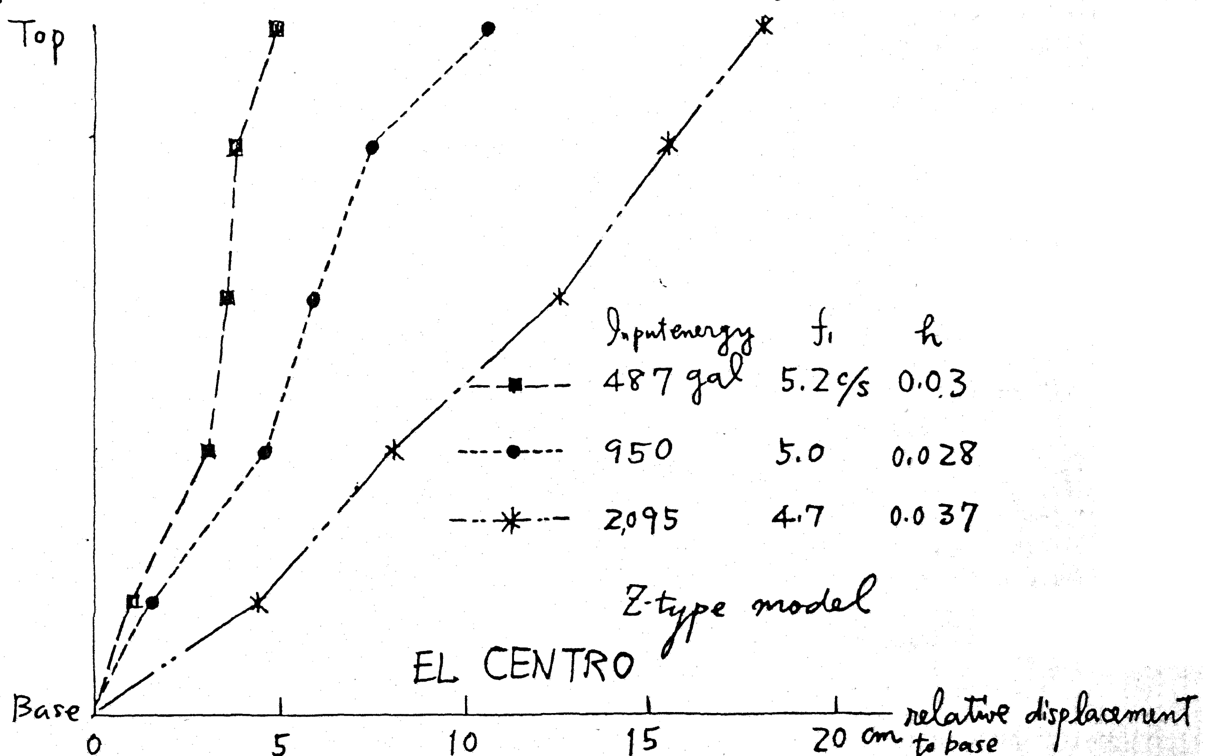

Fig. 7 Calculated response displacement compared with observed value