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From Earthquake Engineering Research to Social-economic Applications

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Two 40-story Steel Office Buildings

Two 40-story steel office buildings have been designed for the site of Taipei Microzonation II with a base shear coefficient of 0.0857.

One building uses SN490 steel in all the columns, and the other changes to use SM570 steel in the columns from the base floor to the 14th floor. The use of SM570 steel has caused the 40-story building to save steel up to 140 ton in total, approximately 3%.

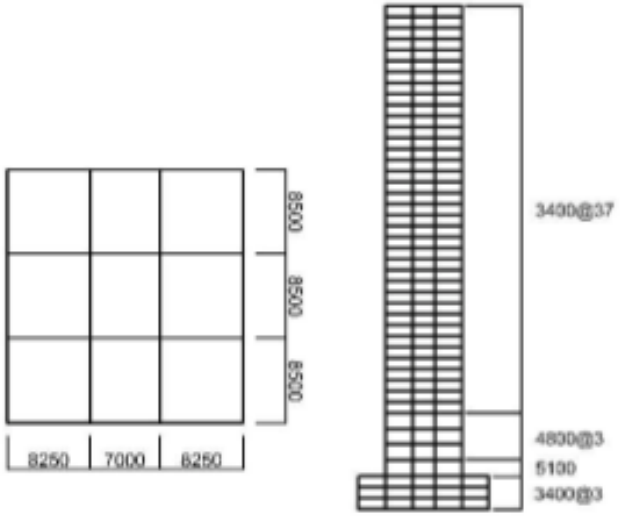


Fig.1 Floor plan and elevation

Table 1 Yield strength, ultimate strength and elongation of SN490B, SM570 and SM490B steels

	Thickness t (mm)	Yield strength (N/mm^2)		Tensile strength (N/mm^2)	Elongation (%)
SN490B steel	25-80	$16 \leqq t \leqq 40$	$40 < t \leqq 100$	490~610	23 min
		325~445	295~415		
SM570 steel	28-70	$16 < t \leqq 40$	$40 < t \leqq 75$	490~610	26 min
		450	430		
SM490B steel	10-36	$t \leqq 16$	$16 < t \leqq 40$	570~720	23 min
		325	315		

Table 2 Amount of SN490B, SM570 and SM490B steels (in ton)

	SN490B steel	SM570 steel	SM490B steel	Total
Case 1	2843	-	2203	5046 (100.0%)
Case 2	1284	1393	2233	4906 (97.23%)

Cost-benefit Analysis of Applying SM570 Steel to Tall Buildings in Taiwan, Advanced Materials Research Vols. 1079-1080 (2015) pp 419-422

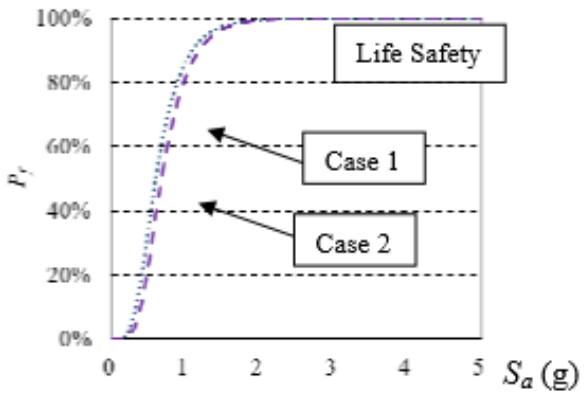
Drift Demands and Fragility Curves

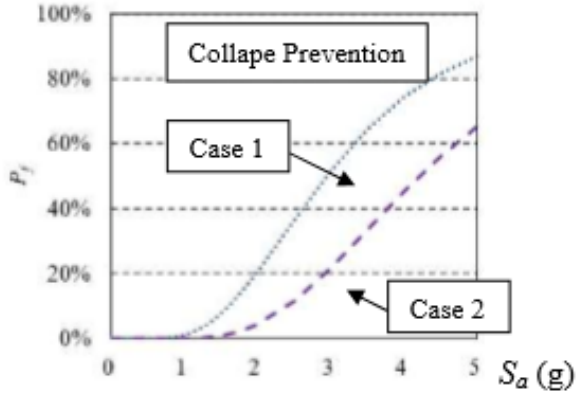
Table 2 Drift responses to design earthquake (DE) and maximum considered earthquake (MCE)

	Drift response to DE			Drift response to MCE	
	Average	Standard deviation (σ)	**1+ σ response**	**Average**	Standard deviation (σ)
Case 1	1.78%	0.52%	**2.30%**	**2.22%**	0.43%
Case 2	1.67%	0.40%	**2.07%**	**2.04%**	0.31%

Table 3 Results of regression analysis

Case 1: SN490B steel box columns			Case 2: SN490B+SM570 steel box columns		
a	b	β	a	b	β
0.0313	0.4340	0.2046	0.0290	0.3789	0.1655





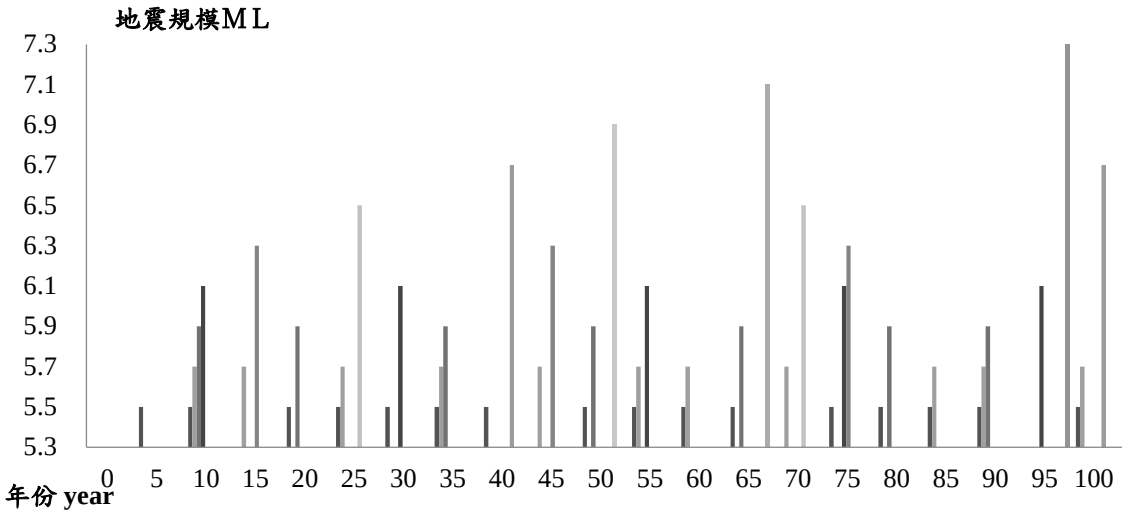
The stress ratios of steel sections and story drift ratios of the buildings have been limited to 0.9 and 0.005, respectively.

The periods (T) of the two buildings are 3.90 sec and 4.06 sec, respectively

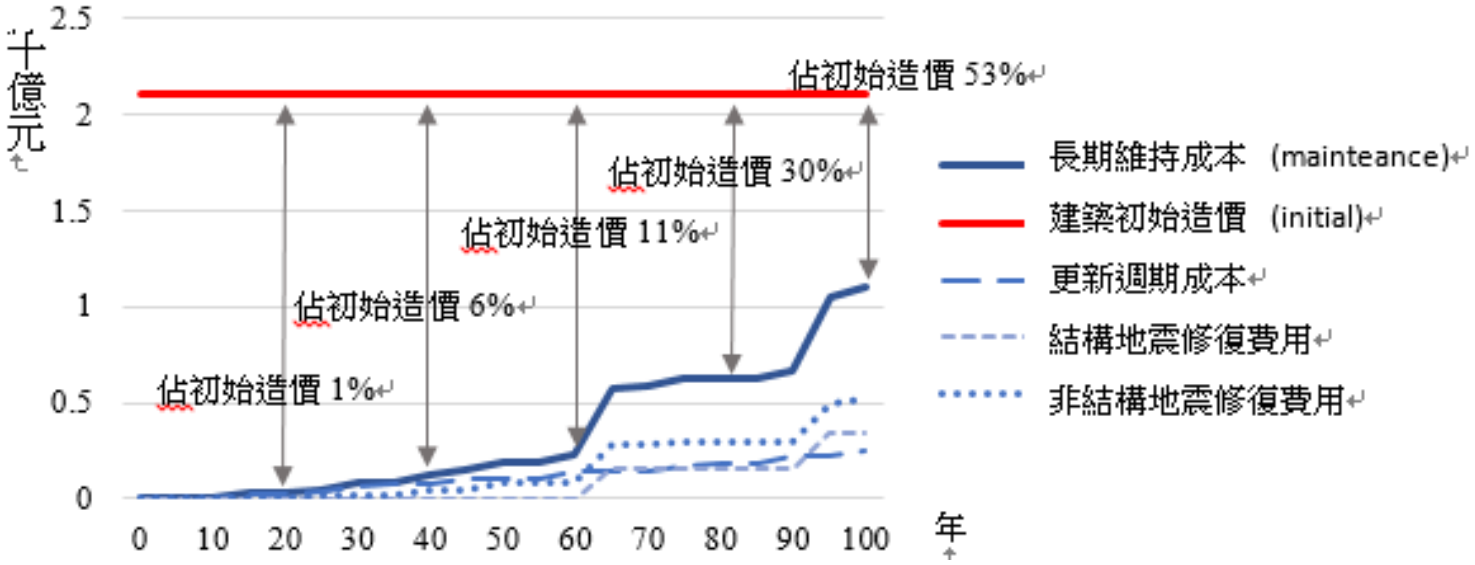
The use of SM570 steel reduces the column sections and building stiffness. To limit the drift of the building, the beam sizes have been enlarged.

That helps reduce the drift demands, improving the building fragility against earthquake collapse

100-year Cost Analysis



		Case I	Case II
Initial Cost	Steel Structure	7.3 億 (5.6-6.7)	7.3 億 (5.7-6.8)
	Architecture	21 億	21 億
Seismic ↓	Structure	3.38 億 (30%)	2.32 億 (23%)
Recovery	Non-structure	5.16 億 (47%)	5.16 億 (52%)
Building Renovation		2.5 億 (23%)	2.5 億 (25%)
100-yr cost	Total	11.04 億 (100%)	9.98 億 (100%)



The use of SM570 steel makes almost no difference to initial construction cost, but that probably helps cut 30% seismic recovery fee

In sum, the cost ratio between 100-year maintenance and initial construction approximates to 0.5, and the cost ratio between seismic recovery and building renovation approximates to 3.0.

Analyses of Long-term Maintenance Cost for High-rise Steel Buildings in Taiwan, submitted to JOURNAL OF ARCHITECTURE

Cost for the Coming Disastrous Earthquake

Maintenance cost for unit area per month (元/坪、月)

	20year	21~40year	41~60 year	61~80 year	81~100 year	Average
Case I	167	202	215	378	424	277
Case II	167	202	215	342	400	265
Current	150	150	150	150	150	150

A primary analysis suggests a necessity of increasing the maintenance cost for the coming disastrous earthquake

There is still a great necessity of further studying the series of earthquake events and the impacts on buildings…