

3. RESULTS AND DISCUSSION

Maximum bending moment occurred in the pile by SESAS analysis for all cases of analysis are summarized in Table 1. It is observed that with pile nonlinear consideration, bending moments are reduced significantly. After exceeding cracking limit, non-linear hysteretic behavior of the elements are considered in the non-linear case which cause hysteretic damping and smaller bending moments are happened. Beyond cracking limit, linear behavior is not realistic for RC elements. In the seismic analysis of bridges in soft clay region, non-linearity in the piles should be considered.

Table 1 Maximum bending moment in the pile

Seismic record	Model	Pile max bending moment (kN-m)									
		Pile linear						Pile nonlinear			
		Case I		Case II		Case III		Case I		Case II	
		Each	Avg.	Each	Avg.	Each	Avg.	Each	Avg.	Each	Avg.
I-III-1	Penz.	7512		19117		4727		4131		5250	
I-III-2	Penz.	8537	7570	18539	19989	5460	4836	5182	4303	5250	5250
I-III-3	Penz.	6661		22312		4322		3595		5250	
II-III-1	Penz.	10339		17831		7723		5250		5250	
II-III-2	Penz.	10870	10367	21607	19587	8993	7892	5250	5250	5250	5250
II-III-3	Penz.	9893		19322		6961		5250		5250	
I-III-1	Single	3107		2634		3086		1864		1675	
I-III-2	Single	2688	2872	2982	2740	2692	2809	1816	1773	2069	1893
I-III-3	Single	2820		2605		2648		1640		1934	
II-III-1	Single	3708		3706		3904		2282		3331	
II-III-2	Single	3822	3742	3923	3772	4034	3884	2116	2160	3068	3137
II-III-3	Single	3697		3686		3713		2083		3012	

Distribution of maximum bending moments throughout the pile are presented in Figs. 5, 6 and 7 for Type II -III-1 seismic record. In Penzien model analysis, maximum pile bending moment reached yield limit in Case I and Case II and approached to yield limit in Case III. However, in single input model analysis, maximum bending moment (Table 1) was much below yield limit. Penzien model analysis should be adopted in seismic analysis of bridge pier with pile foundation in soft clay region from safety point of view.

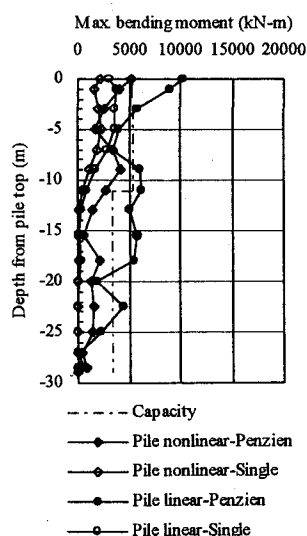


Fig. 5 Max. bending moment in pile in Case I

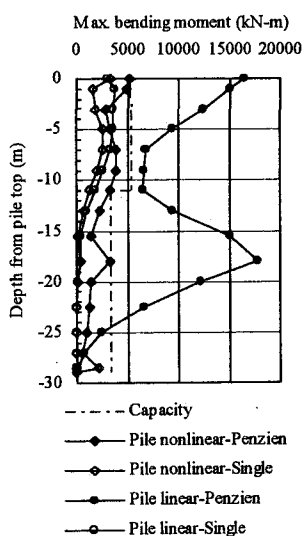


Fig. 6 Max. bending moment in pile in Case II

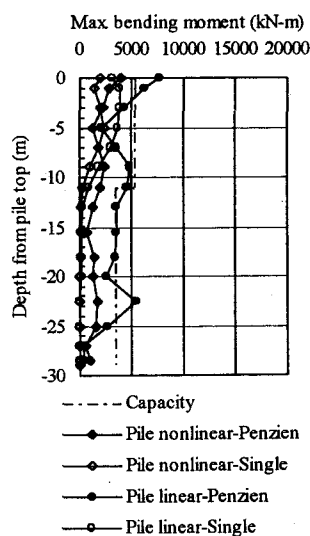


Fig. 7 Max. bending moment in pile in Case III

4. CONCLUSIONS

We propose Penzien model analysis method with non-linear pile behavior consideration for seismic analysis of all bridge structures with pile foundation in soft clay region such as Ariake soft clay region.