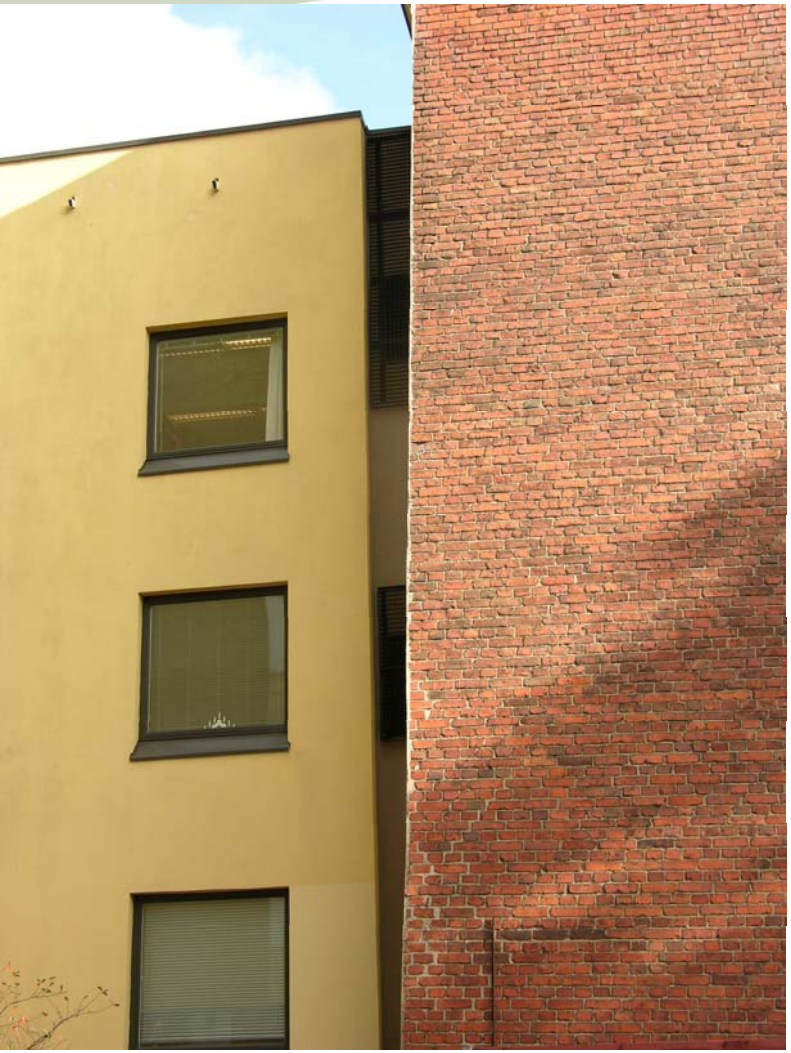

Jouko Lehtonen, Jarmo Virta & Jussi Hattara

Post-underpinning Settlement of the Micropile Underpinning Projects in Turku

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Post-underpinning Settlement of the Micropile Underpinning Projects in Turku

Post-underpinning settlement has been commonly ignored when only minor e.g. elastic deformation has been assumed in practical design of underpinning.

Post-underpinning settlement has not been covered in research literature.

This presentation has a goal to be an opening of discussion on post-underpinning behavior of micropile structures.

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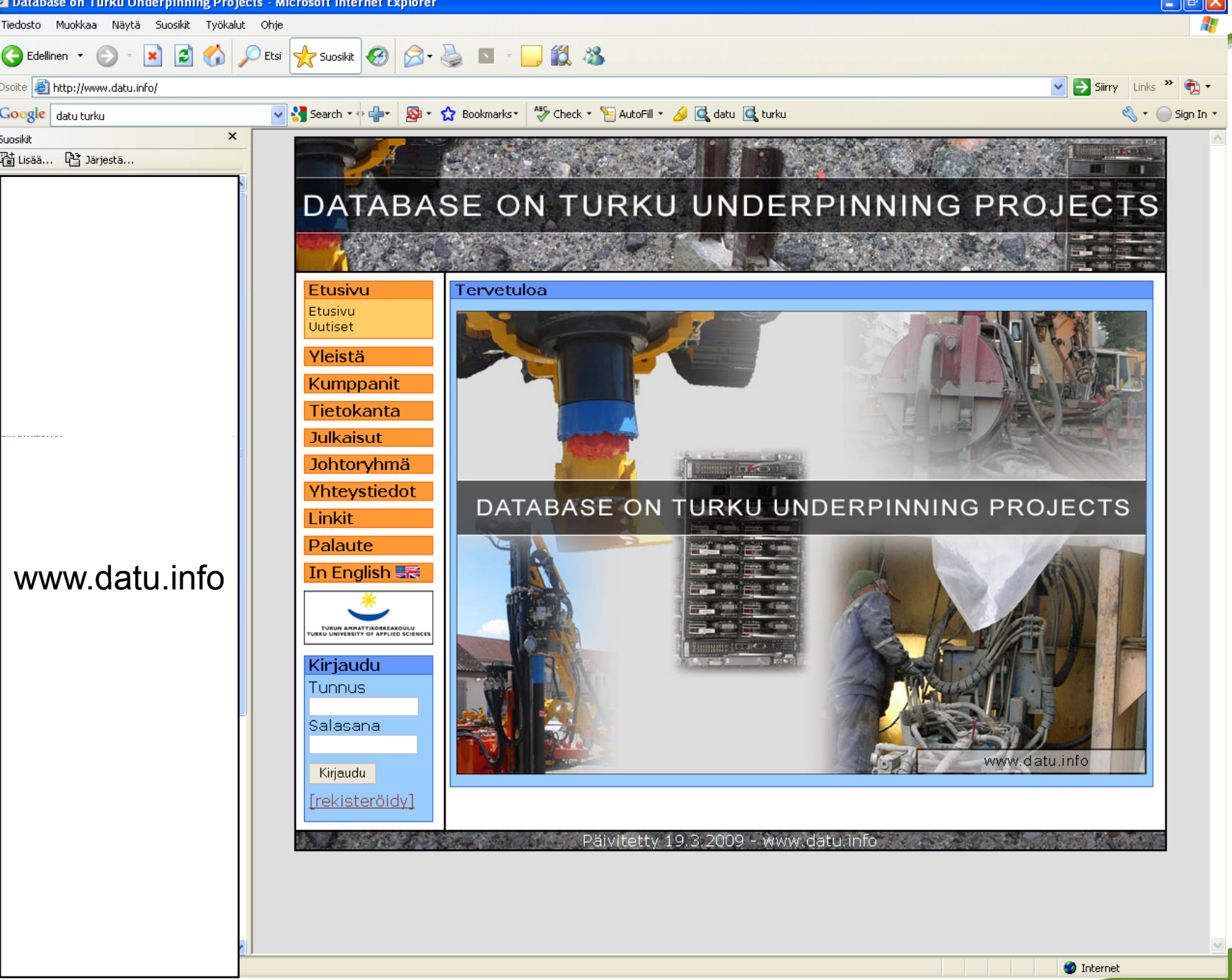
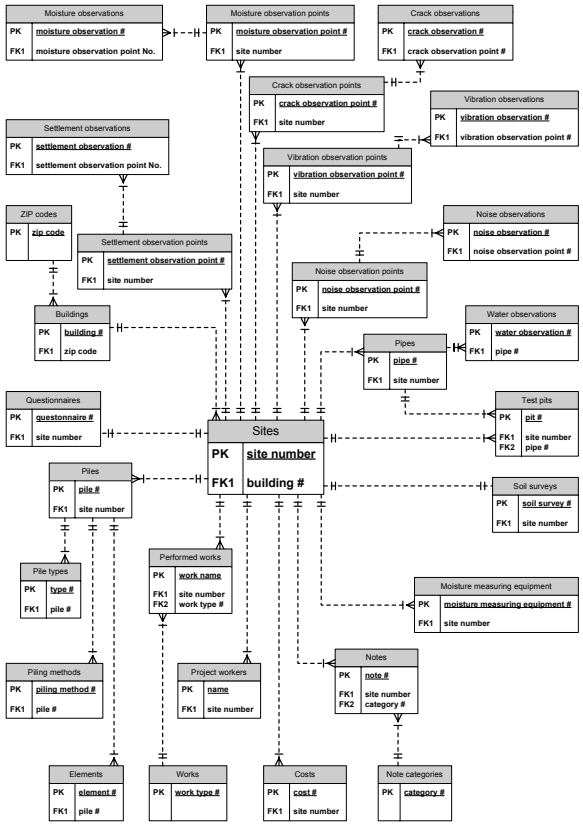
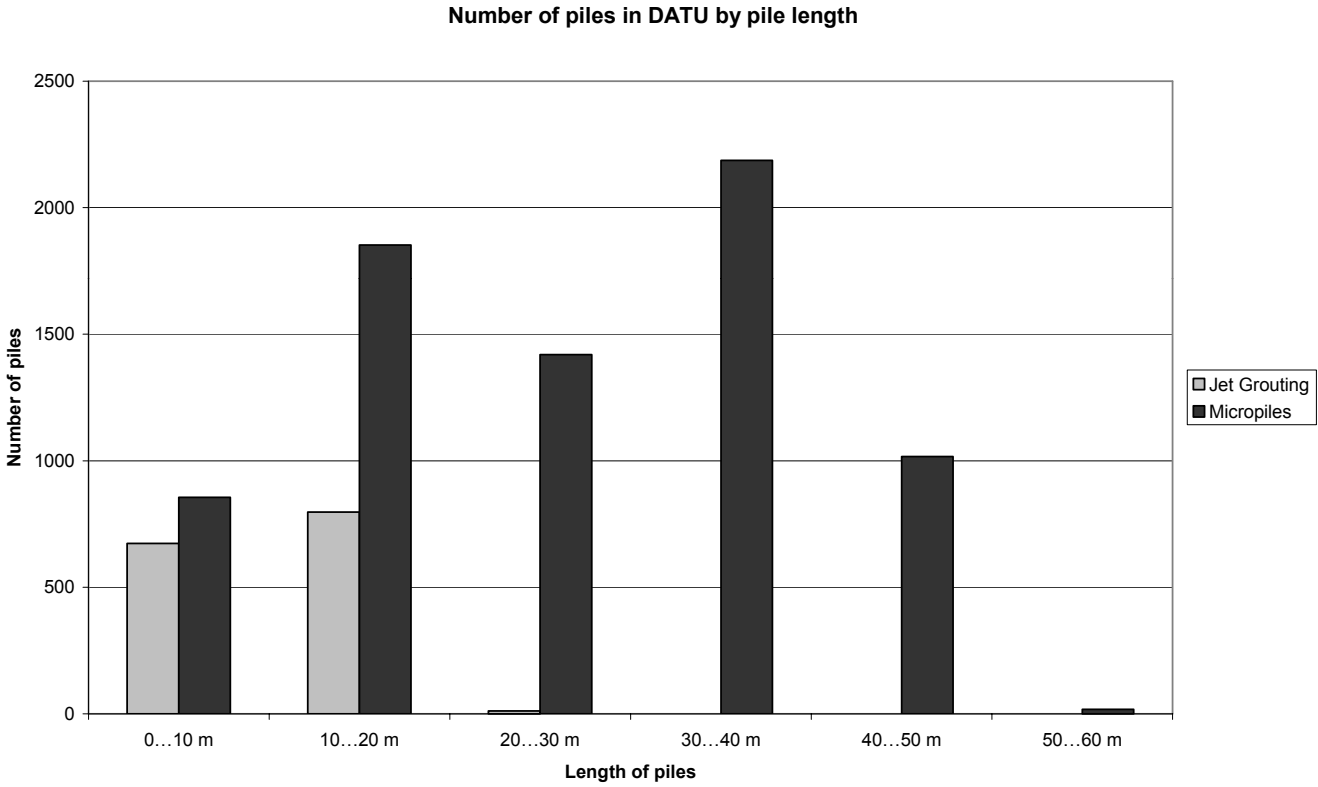


www.datu.info

DATU Database on Turku Underpinning Projects

200 parameters





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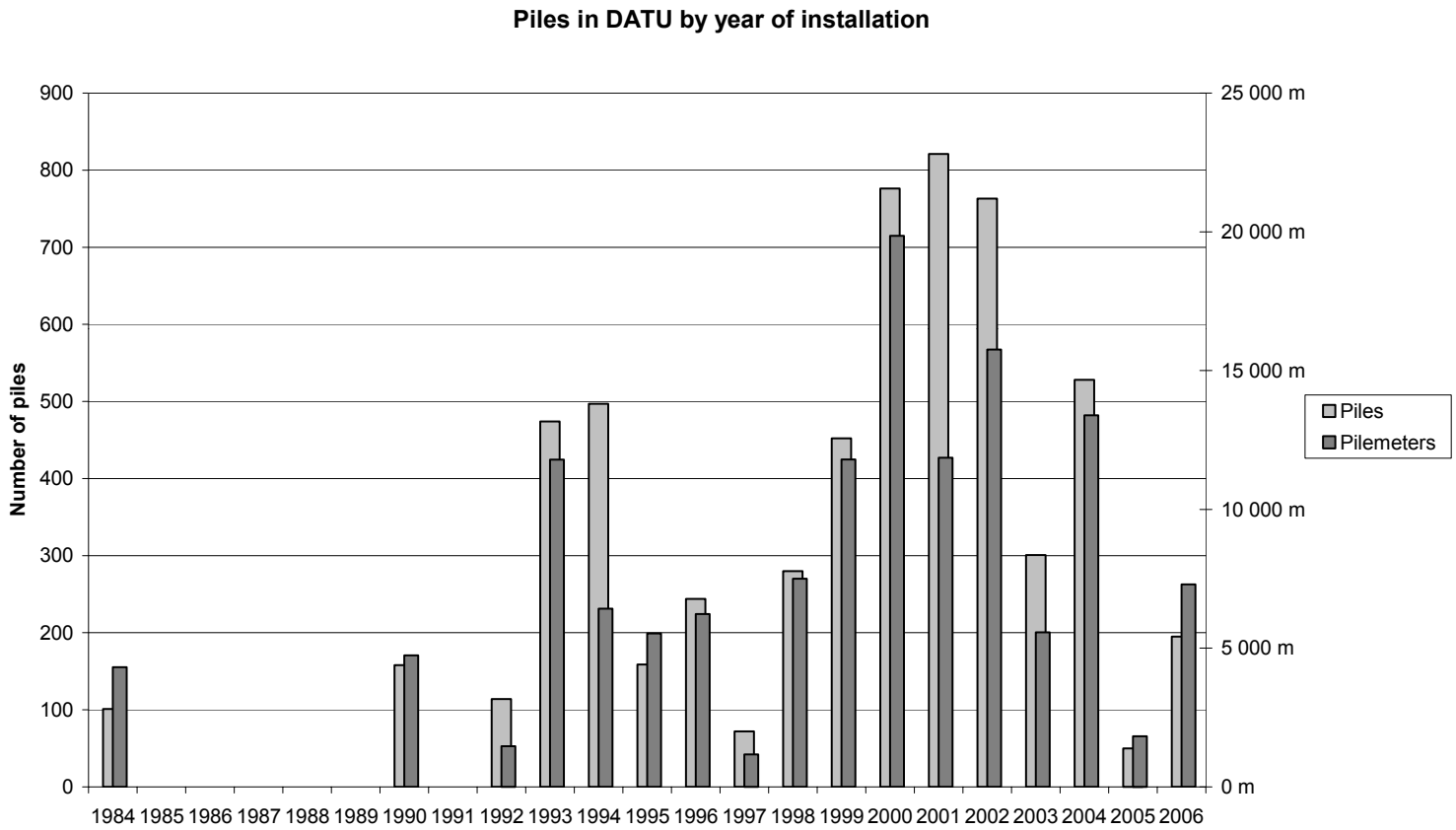
Micropile deliveries in Turku



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Installation of micropiles in Turku

Drilling

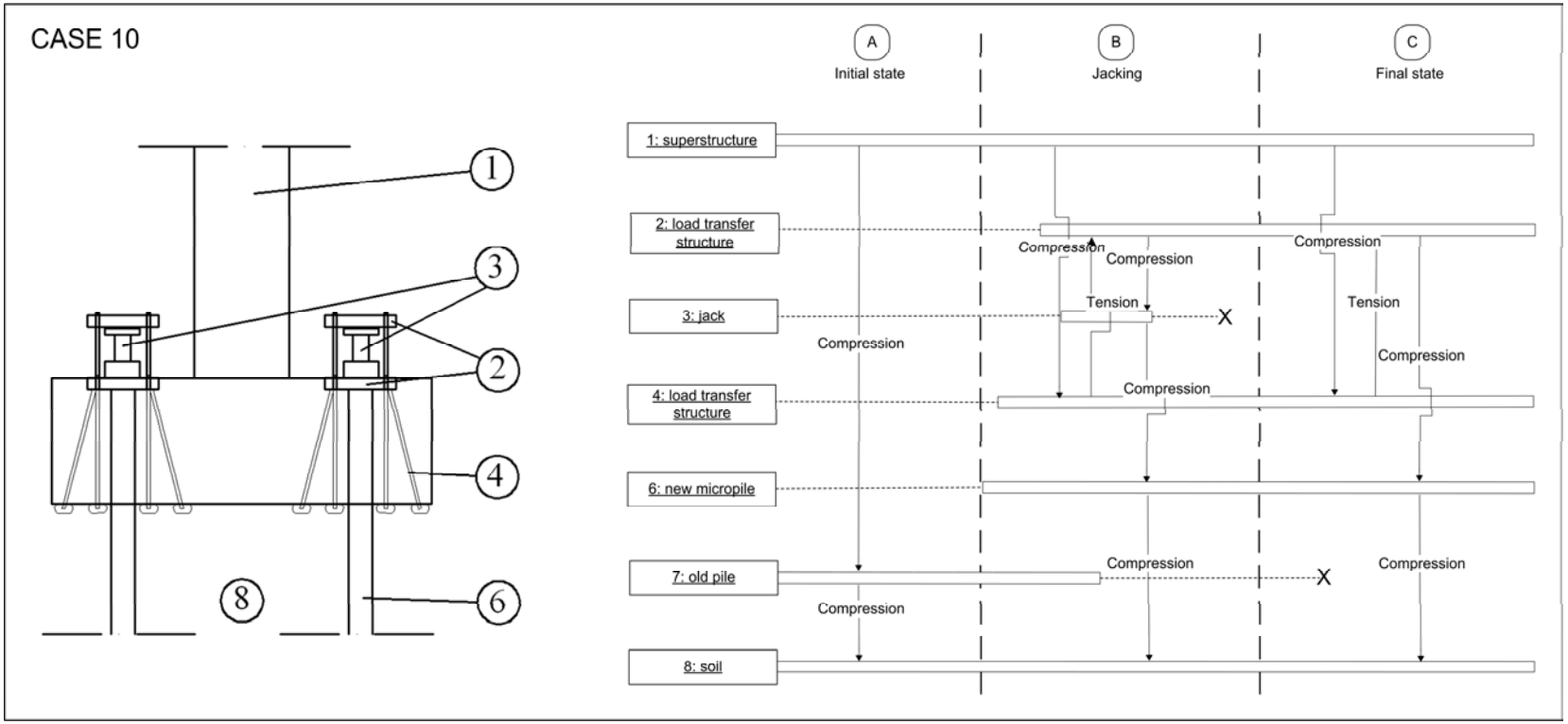
Jacking

Impact driving

Combination in installation jacking/drilling, jacking/driving

In addition, post-jacking for drilled or driven micropiles

Totally 13 load transfer cases has been defined



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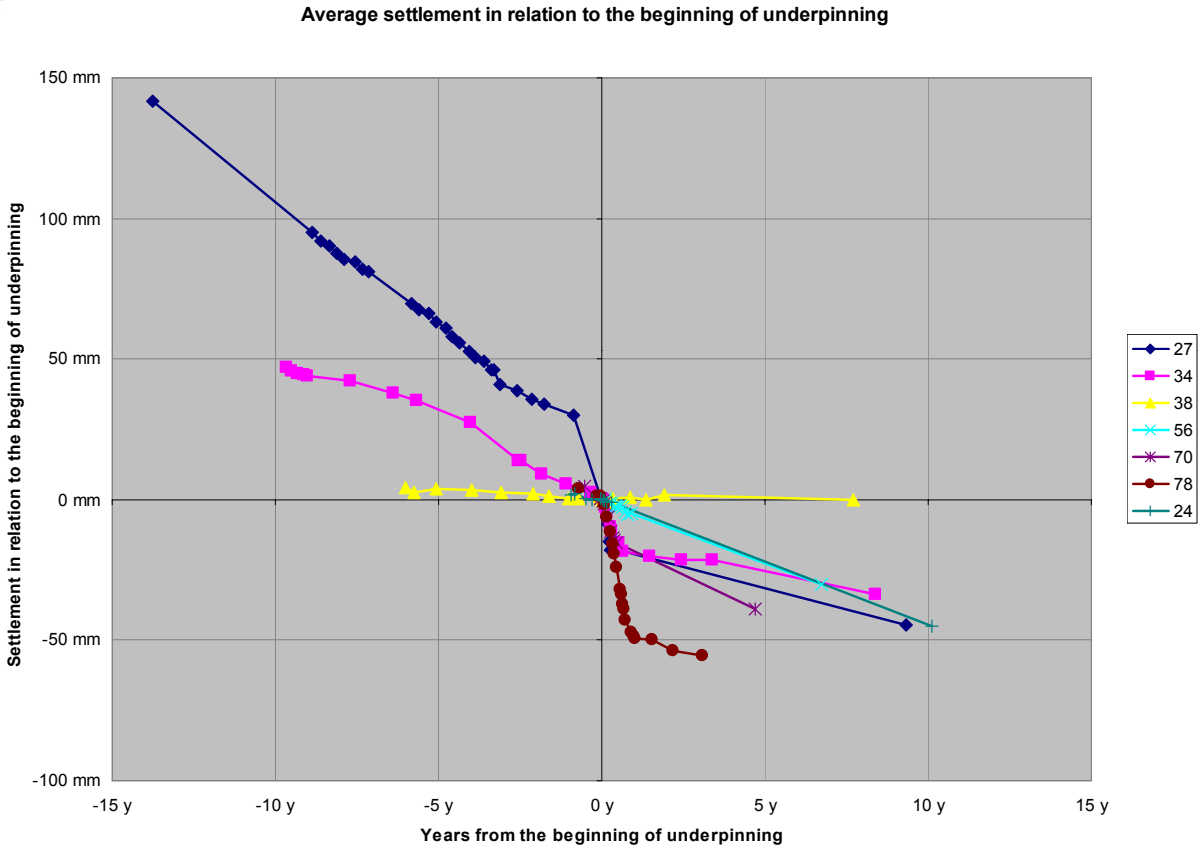
Totally 13 load transfer structure cases has been classified as 4 categories

Table. Categories of load transfer structures in underpinning (Lehtonen and Hyyppä 2009).

	CATEGORIES COVERING CASES OF LOAD TRANSFER STRUCTURES	
	Direct support or minor load transfer structure	**Separate load transfer structure**
Small settlement of superstructure after underpinning (no jacking during installation)	A: 1, 8	B: 2
No movement of superstructure after underpinning (installation with jacking)	C: 9, 10, 13	D: 3, 4, 5, 6, 7, 11, 12



27 driven no pre-loading
34 driven no pre-loading
38 jet gr. no pre-loading
56 jacked pre-loading
70 drilled no pre-loading
78 drilled no pre-loading
24 jacked pre-loading

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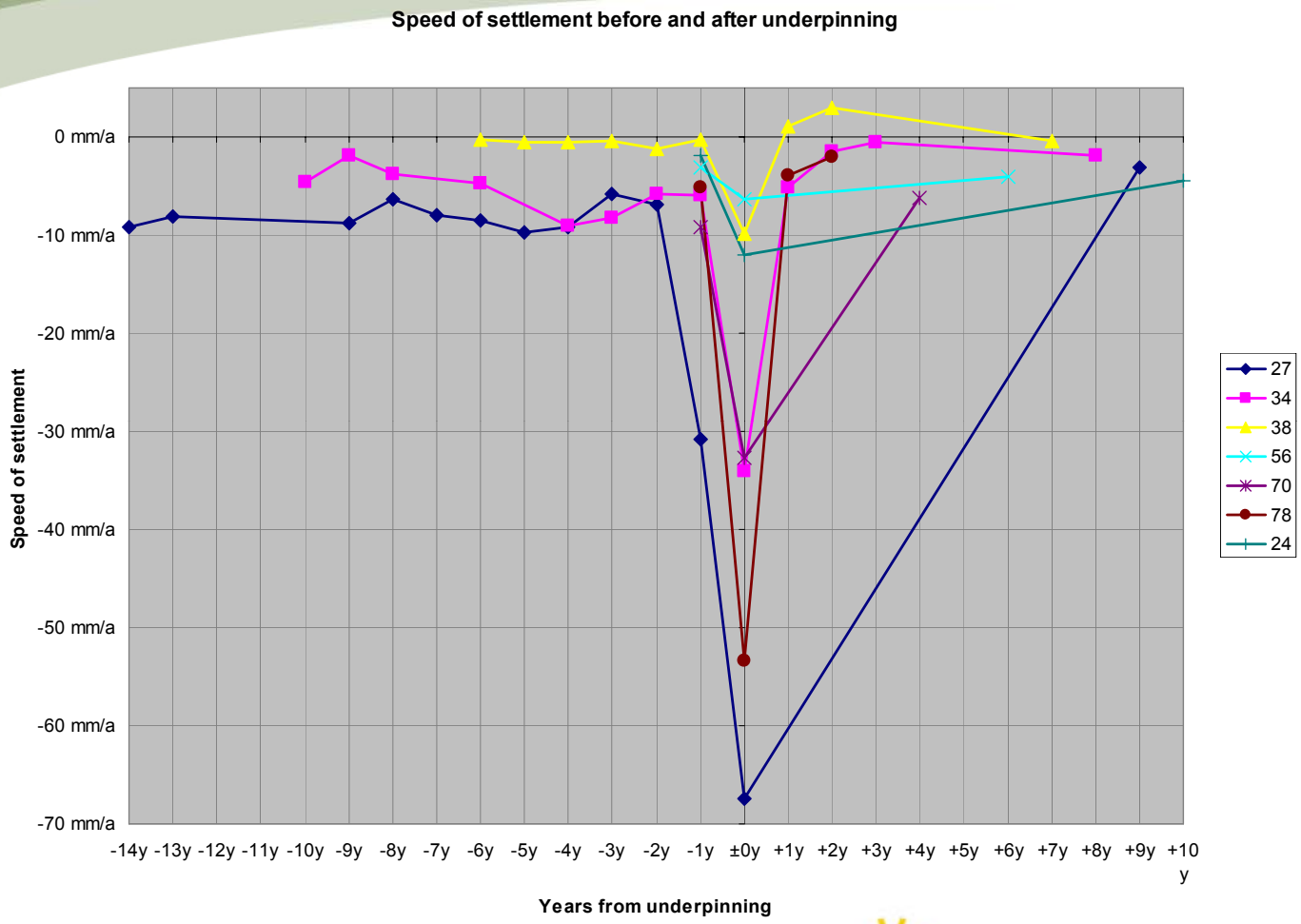

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Site	Micropile type	Total settlement	Settlement during underpinning	Post-underpinning settlement	Elastic deformation of pile shaft
24	jacked	45,2 mm	1,0 mm	44,2 mm	7,0 mm
27	driven	44,4 mm	17,4 mm	27,0 mm	22,3 mm
34	driven	33,6 mm	15,3 mm	18,3 mm	11,5 mm
38	jet grouting	0,1 mm	-0,9 mm	1,0 mm	N/A
56	jacked	30,2 mm	5,0 mm	25,2 mm	31,0 mm
70	drilled	39,0 mm	11,3 mm	27,7 mm	31,4 mm
78	drilled	55,7 mm	49,3 mm	6,4 mm	55,3 mm

Observations

Settlement speed of foundations seems to increase during the underpinning phases. Typically superstructures settle 10 to 40 mm due to vibration and load transfer operations in underpinning. Sometimes settlement during underpinning can be even more, 50 to 70 mm.

Settlement continues after underpinning. If the micropile and load transfer structure system are preloaded the settlement should be minimal, but an observed case had settled for additional 25 mm in six years. Typical post-underpinning settlement is less than 30 mm and speed of settlement is less than 3 mm per year.

The settlement after underpinning is typically less than half of the settlement before underpinning.

Conclusions

Foundations are underpinned mainly to prevent harmful settlement, to enhance bearing capacity, or for seismic retrofit. In many cases, the need for repair work on foundations is due to rot in wooden piles. Many methods are available for foundation underpinning, micropiles and jet grouting having been common in recent times. A new micropile or a jet grouted column is attached to the existing superstructure, often by means of an even highly complex load transfer structure. The aim is often to mobilize the elastic transformation of the micropile already during the installation phase by using jacks.

Leveling of underpinned buildings is highly important during the renovation phases. Post-underpinning observations will be collected to the DATU database in order to create clearer picture on long-term behavior of underpinned foundations.