Low strain integrity testing as quality control of old piles for reintegration in a new foundation

Oswald Klingmüller

GSP, Mannheim - Germany

Introduction

A new storage, tools and workshop building was to be constructed over the foundation of a demolished power plant section. The old piles have been installed about 35 years ago and are according to the only available records enlarged base piles (System "Franki"). For the integration into the new foundation 66 piles have been tested. The piles had to penetrate a soft upper layer to reach the bearing stratum of clayey rock. If this length in addition with constant cross section was verified by low-strain-testing piles could be accepted for the new foundation.

Signal interpretation

Figs 1 to 5 show typical signals that have been obtained by low strain testing.
As can be seen the time histories of pile top velocities deviate considerably from the ideal trace as collected for a newly installed bored cast in situ pile as shown in fig. 6 or from the simulation of enlarged base velocity time histories as given in fig. 7 .

Several superimposing effects have to be considered as the base enlargement by stiffening soft concrete by means of a drop weight will produce individual pile bottom shapes according to the condition of the degraded surface of the rocky layer.

Therefore some of the piles will have no increase in cross section and might firmly sit on the stiff layer as shown in fig. 8 . Other piles will have a large increase in cross section and might be separated from the surface of the rock by a thin layer of loose soil material (see fig. 9 and fig. 10). With this enlarged base in a clayey rock a clear tip reflection could only be obtained in few cases.

A special feature of the signals can be recognized in fig.10 . Some piles show a decrease in impedance shortly before the enlarged base. As no individual piling records have been available it was not possible to decide whether this feature was caused by the soil condition or a special installation procedure.

Signal classification

According to accumulation of certain features a classification could be carried out with respect to signal properties:

1. Signals with clear tip reflection and no indication of impedance deviations
2. Signals with enlarged base characteristic and no indication of impedance deviations
3. Signals with weak tip reflection or no enlarged base characteristics and no indication of impedance deviations
4. Signals with tip reflection and strong impedance decrease
5. Signals with tip reflection and impedance increase
6. Signals without tip reflection and impedance decrease
7. Signals with multiple superposition of effects and questionable tip reflection

The frequency distribution of the signals according to the classes shows fig. 11.

Pile classification

Following the signal classification the respective piles have been classified in 5 categories :

1. Piles fully usable
2. Piles with little deviations but fully usable
3. Piles with impedance reduction but clear pile bottom features
4. Piles with impedance reduction and questionable pile bottom shape
5. Piles unusable

As can be seen by the frequency distribution in fig. 12 the classification shows that 9 piles must be rejected. Piles in classes 3 and 4 have been assessed usable if the planned loading was medium for piles class 3 and low for piles class 4.

Conclusion

By the application of "low-strain" integrity testing a foundation of mixed old and new piles could be achieved that was totally conforming with today's reliability demands. Because of the high effect for the assessment of the piles the cost for integrity testing was as high as 10% of the cost for a new pile but still it can be said that a quality control by low strain integrity testing is well paying of.
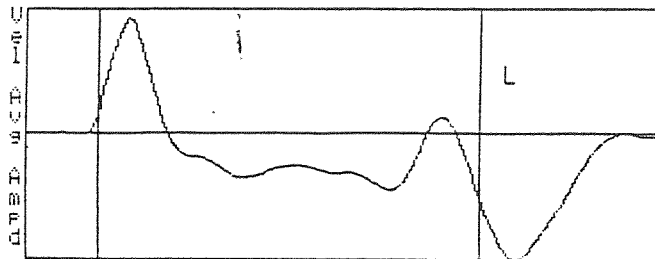
Figure 1 : Example pile - signal class 1 / pile class 1
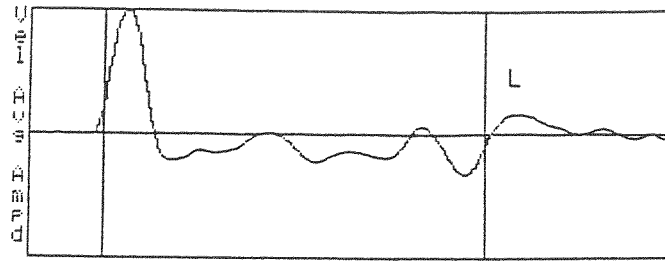
Figure 2 : Example pile - signal class 6 / pile class 2
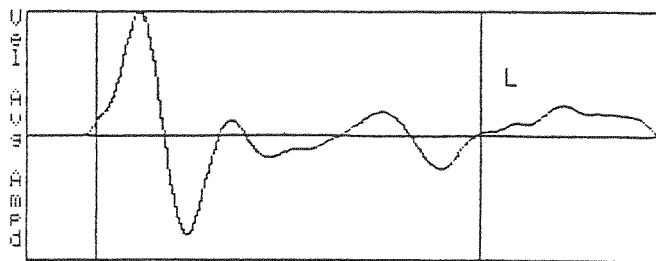

Figure 3 : Example pile - signal class 3 / pile class 3
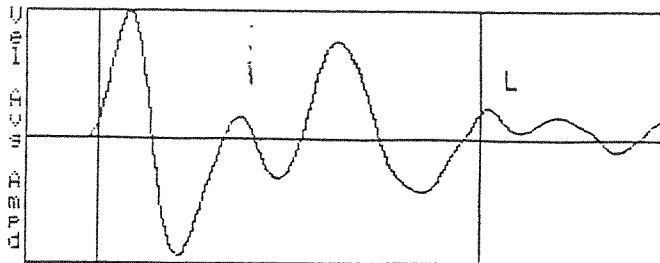

Figure 4 : Example pile - signal class 4 / pile class 4
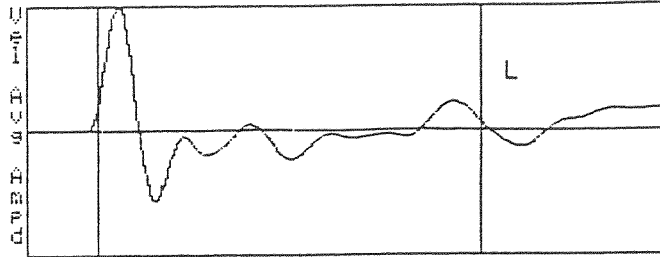
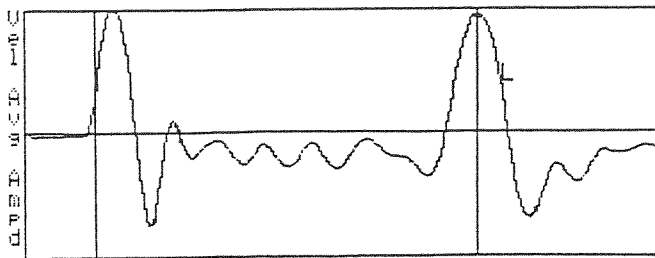Figure 5 : Example pile - signal class 5 / pile class 3

Figure 6 : Newly installed cast-in-situ pile without enlarged base
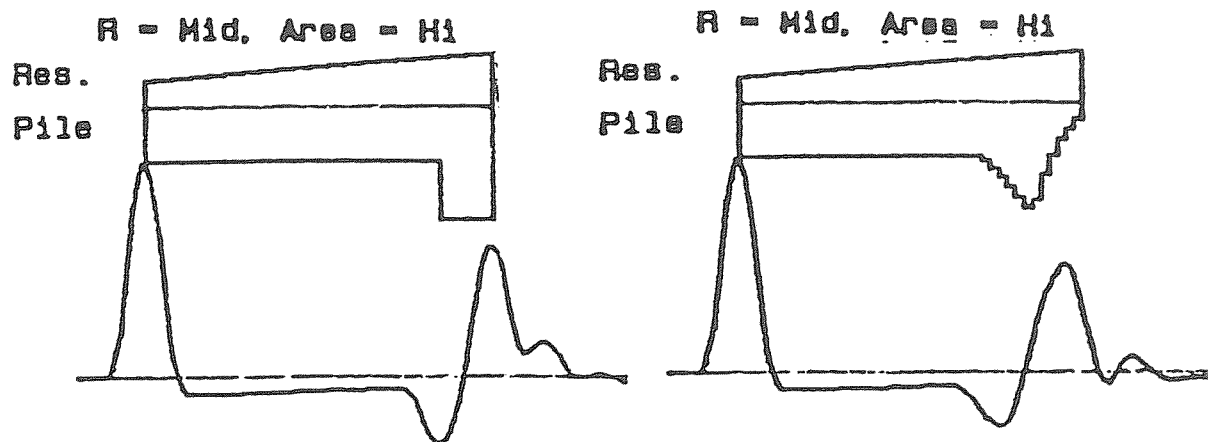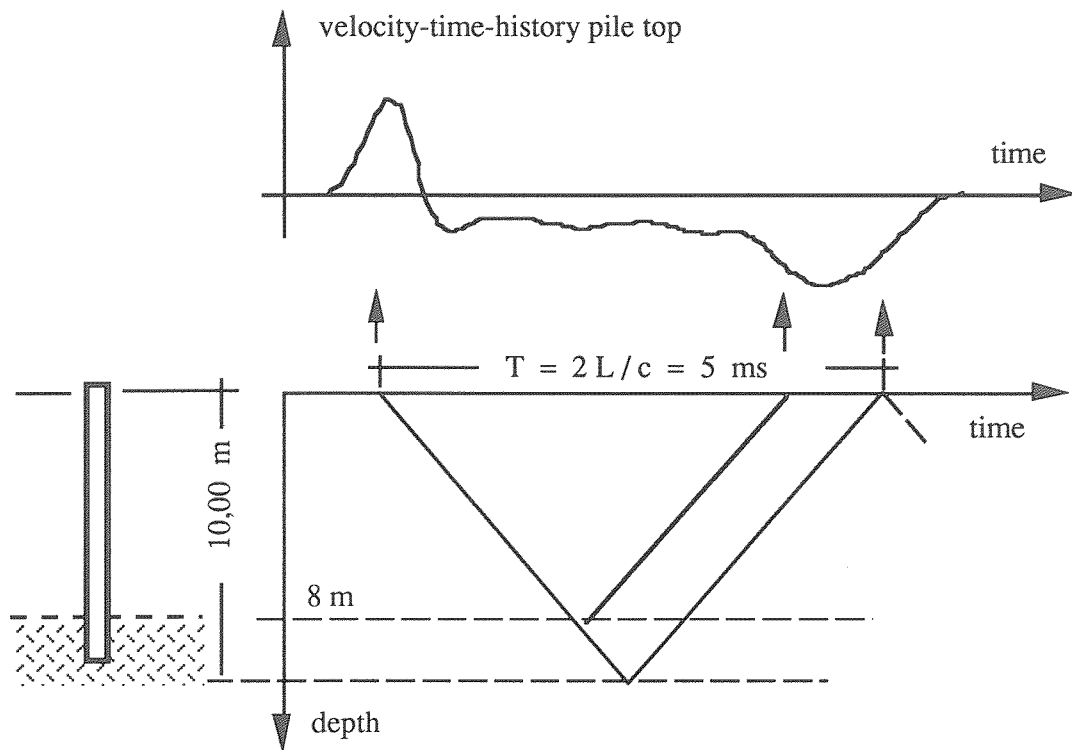

Figure 7 : Simulation of enlarged base piles

Figure 8 : Pile embedded in rock
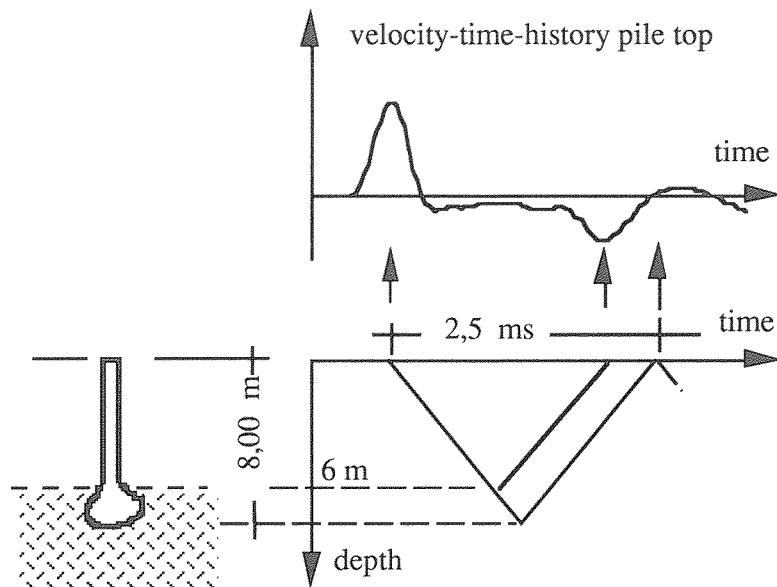

Figure 9 : Pile with enlarged base in rock

velocity-time-history pile top

time
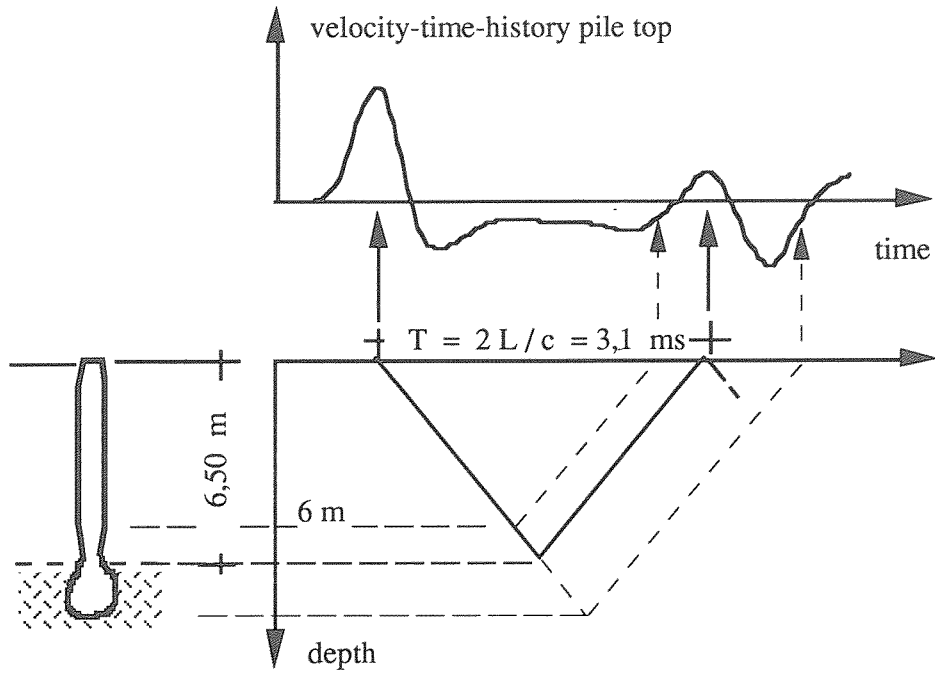
$T = 2 L / c = 3,1$ ms

6,50 m

6 m

depth

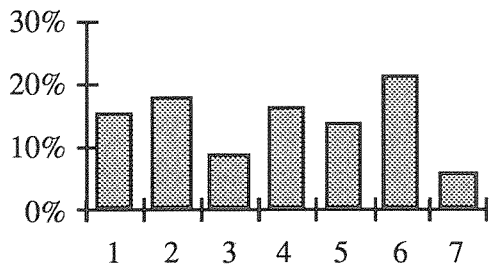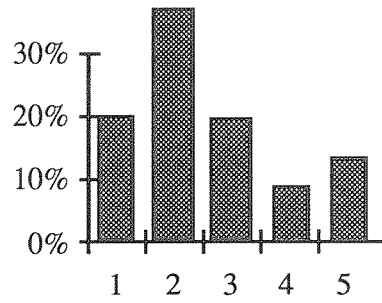Figure 10 : Pile with enlarged base in firm soil and necking

Figure 11 : Frequency distribution
of signals

Figure 12 : Frequency distribution
of piles

632