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Dimension of liners for reconstruction of damaged pipes

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Summary

Introduction

The endangering potential of imperfect sewers to ground water and soil has resulted in systematic maintenance in the past especially at public sewerage systems. The experimental verification of calculation methods in ATV M127 T. 2 was the essential aim of a research work done at the LGA Bayern. This projekt was financed by the Bundesministerium für Raumordnung, Bauwesen und Städtebau and the LGA Bayern. Further support was given by Fa. Gollwitzer (preparation of the concrete pipes) and Fa. Insituform (installation of the liners).

Experimental setup

Large scale attempt was carried out on concrete pipes DN 800 (diameter 800 mm) equipped with liners. Fig. 1 shows a sectional view of the testing model. To get defined damages, in literature usually appointed as a ring with four hinges the concrete pipes were indented in crown, sole and abutments. At each attempt two liners with different thickness (9 mm and 18 mm) were used to comment on the influence of various liner stiffness on the loadcapicity of the whole system on the one side and the strain on the liner on the other side. As soil for the first experiment sand was used, for the second a substitute material was chosen to simulate a cohesive soil

The main attention of the research was to observe the breaking and the following deformation of the linked system. The liner and the concrete pipe deformation was measured in two sections. In Fig. 2 the measurement points for the liner deformation are shown. The concrete pipe deformations were measured in the corresponding points. With braces steel wires were fixed in the liner and the concrete pipe. They were conducted from the testing model by an independent measurement axis. The deformations were measured by the change of length of the steel wires.

The measured extention in crown, sole and abutments allows to concluse on material strain. The concrete extension was measured with strain gages in such parts of the pipe, where the developement of hinges was to estimate.

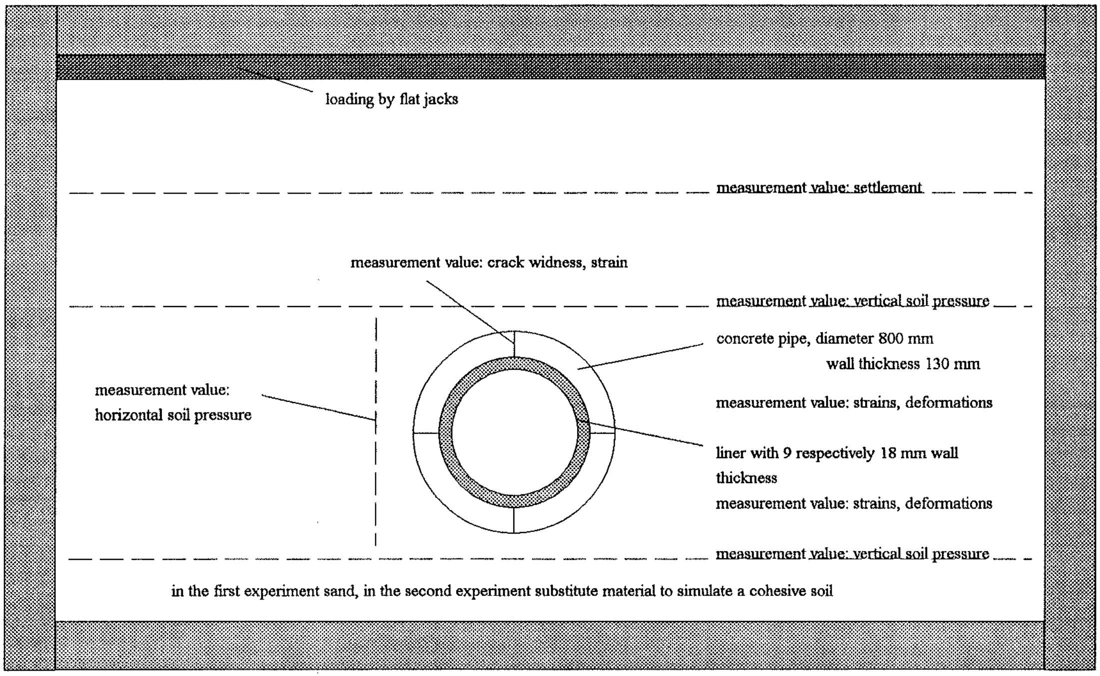

Fig. 1: sectional view of the testing model

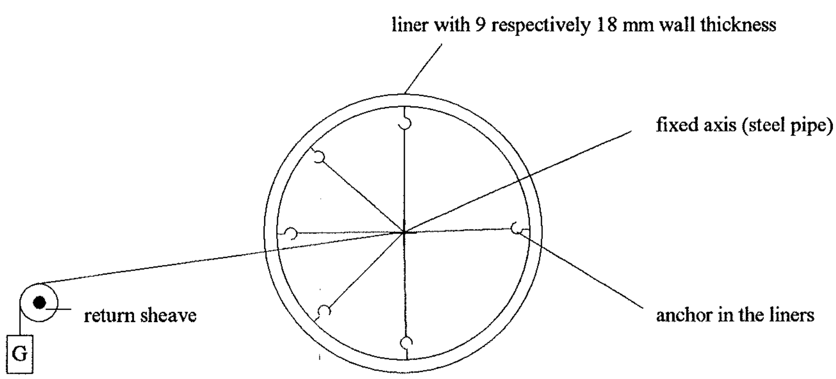

Fig. 2 measuring of the liner deformations in the cross sections I and II

Opposite to the concrete strain gages (on the outside of the pipe) crack-width in the abutment areas were measured.

During the attempts soil pressure and settlements were measured in different sections. Pressure sensors from Fa. Glötzel were used for observation of soil pressures, rubber tube levels for observation of settlements.

Results

The results were related to an averaged soil pressure. The maximum liner strains occured in both attempts in the sole. Fig. 3 shows the results of attempt one. It also illustrates that there´s almost no strain in the liner up to an averaged soil pressure of 100 kN/m². Obviously the developement of hinges continues up to this load step. The calculation models of [1] are not able to describe this proceeding.

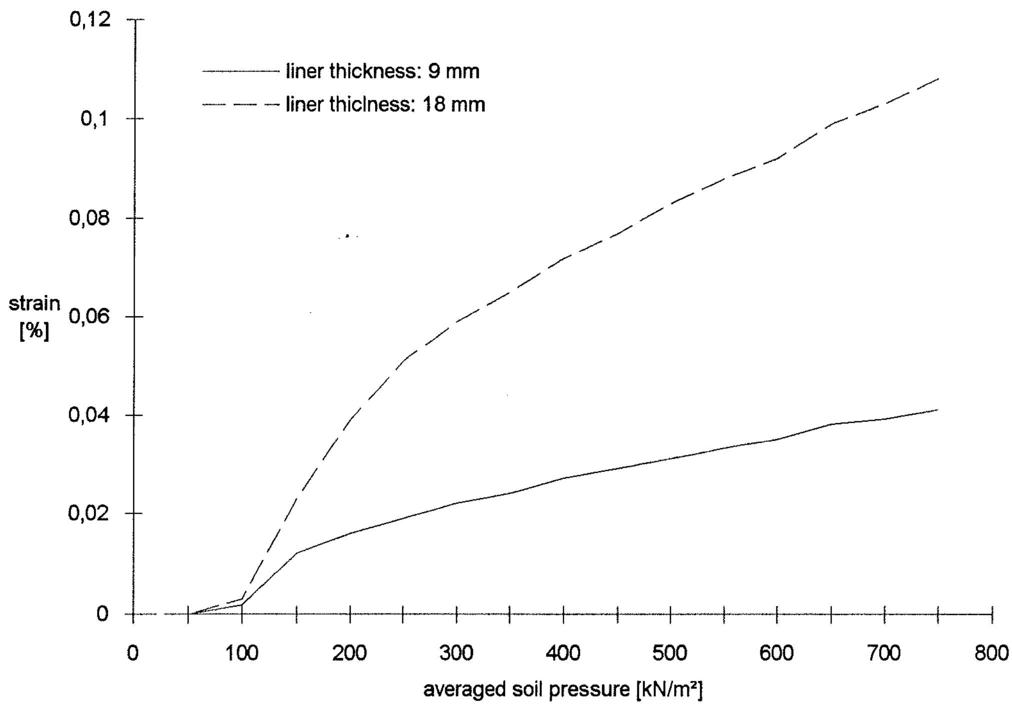

Fig. 3: measured strains in the sole of the liner (first attempt)

Fig. 3 also shows that the thin liner only receives half the strain the thick liner gets regardless the load step. This proportion was also confirmed by the second attempt. These results indicate that the liner stiffnes has not a significant influence to the stiffness of the whole structure but gets the deformation of the broken concrete pipe as a forced deformation. The relation between strains is nearly the same as between liner thickness.

Finally Fig. 4 is a good comparison between the resulting liner deformation from the first attempt and the calculated results applying [1]. The doubling of the liner thickness has only little influence on the diameter change (nearly 10 %). Thus the stiffening effect from the liner on the whole system is also small.

In addition Fig. 4 illustrates some discrepancy between calculated and measured results, which should be discussed here.

The calculation results in nearly the same diameter changes independent from the liner thickness. The effects of the liner thickness on the deformation which were recognizable in the attemp cannot be simulated with the calculation model. For low load areas the calculation model cannot describe the developement of (hinges). The calculated deformations are much higher than the measured deformations.

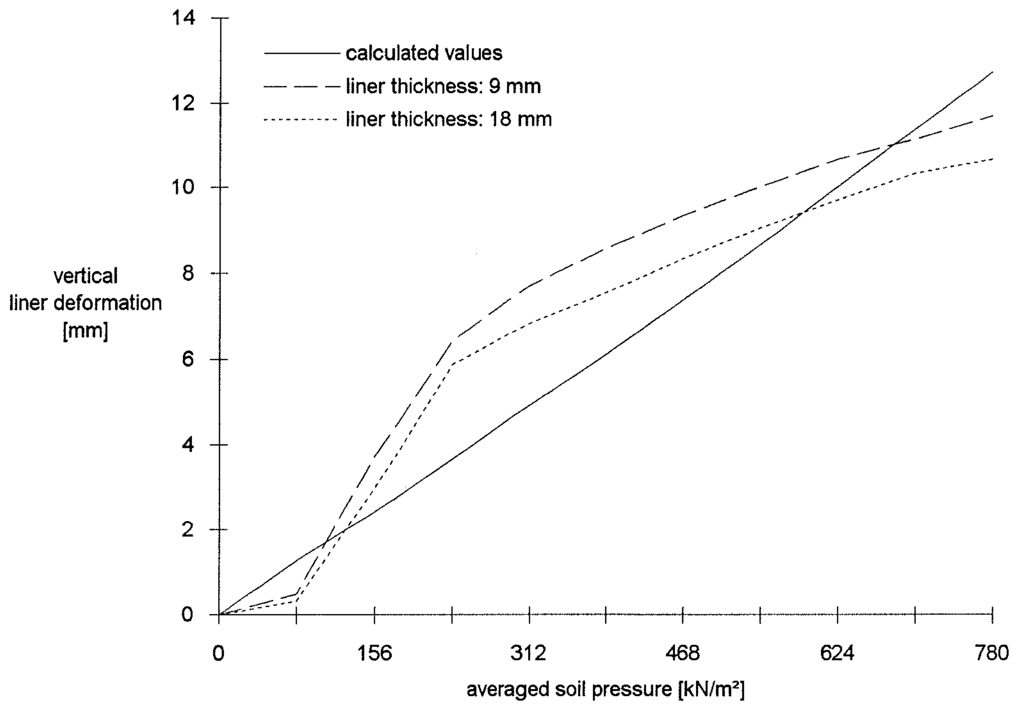

Fig. 4: vertical cange of liner diameter (first attempt)

Summary

The comparison between experimental and numerical results shows no satisfying correspondence. Further modifications of the models as far as the mechanic behaviour of soil is concerned seems to be necessary.

Pipes reconstructed with liners have a significant deformation ability. In the second attemp a vertical diameter change of 22,8 cm could be produced without achieving a system collaps. It´s to concluse that occuring cracks (even with a width of some mm) don´t mean loss of sufficent stability of a channel.

Further the measured liner strains show that thinner liners are not so demanded. That means in comparison to ATV A127 [2] which is usually used at the moment significant economies can be achieved.

References

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