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# The Preservation of the Old Town of Stockholm

## La Préservation de la Vieille Ville de Stockholm

H. BOHM Chief Engineer, Stockholm Office of Housing and Real Estate, Foundation Division, Stockholm, Sweden

**SYNOPSIS** The preservation of the Old Town of Stockholm is to a great deal a foundation reinforcement problem.

### THE OLD TOWN THROUGH SEVEN CENTURIES

The island on which the Old Town is situated is a spur of the Brunkeberg esker, which was formed during the glacial period. The strategic position of the island in the outlet of Lake Mälaren into the Baltic Sea entailed its early importance for trade and political power.

When Stockholm was founded in the 13th century the island was less than half of its present size. The oldest buildings were situated on the highest plateau of the esker and were surrounded by a town wall. Outside the walls ran the common streets, the long streets of today. Probably about 1300 filling out started in the shore area. The fill consists of all sorts of materials such as sand and gravel, timber, plant remains, fire rubble and household refuse and rests mainly on the surface of the esker, however in some places it rests on clay. Close to the shorelines the thickness of the fill varies between 10 and 20 m.

Building expanded onto the filled - in land, in narrow blocks formed between the passages leading down to the landingstages. The houses were here founded on wooden piles and/or grillages of logs. Due to the land uplift (in Stockholm 40 cm per 100 years) these wooden foundations have been raised over the ground water table, allowing them to decay.

Not until the 17th century could the Old Town be regarded as a town of stonehouses. The change of the town was initiated after a fire in 1625 which destroyed the buildings in the southwest part of the island. The 17th century left its mark on the buildings and gave the Old Town the character, which it has largely retained until today. Contrary to expectations, however, the old buildings were not demolished entirely. Use was made of the medieval foundation walls, cellars and a large part of the brickwork in the new buildings.

During the first half of the 19th century the town became overpopulated and the buildings were badly worn and, slum-like. These conditions led to a number of regulation proposals during the period 1850-1916. These proposals involved the complete demolition of the buildings in the Old Town. With a few exceptions, however, these pretentious regulation plans never passed through the paper stage. At the turn of the century instead an interest was awakened for the Old Town as a historical document. The turning-point came in an architectural competition in 1923. The first total renovation work was carried out in the block "Cepheus" in 1936-38.

In 1960 the Building Committee appointed a special committee that drew up the principles for the renovation of the Old Town. Matters of financing and general economic support were taken up by the state. Comprehensive building renovation began towards the end of the 1960's. In one decade, more than half of the sub-standard flats were renovated up to modern standard; often without necessary foundation reinforcement.

In 1978 a town-planning proposal was ratified by the government for the Old Town. The entire area has in that plan been classified a reserve of cultural and historical value. The plan is accompanied by rules and recommendations for preservation, renovation and foundation reinforcement.

The expert committee began by taking up the question of foundation reinforcement. An inventory made in the buildings in the filled-out areas suggested that not only vertical movement but also horizontal movement may have occurred.

The work started with extensive studies of all older information about foundation conditions. On the basis of this inventory further investigations were made including:

- . sounding and sampling with heavy drilling equipment
- . investigation of foundations in trial pits (about 30)
- . radiocarbon dating of foundation timber
- . corrosivity measurements (about 25 points)
- . groundwater measurements (about 20 points)
- . measurement of settlement (about 1300 points)
- . measurement of horizontal movements in soils and buildings
- . damage inspection
- . techno-economic follow-up five foundation reinforcement projects
- . suitable way of financing the reinforcements

Altogether, a large number of investigations have been analysed. For example, the findings from about 350 trial pits have been studied.

These investigations were complicated by the difficult soil and foundation conditions in the Old Town, including relatively impenetrable fill, cramped cellars, copious groundwater in trial pits, absence of a stable reference point for measurement of movements on the island, etc. The result of these investigations is as follows.

#### FOUNDATIONS

Within the medieval shoreline most buildings rest on the good ground of the esker. Outside this line on the loose, filled in ground, the buildings are, as a rule, founded on wooden piles or grillages. In the proximity of the medieval shoreline, where soil conditions are varied, the type of foundation can vary below individual buildings - a condition with drastic consequences in many cases. From the 1930's new buildings have normally been founded on concrete piles. The driving of concrete piles has caused such damage to adjoining buildings, however, that the method has been abandoned.

During this century some 60 buildings have had their foundations reinforced. The first foundation reinforcement projects in the 1920's consisting of cutting-off rotted pile tops and casting concrete foundation walls below the water table. Success was far from guaranteed, however, due to the very varied quality of bearing capacity of the piles. Since the 1930's the jacked pile method (Megapiles) has dominated. However, this method also has disadvantages when used in the Old Town. Therefore jointed slender steel piling techniques has been developed.

#### SETTLEMENT

The fill is settling continually with a rate of between 2 and 7 mm per year.

The old buildings along the shorelines have been settling for a long time. The rate of settlement varies, normally between 1 and 6 mm per year.

#### SETTLEMENT DAMAGE

The damage due to settlement takes the form of cracks, deformation of walls and beams, warped window frames and doors. Leaning walls and whole buildings are common. Many buildings are severely damaged. In some cases there are risks that parts of buildings can collapse. However, the damage is often concealed by recent repairs.

#### GLIDING OUT TOWARDS THE WATER

The buildings on the fill show more or less clear signs of previous movements towards the water. These signs led to the obvious question whether horizontal movements are still in progress, and whether in that case they are large enough to have any practical influence on the choice of foundation reinforcement method. In order to answer this question measurements have been made in soil and buildings.

The result is as follows. There are no clear indications of on-going sliding of the fill towards the surrounding water. Measurements in some buildings along the eastern shore indicate that small movements (1-2 mm per year) may be in progress.

The primary reason for the horizontal movement is believed to be uneven settlement. Foundation reinforcement with piles will stop these horizontal movements.

#### NEED OF FOUNDATION REINFORCEMENT

In all 120 buildings are considered to be in need of foundation reinforcement sooner or later. The total foundation reinforcement cost for these buildings amounts to 216 million SEK. The majority of these buildings are privately owned. Since the present financing system is not sufficient this question has been investigated. A proposal will be made that the community as well as the State and the house-owners should cooperate in financing of foundation reinforcements in the Old Town.

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