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## **Analysis of Deterioration of Civil Buildings in South Ukraine**

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### **Summary**

The southern regions of Ukraine are known for particularly numerous cases of deformation of structures built on collapsing soils. Deformation of different building types and various method of containing it have been analysis as well as the cost of damage repairs determined. The stress-strain state of buildings with foundations in the condition of inhomogeneous deformation has been defined by applying the Finite Element Method.

### **1. Protection of buildings against collapsing deformation**

The following protective measures are usually carried out in the standard practice of public and residential building construction:

- driving of precast concrete piles through the entire collapsing soil layer;
- eliminating the collapsing properties of the soil by compacting its entire layer;
- applying a package of designing waterproofing measures by way of setting up two-metre-thick pad foundations, concrete girdles, contraction joints, etc.

The most expensive but at same time the most reliable is the first of the above procedures, while the third one is the least expensive.

A protective procedure is to be selected by taking into consideration both the soil and the type of a building. Single houses are built without any special protection. Buildings of up to six stories are protected mainly by a package of design and waterproofing measures. About 50% of 7-10-storey buildings are also protected by the same package when 45 percent of them are erected on compacted soil. And only 5% of them are erected on pile foundations. Majority of 10-storey or taller buildings are put up on pile foundations and only some of them—on compacted soils.

### **2. Deterioration of buildings**

Buildings in service are deteriorated because of inhomogeneous moistening of the underlying soil mainly due to water leakage out of water conduits. The kind of deterioration generally depend on the type of building. The most serious deterioration which are sustained by buildings of four to

six stories are due to their hogging. Repair expenditures comprise 8-10% of the building cost. The observation data on the behaviour of deteriorated building have been statistically analysed and the probability of building trouble free service during their rated lifetime has been determined.

### **3.Determination of stress-strain state of a building**

Calculations based on the revised models were used in order to substantiate the recommendations of design and protective measures for buildings both being deformed and under constructing.

The "building-collapsing soil" system is approximated:

- by solid elements simulating soil with natural moisture content, the moistened soil tract and the zone of compaction;
- by beam elements simulating the piles and the elements of building strengthening;
- by shell elements simulating the building structures.

Using such models facilitates the evaluation of the stress-strain state caused by building deformation. The calculated stress-strain state corresponds to the in-situ damage measurements thus testifying to the adequacy of adopted computation models. Besides the actual influence of settlement upon the building in way of local reduction of the foundation rigidity caused by moistening is to be taken into consideration

The investigations thus carried out, and the analysis of the building stress-strain state in particular, permit of increasing the building reliability by the efficient designing, constructive measures and strengthening the deformed buildings.

Several methods can be used to further the service of deformed buildings:

- strengthening the foundations or arrangement of additional pile foundations using pressure piles;
- strengthening the building structure by steel elements including those prestressed;
- eliminating the building leaning by soil removal from under the foundation;
- jacking up the building;
- induced moistening of collapsing soil.

These are comparatively labour consuming and expensive operations, not always performing their mission. Methods of selecting reinforcements based on calculation promote the reliability of buildings and reduce the expenditures.