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Reinforcement of Apartment Buildings Exposed to Paraseismic Tremors

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Summary

A method of reinforcing prefabricated ferroconcrete apartment buildings subjected to mining earth tremors has been presented. The reinforcement consists in the extra bracing of the longitudinal walls of the staircases by making them thicker and by adding external pillars.

1. Introduction

In the 60s and 70s many new housing developments were built in the towns of Glogów, Legnica and Polkowic (the conurbation of these towns is referred to as LGOM). This was associated with the beginning of the mining of the copper ore deposits there. Since initially it was assumed that the area of mining would not reach the towns, the structures that were erected there were not protected against the effects of mining operations. Soon, however, copper ore was mined not only close to these towns but even under them. This resulted in damage to several structures previously erected in this area. This happened, for example, in Glogów where it became necessary to reinforce five apartment buildings because of their considerable damage and excessive deformation.

2. Description of Reinforced Buildings

The considered structures are located in the *Copernicus* housing development. These are isolated, 13-storied buildings situated on a 11×46 m rectangle plan. They were built from prefabricated reinforced concrete wall plates and floor slabs. The transverse walls perform the load-bearing function. The external walls were constructed as curtain walls welded to the transverse walls. The walls of the staircases longitudinally

constitute the bracing. A scheme of the structural system of one of the buildings is shown in Fig. 1. The buildings are founded on foundation plates.
According to the construction system inventors' design, the vertical and horizontal joints between the prefabricated wall and floor units were to be packed tightly with concrete or, in places, with cement mortar. In reality, because of shrinkage and temperature phenomena, natural deformation, and movements of the building as well as sloppy execution, the concrete and the mortar in the joints soon started cracking and spalling. As a result the spatial rigidity of the building decreased markedly.

3. Paraseismic Phenomena in LGOM Area

The genesis of a mining earth tremor and the mechanism of its action on buildings have been described in a number of papers [1, 2, 3, 4, 5]. These effects are commonly described by the following parameters:

- terrain surface subsidence,
- terrain surface inclination,
- terrain horizontal unit strain (terrain creep),
- the radius of the trough,
- the acceleration of the horizontal vibration of the subsoil.

According to the forecasted effects of the projected mining [7], the first four of the above quantities will be small enough not to cause the destruction of the considered buildings, particularly that they are founded on foundation plates. Whereas the expected horizontal acceleration of the subsoil producing kinematic excitations in these structures is great enough to cause their failure.
According to [6], the boundary value above which inertial forces should be taken into account in the design is the terrain horizontal acceleration of 50 mm/s^2. The maximum acceleration measured so far in the LGOM area is 291 mm/s^2 and the boundary forecasted acceleration should not exceed 400 mm/s^2.

4. Damage to Considered Buildings

The following kinds of damage caused by mining operations were found in the considered buildings:

- cracks in the joints between the wall prefabricated units and the shielding prefabricated units. The cracks were 0.5 ÷ 0.2 mm wide;
- the separation of the curtain walls from the transverse load-bearing walls. The gaps were a 0.5 ÷ 0.5 mm wide.

The tenants complained that during tremors they could feel the building moving, the lamps were swinging widely, objects were falling from the shelves, so that they felt the urge to flee from their apartments. The subjective impressions were confirmed by measurements which indicated that the walls displaced horizontally up to about 70 mm.