Author: mgr inż. Mateusz Smolana

Doctoral thesis: Identification of static and dynamic characteristics of temporary supports of the building

Identyfikacja charakterystyk statycznych i dynamicznych tymczasowych podpór budynków

Supervisor: dr hab. inż. Krzysztof Gromysz, prof. PŚ

Abstract

The dissertation is devoted to the temporary supports of the building consisting of a piston hydraulic jack and a stack of cuboidal steel elements. This type of support is used in the process of removing the buildings' deflections (rectification). During rectification, the supports are loaded with longitudinal forces resulting from the weight of the building, lateral forces due to wind loads, reactions from other supports or adjacent segments, as well as dynamically, for example by movement by vehicles. The safety of the rectified structure depends on the characteristics of the supports, in particular, their longitudinal and transverse stiffness and vibration damping.

In total, over one hundred and twenty tests of supports loaded in the longitudinal and transverse directions, as well as kinematically, were conducted in a purpose-designed and constructed stand.

The tests of the supports loaded in the longitudinal direction revealed their nonlinear characteristics. In all analyzed supports, in the tested range of loads with longitudinal force, the increase in longitudinal stiffness occurred with the longitudinal load development. In the cycles of loading and unloading of the supports with longitudinal force, four characteristic operating phases and the occurrence of hysteresis loop were observed. In addition, transverse displacements are also noticeable in the longitudinally loaded supports, even with an axially positioned hydraulic jack, and this effect becomes greater the greater the jack's eccentricity is.

The tests of transversely loaded supports also indicated their nonlinear characteristics in this direction. The transverse stiffness of the supports increases with rising longitudinal load and decreases with declining transverse displacement. Five characteristic operating phases and a hysteresis loop are observed in the cycles of loading and unloading with the transverse force of the variable direction. Moreover, the response of the structure to the transverse load applied to the end of the support is different depending on whether the load causes an enhancement or a reduction of the already existing transverse displacement resulted from the longitudinal load and imperfections.

The kinematic tests of the equivalent system of support showed that the frequencies of the free vibrations of the first form and their damping depend both on the value of the longitudinal load and the vibration amplitude.

The causes of nonlinear characteristics have been identified, which represent two groups of geometric imperfections related to the inaccurate adjoin of cuboidal elements and mutual shifts of the rolled profiles forming the stack. The conducted analyzes allowed for the construction of the model of support loaded longitudinally, transversely, and kinematically, which revealed good compliance with the results of the experimental tests. Moreover, an alternative support solution was proposed. In this type of support, the imperfections of both groups were reduced, thus better characteristics in the context of the rectification process were obtained.

Gliwice, 12.03.2021