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Assignment of Tasks for Experimental Research of Large-Diameter Thin Shells with Infill

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ABSTRACT

A method of studying the nature of the stress-strain condition of thin shell structures is proposed in the paper. The proposed method takes into account the interaction (in a physical model) in between ground environment and thin shell with filler. The method is one of the steps in creating a more accurate mathematical model of thin shell structures interacting with infill and foundation.

KEY WORDS: thin shell design; elastic filler; model researches; mathematical model; proof-of-concept setting.

INTRODUCTION

Thin shell structures with infill are one of the most rational types of construction designs. They are used in hydraulic, industrial and civil engineering. Joint structural performance of relatively low-cost infill and the shell material (keeping the infill in a design position) is highly effective. For instance, such structures are used in construction of waterfront and protecting structures (Fig. 1).

Fig. 1. Installation process of the basis for a transfer and elevation deck "Lukoil-II" from shells of major diameter (Vysotsk-city)[1]

Now, such structures are calculated by means of the computer programs based on a finite element method (FEM), with introduction of a flock of the assumptions concerning conditions of interaction between a wall of a shell and the infill, and also their joint activity with foundation soil.

[1] Pictures are taken from http://shelfspb.ru

Because of insufficiently studied interaction between these two elements of a structure, special constructive provisions (such as shelves, ribs, etc.) are foreseen in the design in order to exclude inadmissible strains that complicate the process of manufacture and mounting of structures narrowing down area of their application. In this connection, it is a topical task to study behavior of the mode of deformation of the shell structures with the infill taking into consideration specificity of interaction between a thin shell and the infill, and between a thin shell and environment of the basis.

Since 1930, theoretical studies of the shell structures activity aimed at building of a mathematical apparatus describing interaction between a shell and the infill were carried out by such scientists as V.Z. Vlasov, A.L. Goldenvejzer, N.A. Kilchevsky, A.I. Lure, S.P. Timoshenko, B.N. Zhemochkin and others. Each of them has grounded his own development trend of a shell theory (Vlasov, 1962; Zhemochkin, 1951). The applied scientific studies designed to adapt the developed mathematical apparatuses for creation of design procedures for the facilities were carried out by the following scientists: I.V. Fedorov and V.I. Titova (1952), then by A.I. Kalaev (1956), G. Shnibelli (1957), E.M. Cummings (1960), N. Ovesen (1962), V.S. Khristoforov (1964) , G.D. Haskhachih (1979) , Sirasi M. (1978), Tokyo Boeki and Kensetsu Kika Tessa (1981), A.T. Bekker and V.I. Seliverstov (1987) and others. Most of the authors carried out their experiments on models in order to specify the design model of a facility, to determine a capability of plane shear inside filler (Cummings 1960; Fedorov and Titova, 1952; Kalaev, 1954; Khristoforov, 1964; Ovesen, 1962), and the effect from various factors on a structural stability was studied in some works.

Now the greatest concern is introduced by specificity of the shell structure activity in the contact zone with the foundation soil. In order to describe the mode of deformation of a structure in the certain area, the "edge effect" is introduced into a shell mathematical model (Ovesen, 1962).

EXPERIMENT SETTING

At this stage, the experiment was set to define the stress pattern in the wall of the thin shell (with infill) established on a rigid non-deformable foundation (Fig.2). For such a purpose, it is assumed that a model corresponds to a real facility and to the events occurring in full scale conditions. *Purpose of the experiment* is to analyze a distribution pattern of pressure in the near-leg shell working area.

As a result of the experiment, the following problems were solved:
- the test unit allowing to load the physical model on rigid foundation was set up;