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A Mechatronic Slip Complex Control when Erecting Monolith Objects

Alexey Bulgakov[a], Sergei Emelianov[a], Natalia Buzalo[b], Oleg Parshin[c] *

[a]*Southwest State University, 50 let Oktyabrya st. 94, Kursk, 305040, Russia*
[b]*Platov South-Russian State Polytechnic University (NPI), Prosveshenia st. 132, Novocherkassk, 346428, Russia*
[c]*Don State Technical University, Gagarin pl. 1, 344000, Rostov on Don, Russia*

Abstract

The paper considers the principles of a mechatronic slip complex (MSC) control for monolith construction, which features the availability of two groups of effectors requiring coordinated work. It has been shown that for the MSC control it is advisable to use a two-level structure; the upper level tasks of which are planning the complex hoisting and synchronizing the operation of control mechanisms, while the tasks of the lower level incorporate the development of control signals formed at the previous level. In order to remove the complex deviation from the designed location it is suggested to apply the method of the MSC movements planning with due account of limitations for control and effects of disturbing influences on the structure being erected.

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Keywords: Building; slip forms; automation; mechatronic complex; control

1. Introduction

Construction of monolith objects is connected with great labor effort and multiple adjusting operations especially when erecting structures with varying cross-section and walls width. The analysis of monolith construction technology has shown the expediency of designing mechatronic complexes on the basis of slip forms as they provide automation of the project erection with continuous-cyclic placement and consolidation of concrete. Consideration of different variants of the MSC development on the basis of slip forms has led to the idea of using a movable platform 1 bearing against columns 2 with help of lifting posts 3 which are equipped with jacks 4 (fig. 1). The forms 5 are suspended

* Corresponding author. Tel.: +7 961 271 2523; fax: +7 4712 504850.
E-mail address: a.bulgakow@gmx.de

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from the platform by means of radial displacement mechanisms (RDM) 6 thus providing for the adjustment of panels location. For the purpose of lifting it is advisable to use frequency control

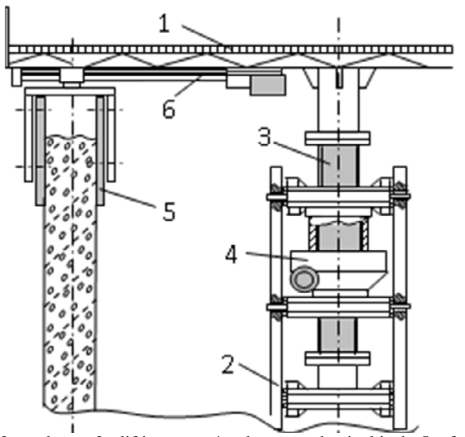

Fig. 1. Slip form: 1 - movable platform; 2 – column; 3 - lifting post; 4 - electromechanical jack; 5 – form; 6 - radial displacement mechanism.

electromechanical jacks, which allows to adjust hoisting speed and to synchronize movement. For the RDM it is preferable to use an induction motor drive with relay control. The main tasks of the mechatronic complex control are to lift the platform with forms during the process of concrete placement, change panels location when lifting, adjust the platform position when shifts or torsions occur, and synchronize the equipment operation.

2. Characteristic features of the MSC control

The distinctive feature of the MSC is the availability of two groups of effectors: hoisting jacks and RDM that require coordinated operation. During the process of operation the jacks experience considerable static and dynamic loads which are irregularly distributed in the jacks. When the platform lifts, the load changes due to concrete – panels interaction (fig. 2).

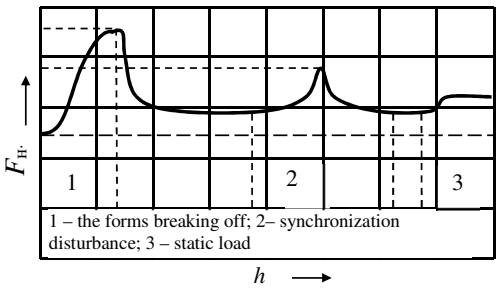

Fig. 2. The load changes on the slip platform.

During the operation irregularity of hoisting the jack loads can be up to 75-86%, which results in a violation of the platform horizontal displacement, its deviation from the designed axis and twisting of the platform with forms. Such operation condition of hoisting jacks makes stringent requirements to drives and causes the necessity to synchronize lift speeds.

RDM operation is under the influence of friction and elastic forces appearing with the deformation of the forms elements. When the synchronization of the operation of hoisting and adjusting units is broken, reaction forces in concrete additionally act on the RDM, and they have a non-linear character (fig. 3). This causes an increase of load