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NUMERICAL ANALYSIS OF SPECIAL MODULAR BRIDGES

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ABSTRACT

Subject of considerations is numerical static and dynamic analysis of special bridges. Floating ribbon type bridges and folding modular bridges are discussed as the special bridges. Floating ribbon type bridges consist of identical modules. Practical applications of such constructions showed series advantages of floating bridges. It was affirmed that floating bridges are special structures with original features e.g.: the short time for setting up, the easiness and short time for adaptation to the various operating conditions (crisis situations) and to the expected service loads. These features of floating bridges decide about their usage as temporary bridges located on busy transport routes. Floating bridges can be used as substitute water crossing for the repaired permanent bridges, the failed during natural disaster bridges or the used in extreme (warfare) conditions temporary bridges as well. Floating bridges create the kinematics chain of the same modules - single pontoons or barges immersed in water. Pontoons are connected by articulated joints at the bottom plane and have free contact at the road plane. Such way of connection affords possibilities for inelastic rotations limited by clearances between pontoons under the influence of the external load. Clearances cause discrete discontinuous displacements formation and nonlinear changes of internal forces. Floating bridges subject to complex interactions during the standard operating. External forces from mobile vehicles, reactions of the water and the mutual pontoon interaction (changes of the bridge configuration in connection with the exhaustion of clearances between pontoons, pontoon crashes) are essential interactions that should be taken into considerations. Investigations of such structures with their complex interactions are very difficult scientific problem.

Another type of modular structues discussed in the paper are folding bridges. Folding bridges are built from ready, repeatable components. They are designed to quick and multiple construction of water crossing. Folding bridges are used as temporary bridges usually. They

replace railway or road bridges in cases of failure or destruction of stationary structures. Folding bridges belong to special modular structures because they are built from the same elements connected by quasi-rigid joints. The large exploitation clearance is there in each joint. Such clearances enable limited rotations of adjoining components. It influences on the geometric-elastic character of structure deformations. Clearances in joints increase during the exploitation process of the folding bridge. Initial clearances play important role in work of the folding bridge. They enable assembly and disassembly of bridge components and make these processes easier. Clearances decide on the preliminary deformation and effort of folding bridges as well. The influence of clearances' changes on operational features and safety work of folding bridges was investigated in this paper. In this paper FEM approach was proposed with unilateral constraints and clearances taken into consideration. The modelling procedure for structure with clearances occurring between individual bridge components was presented. Discrete model of folding bridge cannot be developed directly. Difficulties with modelling of such structure caused by the clearances occurring.

Scissor bridges belong the group of special bridges as well. They are characterized by high mobility and modular structure. A characteristic feature of such structures is easy and quick assembly and disassembly of individual components even in difficult field conditions (e.g. in mountains). Such feature decides that scissor bridges are especially useful in case of natural disaster or war conditions. Single module-span is consist of two spanning part of the bridge (two main truck and support structure). Between modules of the single bridge span are used pin joints. Traditional methods are used in design and analysis such bridges, but some simplifications in static schemes are needed to be introduced. It causes limitations in computations automation and adaptation in numerical analysis. Experimental strength analysis of special modular bridges considered here is expensive and very time-consuming. Because experimental study with the large multicomponent objects are difficult (from the organizing point of view) and often impossible to carry out, it has been decided to perform numerical investigations. Some aspects of this numerical analysis of special bridges will be presented in the paper. Structural clearances are defined in each joint between modules in computer simulations. They influence significantly on the work of such modular structures. Various models and calculation methods used in numerical analyses of special bridges as well as geometrical, 3D shell and solid models of the special bridge span will be discussed in the paper. These models will be used in kinematical and dynamic simulations and strength FE analysis of the special bridge

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