PROOF LOAD TESTING OF IMS BUILDING STRUCTURE AND BEHAVIOR OF SLAB JOINT

Nebojša Milovanović[1]
Željko Flajs[2]

UDK: 69.057:624.042
DOI: 10.14415/konferencijaGFS2014.019

Summary: *IMS building technology has always been an ideal solution for buildings resistant to seismic effects, or objects with large capacity due to the specific system and methods of manufacture. The building has been recently completed in Osijek, Croatia. This paper performs a comparison between numerical and experimental values of structure and provides new solutions of slab joints between two IMS slabs. Numerical model was developed in accordance with European standards, and the proof load test was conducted according to standard SRPS.U.M1.047:1987.*

Keywords: *IMS system, Eurocode, Proof load testing, Slab joint details*

1. INTRODUCTION

IMS Building Technology is an advanced system for industrialized building. It is based on prefabricated reinforced concrete elements of the skeleton frame structure, assembled on-site and joined using post-tensioning tendons.

The prefabricated concrete frame consists of columns, beams, floors slabs, shear walls and staircases which enable the construction of a wide variety of different buildings, produced out of relatively small number of typical elements, precast industrially in large series. IMS building system during its existence withstood numerous foreign regulations depending on the countries where it was built. European regulations for the design and building of structures are already in use in most of our neighbours .It's the matter of time when they will be used in our country. We recently completed Pilot residential building with the IMS technology system in the Republic of Croatia in Osijek. Since those European regulations are already in use in Croatia, IMS technology system had to be designed and constructed in accordance with European regulations for the very first time. This pilot project was very important for us, because it showed that it can be adapted to all the strict requirements of the European group of standards. The paper mainly presents the way that we conducted proof load tests of some slabs in the IMS system, a standard that we apply for the tests, as well as concerns that we had during the designing project in terms of achieving connections at the junction of two adjacent slabs.

[1] Nebojša Milovanović, dipl.građ.inž., Institute for testing materials-IMS Institute, Bulevar vojvode Mišića 43, Belgrade, Serbia, tel: +381112652165, e–mail: nebojsa.milovanovic@institutims.rs
[2] Željko Flajs, dipl.građ.inž., Institute for testing materials-IMS Institute, Bulevar vojvode Mišića 43, Belgrade, Serbia, tel: +381112652165, e–mail: zeljko.flajs@institutims.rs

2. TECHNICAL CLARIFICATIONS

[1] The Residential building in Osijek was in the final stage during the proof load testing's . The building has underground garage + ground level + fifth levels and it is formed in the shape of the letter L. The structure is designed as cast in situ for underground and ground level, while the rest of levels are formed as a prefabricated structure. Total area of building is about 8,200 m^2. On the building are represented almost all types of precast slabs that can be manufactured in a facility of "Gradnja" in Osijek. Throughout the design phase of this project and its performance various incentives were taken into consideration that would assist in the direction of faster work execution of the structure. One of the most important is certainly the type of joint connection between two adjacent slabs during mounting. Every manufactured slab has extension of reinforcement bars (2∅12mm) at the top of secondary ribs. After slabs mounting they are welded in the way to keep their continuity in the top zone of secondary ribs. The detail is shown in Figure 1.

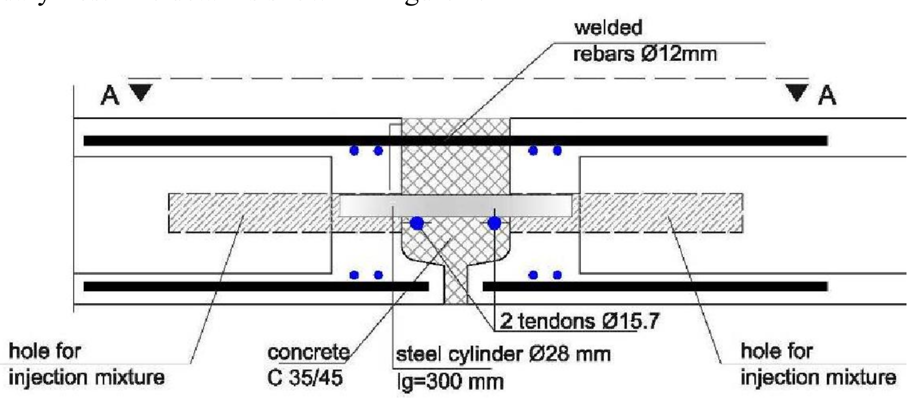

Figure 1. Detail of slab joint

Since the IMS technology system is very specific and incomparable to the typical prefabricated structures, and as such does not fall into the category of structures that can be tested according to some of European norms, testing of these kind of structures will be carried out according to Serbian norm SRPS.U.M1.047 1987 since we have a large database of samples tested in the IMS technology system that were studied for the last 40 years. In a similar way, testing of this building will be conducted in a similar manner.

3. PROOF LOAD TESTING

Test load of building structure was carried out on the roof level, since it is the simplest to set up a test load using a crane. In agreement with the Investor (in this case, and Contractors) as a test load were used euro pallets with clay products known as weight on the top (650 daN). For as much of the impossibility to insure complete area with design loads, designers and engineers of this building have decided to load the slabs which are most affordable at the time of testing. Test load as showed in Figure 2, had to be satisfied.

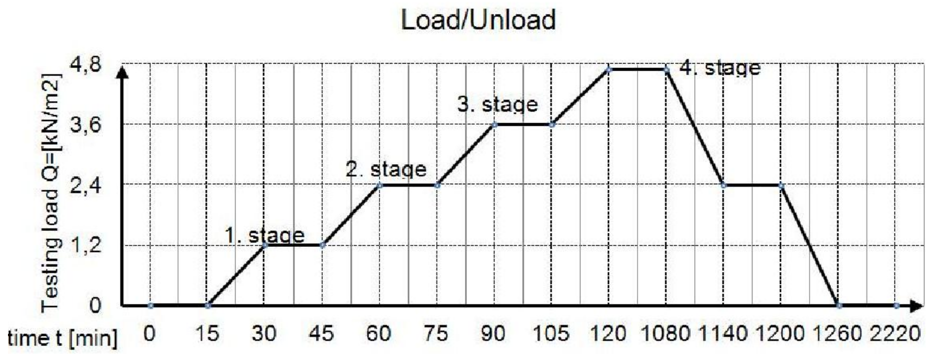

Figure 2. Regime of slabs testing

For this kind of regime, the appropriate load has been defined as clay product on the euro pallets with weight of 650 daN/m^2 (hatch areas). The presented scheme is just one isolated part of roof level which has been tested.

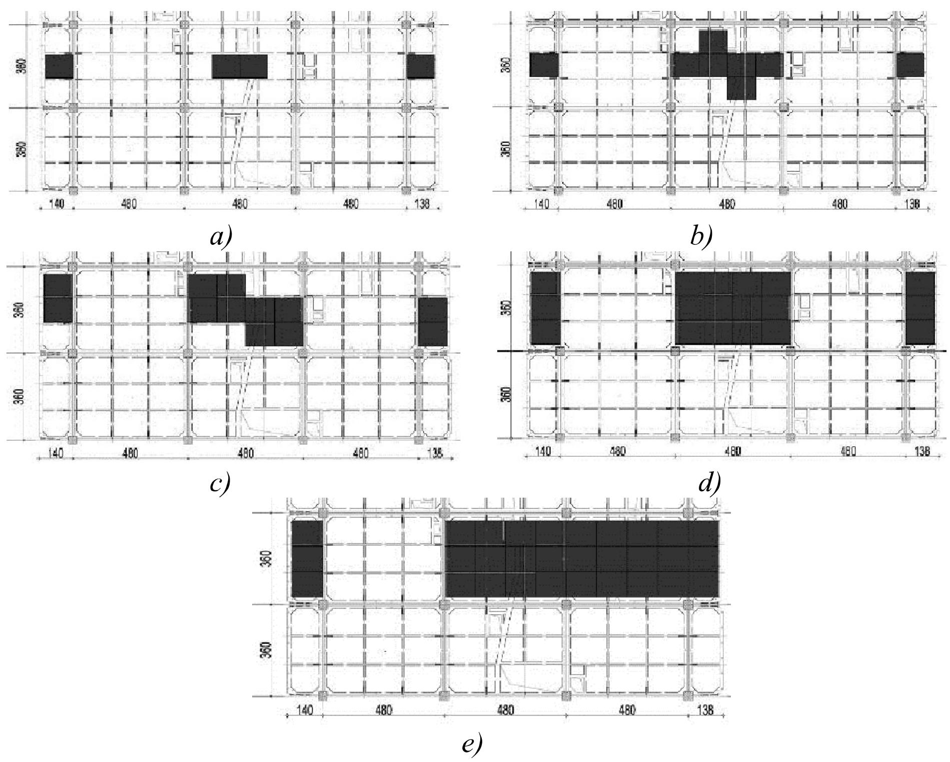

Figure 3(a-e). Load phase

The main objective of this study is primarily a correlation between the stress-strain state of numerical and experimental (real) model structures. Due to the fact that the continuity

of the joint connection of secondary ribs is very important parameter for analysis, at the junction of secondary ribs, reinforcement bars in the middle slabs are discontinuous on both sides of two adjacent slabs in order to compare these results with the results of the same type of continuous slabs.
The floor slabs was tested according with :

- Phase I: ~1/4 Qtest, symmetry (Figure 3a)
- Phase II: ~2/4 Qtest, symmetry (Figure3b)
- Phase III: ~3/4 Qtest, symmetry (Figure 3c)
- Phase IV: ~4/4 Qtest, symmetry (Figure 3d)
- Phase V: ~4/4 Qtest, asymmetry (Figure 3e)

4. DISPOSITION OF INSTRUMENTATION

Test load of building structure was carried out on the roof level. Due to load testing, vertical displacement and deformation were measured. Deformations were tracked with mechanical deformeters „HUGGENBERGER“ type with measuring range of 254mm and strain gauges type „TML“ PL-20 (±10000 μm/m). Vertical displacement were tracked with mechanical transducers type „HUGGENBERGER“ and inductive transducers type „HBM“ WA100. Table 1 shows number of measuring points that were tracked during a load testing.

Table 1. Applied instrumentation

	Mechanical deformeters	Strain gauges	Mechanical transducers	Inductive transducers
Deformations (Stress)	16	29		
Vertical displacements			10	8
	45		18	

All measuring points are located on the underside of the structure. Continuous monitoring data acquisition device is achieved with "HBM" type SPIDER 8 and switch boxes "BLH" with 10 channels, as shown in Figures 4 and 5. Figure 6 shows disposition of measuring points.

Figure 4. Acquisition devices

Figure 5. Acquisition devices

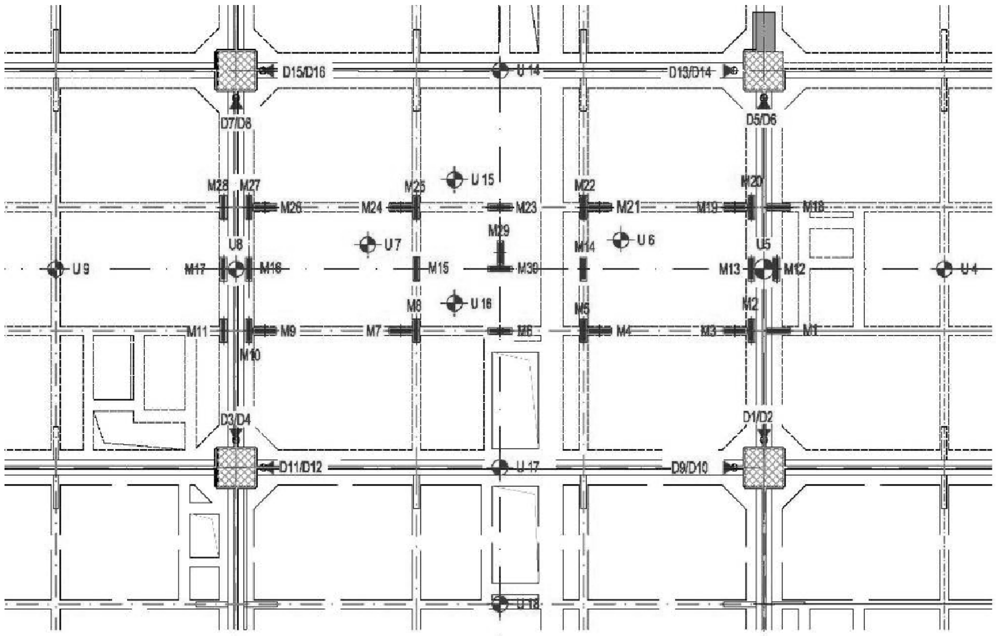

Figure 6. Disposition of measuring points

5. TESTING RESULTS

Numerical model of IMS structure was made in “Radimpex” software, “Tower 6”. Load analysis, dimensioning and seismic analysis were performed in accordance with European regulations (Euro codes 1990,1991,1992,1998). The results of tested slabs are isolated comparing with complete model to make it easier to view results, following appropriate boundary conditions. Figure 5 shows diagrams of the vertical displacement in stages. The measured values are given in parentheses.

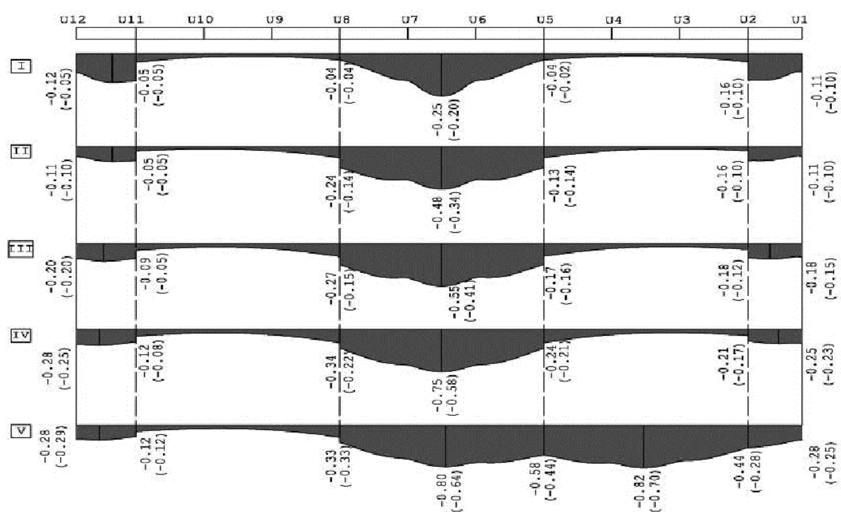

Figure 7. Vertical displacement diagrams [mm]

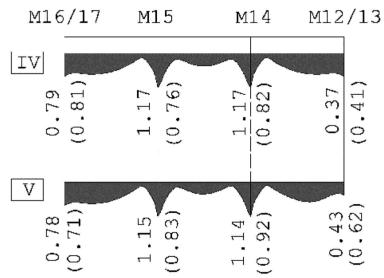

Figure 8. Diagrams of strain state in phases [Mpa]

6. CONCLUSION

After completing the load testing and processing of data, we concluded that a rigid joint connection which is achieved by welding the upper reinforcement of two mutually adjacent ribs during the implementation of work has no impact on the achievement of rigid connection joints. With it's abolition (breaking the weld profile fitting) at the spot and testing it, we have quite similar results that correspond to rigid connection in the numerical model. The reason for the acomplishment of the rigid connection, despite interruptions reinforcement bars, are steel cylinders (deviators ropes for pre-stressing) located directly below mentioned connection joints in secondary ribs , and which are exposed to strong pressure from two ropes ∅15.7 mm. Whilst in the process of work execution steel cylinders are left in the horizontal gaps in adjacent plates after lowering tendons into the designed position . Steel cylinders and precast slabs connection is further secured with injecting mixture into the cylindrical hole, in which way it is achieved that prefabricated elements work together in the form of rigid connection joints. Substantial savings were made during work execution of IMS structure and the simplification of the installation of the elements themselves, since there is no need for welding reinforcing bars in the upper part of the two adjacent precast slabs.

REFERENCES

[1] Milovanovic, N., Flajs, Z.: Tehnical report IKT 02/13, 2013.

ИСПИТИВАЊЕ ИМС КОНСТРУКЦИЈЕ ПРОБНИМ ОПТЕРЕЋЕЊЕМ И ПОНАШАЊЕ СПОЈЕВА

Резиме: *ИМС технологија градње је увек представљала идеално решење за објекте отпорне на сеизмичке утицаје односно објекте велике носивости због специфичности система и начина израде. Недавно је завршен Пилот објекат у Осијеку, Република Хрватска. Овај рад врши поређење рачунског и испитног модела и даје нова решења везе између две ИМС таванице. Рачунски модел је урађен у складу са Европским нормама, док је испитивање спроведено према стандарду СРПС. У. М1.047:1987.*

Кључне речи: *ИМС систем, Еврокод, Испитивање пробним оптерећењем,везе*