CIB Joint International Symposium 2009

CONSTRUCTION FACING WORLDWIDE CHALLENGES

Dubrovnik, September, 27-30

PROBLEMS IN LARGE SCALE PRECAST CONSTRUCTION PROJECTS

Prof. Vjeran Mlinarić, Ph.D. Civ. Eng.
Faculty of Civil Engineering, Univesity of Zagreb, Zagreb, Croatia
mlinaric@grad.hr

Zvonko Sigmund, MEng. Civ. Eng.
Faculty of Civil Engineering, University of Zagreb, Zagreb, Croatia
zsigmund@grad.hr

In touch with large scale projects all types of occurrences can be seen. Such large scale projects should present a great composition of first class organization in every part of project stages. In architectural design, structural analysis, production, building site organization, transportation, etc. The choice of the construction system to satisfy all the wanted outcomes is tough. Wrong choice and combination of construction systems can result with complication of building process, overrunning of time limits, which all result with multiple rise of building costs. This article is orientated on showing the occurring problems if a project is not planed properly and directs a reader or a potential project manager to choose a proper choice of combining several building systems.

KEYWORDS: precast, large scale, problems.

INTRODUCTION

Each project is induced for answering problems and satisfying needs. While answering to the project's problems responsibility of each engineer is to choose the right construction design. Chosen construction design needs to be able to satisfy several factors, like:

- set the right answer to the project's problem
- adequately accommodate needs of esthetics
- satisfy building codes and regulations

Each engineer, after deciding to build and form his construction using precast building system, has to follow some rules of precast building. Tendency to standardize dimensions and qualities of element is a must. Limiting numbers of different type cannot be avoided. With those limitations, an engineer is forming or choosing a precast elements assortment that provides flexibility of building and architectural unity of an object.

Large scale construction projects usually have several common critical requirements that need to be fulfilled. Time limitation and high architectural and esthetic requirements are the most propounded ones. In order to satisfy both of these aspects, it is not rare that engineers decide to use a combination of several different construction systems. Either concrete precast, steel, reinforced concrete, or steel – concrete composite systems are used. By using precast concrete, speed of production and quality of produced elements is gained. On site production is characterized by reduced number of workers and material. To achieve the complex architectural design, the usage of steel – concrete composite building system is needed.

LARGE SCALE PROJECTS PROBLEMS

As mentioned previously, in order to fulfill requested speed of building and yet to keep the esthetical qualities of these projects, solution of the problem is usually attained by combining several construction systems.

By deciding to use a combination of construction systems, a group of problems appears. The actual problem is how to chose and combine those systems optimally. Poor solution of structure organization can result with complex building process, organization and planning of the site, and reduce ability to respect time limitations.

Table 1: Percentage ratio of precast construction in whole project

		Construction system					
Dilatation	Level	Precast area [m2]	Monolith area [m2]	Steel area [m2]	Composite area [m2]	Sum area [m2]	% (precast / sum)
A	1	3657,3	2741,5	0	0	12797,6	57,2
A	2	3657,3	2741,5	0	0		
B	1	2260,3	693,8	0	2622,8	11305,7	20,0
B	2	2263,1	693,8	371,9	2400		
C	1	2374,3	1276,8	0	1122,5	9791,7	24,2
C	2	3111,5	532,7	1373,9	0		
D	1	3567,1	1010,8	0	1011,6	11885,9	30,0
D	2	3567,1	1010,8	1718,5	0		
E	1	2225	1123,3	0	3182,9	13242,9	16,8
E	2	2397,1	656	740,4	2918,2		
F	1	2475,3	436,5	0	0	5823,6	42,5
F	2	2475,3	436,5	0	0		
G	1	3564,1	1659,9	0	1742,5	14198,7	25,1
G	2	3789,4	1336,2	2106,6	0		
H	1	1988,8	687,6	0	1509,1	9135,2	21,8
H	2	2273	1065,3	679,3	932,1		
I	1	3786,5	875	0	627,5	11116,7	34,1
I	2	4100,8	958	0	768,9		
J	1	1476,2	966,2	0	2937,7	10760,2	13,7
J	2	1476,2	966,2	0	2937,7		
K	1	2776,9	1793,2	0	1574,8	12210	22,7
K	2	2887,5	1000,6	1840,9	336,1		

From the precast to sum area ratio can be concluded that this kind of building is not specific for precast building system. Such combining of systems cause problems in execution of projects in each aspect.

BUILDING PROCESS COMPLICATIONS

In order to prevent time delays, when merging construction systems, it is of essential importance to have highly organized production program with two way information flow between building site and production site. If necessities are not considered production halts with high expenses.

Time delays usually occur when poor planning is done. Poor planning in precast construction system usually means that time for monolith concrete construction to obtain its bearing capacity is not taken in account. Although this may seem as basic civil engineering knowledge it is not rare that those facts are left out while planning time schedule.

Figure 1: Completion of the precast construction depends on the completion of the monolith construction

Figure 2: Completion of the stair case dictates the precast construction completion

BUILDING SITE AND PROJECT PROBLEMS

Delays and problems can be evoked with non synchronized project documentation (e.g. scaffolding plans and precast mounting plans), by poor on site coordination, or poor on site control.

Figure 3: Due to poorly perfected project documentation mounting of monolith beam was impossible without additional processing of the precast element

Figure 4: Poorly perfected project documentation resulted with a need to additionally process the precast element

PRICE PROBLEMS

The most common result of problems during construction is a price increase. But in concrete precast construction, price of the construction raises potentially by producing specific precast element types that are used only once or twice during the whole building process.

Table 1: Concrete precast elements to positions ratio

Dilatation	Colum			Beam			Plate		
	pcs	pos	pcs/pos	pcs	pos	pcs/pos	pcs	pos	pcs/pos
A	45	18	2,50	89	21	4,24	177	34	5,21
B	35	22	1,59	55	38	1,45	118	55	2,15
C	36	28	1,29	65	38	1,71	141	59	2,39
D	42	31	1,35	65	59	1,10	176	66	2,67
E	49	42	1,17	64	56	1,14	116	46	2,52
F	28	16	1,75	45	24	1,88	132	55	2,40
G	55	46	1,20	79	49	1,61	191	70	2,73
H	44	40	1,10	73	61	1,20	143	87	1,64
I	39	32	1,22	65	53	1,23	212	90	2,36
J	32	27	1,19	44	36	1,22	72	38	1,89
K	39	31	1,26	70	62	1,13	151	84	1,80
Sum	444	333	1,33	714	497	1,44	1629	684	2,38

By observing number of elements and element position ratio, it is obvious that decision of using precast concrete building system was not used correctly. The advantage in price and speed of building in precast system did not get used as planned.

As can be seen from the **Table 1** the number of elements to element position ratio is mostly about 2, where the expected ratio for would be at least 30%-40% of the number of elements. With that ratio the production and the choice of precast building system would have been reasonable.

TIME LIMITATIONS PROBLEMS

Table 2: Building time table

Construction part	Dilatation	Height (from - to)	Planed Start	Planed end
Single foundations	H		02.09.'08.	08.09.'08.
Precast columns	H	0 - +12,75	28.08.'08.	09.09.'08.
Bearing construction	H	0 - +5,85	05.09.'08.	17.09.'08.
Precast beams	H	+5,85	09.09.'08.	18.09.'08.
Precast plates	H	+5,85	06.10.'08	14.10.'08.
Bearing construction	H	5,85 - +12,75	17.09.'08.	29.09.'08.
Precast beams	H	+12,75	18.09.'08.	27.09.'08.
Precast plates	H	+12,75	27.09.'08.	06.10.'08.

As can be seen in **Table 2** for the same dilatation the works are not planned properly, nor can they be synchronized by this plan. For instance single foundations are supposed to be finished for erecting columns, while production of single foundations has not even started. In order to mount beams and plates all the bearing parts of monolith construction are supposed to be finished and ready to take over the weight of precast structure. This is impossible due the fact that those parts have been finished the day before.

By taking these facts in account while planning, time schedule is less endangered.

CONCLUSION

Precast concrete construction system use is reasonable when composing any type of building construction, when architecture is characterized with typical construction spans and larger number of same construction element types. In such constructions, the industrialized production of elements is preferred with all the positive effects of industrial production: series production don by educated and specialized staff, high quality products, and minimal usage of scaffolding.

By observing number of precast elements and element type ratio in any project, we can easily conclude if a precast concrete building system is used correctly and optimal.

Simple tasks can result with immense problems if a project is not planned and controlled properly. Also costs reduction is achieved by understanding advantages of building system that is used. This way simple mistake like e.g. tendency to reduce costs by reinforcing each precast element differently can be avoided.

According to data collected from a project inevitable question can be answered: Is the usage of precast elements and building system reasonable for this project?

By deciding which building system should be used, one should be aware the system advantages and disadvantages. Also one should be aware of requirements for a system to be rentable.

Precast concrete building system use requires developed information flow for decision making in each production point: production, transportation, temporary storage, and assembling of elements.

In order to justify the choice of using the precast concrete building system some sacrifices are needed, so that all benefits of precast building system can be used, and thereby reduce building costs.

REFERENCES

Kovač, B.; Brana P.; Vidaković, D. (2006) Tehnologija građenja – handbook. Osijek: Faculty of Civil Engineering

Lončarić, R. (1995) Organizacija izvedbe graditeljskih projekata. Zagreb: Univesity of Zagreb

Arizanović, D.B. (1997) Tehnologija građevinskih radova. Beograd: Uinversity of Beograd

Ivković, B.; Arizanović, D. (1990) Organizacija i tehnologija građevinskih radova. Beograd: Uinversity of Beograd

Trivunić, M.R. (2000) Montaža betonskih konstrukcija zgrada. Novi Sad: University of Novi Sad

Ćirović, G.; Mitrović, S. (2007) Tehnologija građenja. Beograd: Civil Engineering and Geodesy academy