World Academy of Science, Engineering and Technology
International Journal of Structural and Construction Engineering
Vol:11, No:4, 2017

Non-Chronological Approach in Crane Girder and Composite Steel Beam Installation: Case Study

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Open Science Index, Structural and Construction Engineering Vol:11, No:4, 2017 publications.waset.org/10006927/pdf

***Abstract*—**The time delay and the structural stability are major issues in big size projects due to several factors. Improper planning and poor coordination lead to delay in construction, which sometimes result in reworking or rebuilding. This definitely increases the cost and time of project. This situation stresses the structural engineers to plan out of the limits of contemporary technology utilizing non-chronological approach with creative ideas. One of the strategies to solve this issue is through structural integrity solutions in a cost-effective way. We have faced several problems in a project worth 470 million USD, and one such issue is crane girder installation with composite steel beams. We have applied structural integrity approach with the proper and revised planning schedule to solve the problem efficiently with minimal expenses.

***Keywords*—**Construction management, delay, non-chronological approach, composite beam, structural integrity.

I. Introduction

CONSTRUCTION industries started to make structured and creative approaches in taking decision while building complicated structures. However, non-chronological approach from the tradition will bring creative solutions, where the creative approach suited to the existing conditions will be adopted [1].

In major construction projects, there are three major factors causing the delay according to [2]: The input factor, internal environment, and exogenous factor. According to [3], the input factors curtailing the project progress are: labour, capital, energy, design, material and equipment. The delay based on any of the above-mentioned input factor imposes project time delay and financial difficulty to the contractors, whereas the awful internal and external environment may cause further delay in the project.

The factors causing the delay were surveyed by Fugar and Agyakwah-Baa [4], where they listed 32 causes of delay and they were grouped into nine major areas: materials, manpower, equipment, financing, environment, changes, government action, contractual relationships, and scheduling and controlling techniques. They derived a relative importance causing the delay against each other, and the equipment breakdown or unavailability is ranked at 17 out of 35 causes. Thus, a creative approach in replanning the construction work may mitigate the delay due to equipment availability and also may avoid the failures in certain cases.

Aziz [5] carried out a survey to identify the factors which were supposed to affect delay in the Egyptian construction project. The authors identified 99 factors causing delay and they classified them under nine major categories. Assaf and Al-Hejji [6] conducted a survey on time performance of different types of construction projects in Saudi Arabia. These authors identified the causes of delay and their importance according to each of the project participants. The most common cause of delay identified by all the three parties is "change order". However, the change of order is sometimes needed to avoid the time delay. We have followed a non-chronological approach through our creative ideas and case-study analysis to solve a specific issue.

The problem of time and cost overrun arise due to several factors that affect the time and cost in construction. Several research works have been focused in revealing these responsible factors which were reviewed carefully. In this paper, we present the outcome of our non-chronological approach with creative ideas in handling two major problems in a project where the availability of equipment (overhead crane girder) and installation procedures of overhead crane girder with steel composite structure installation were handled in an effective way to avoid delay and to ensure structural stability.

II. Background

In a project with two-story massive building, we have to install a 19-meter long overhead crane girder just below the ground level. There was a composite beam (steel and concrete) of 42-meter length at the ground floor and it crosses 90 degrees at the center of overhead crane girder. There were five numbers of composite columns located above the ground floor composite beam and similar structure continued up to second floor. Moreover, the composite beam supports floor slabs and beams of 10 m wide on both sides at each floor. The usual chronological procedure is described as below:

A. Chronological Procedure

a) Install the overhead crane girder.
b) Install the steel beam and perform the cast-in-situ concrete with other beams to complete the ground floor.
c) Install the steel columns above the composite beam up to the first level and perform the cast-in-situ concrete for the composite column.
d) Perform the cast-in-situ concrete for the first level floor along with composite beam.
e) Install the steel columns above the composite beam up to the second level and perform the cast-in-situ concrete for the composite columns.
f) Perform the cast-in-situ concrete for the second level floor

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beams and slab along with composite beam.

g) Install the penthouse floor elements.

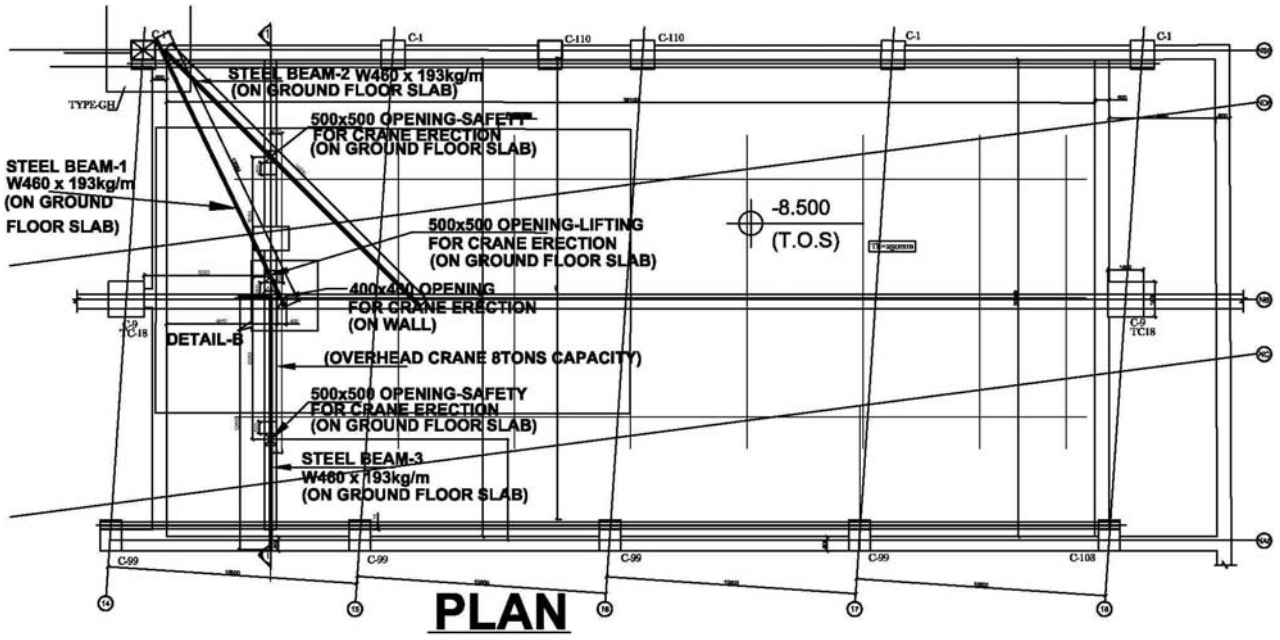


Fig. 1 Plan view of crane-girder below the ground floor slab

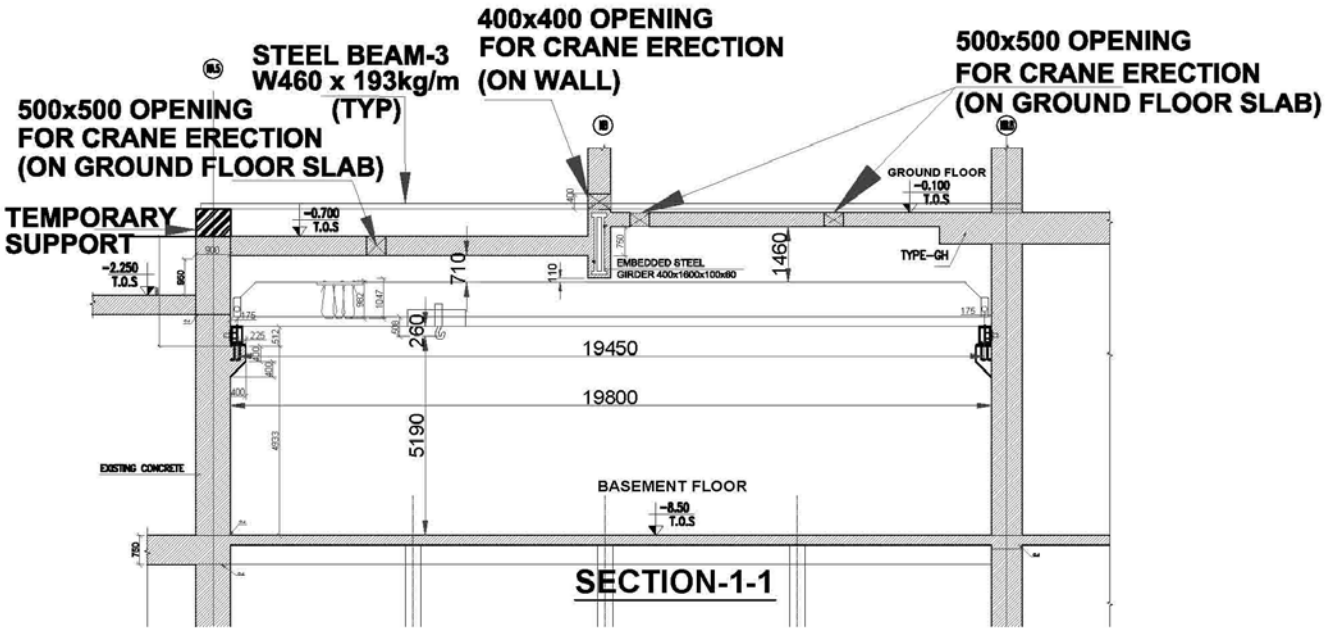


Fig. 2 Section view of crane-girder below the ground floor slab

B. Problem in Chronological Procedure

Firstly, there may be a delay in installing the overhead crane girder due to its non-availability, which may impose stoppage of construction for few months. Further, there is a possibility of structural cracks in the composite beam and related concrete floors. Thus, it has to be installed in later stage of the construction process.

Secondly, the concrete casting of composite beam at each floor along with the composite columns will lead to deflection in the steel beam, and further cracks may develop in concrete slabs and beams.

III. Proposed Non-Chronological Procedure

Our structural engineering team has analyzed the situation, and we designed the steel beam with and without concrete and studied the deflections.

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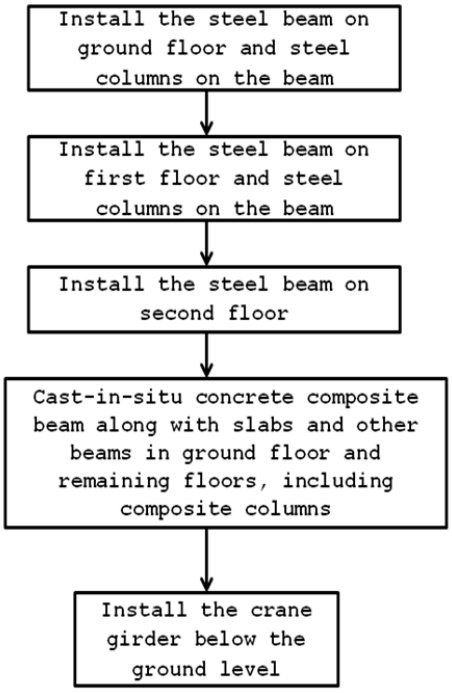


Fig. 3 Proposed non-chronological procedure

A. Situation Analysis for Choosing Non-Chronological Approach

We have analyzed the rate of deflection of the steel composite beam utilizing SAP2000 structural software. We have observed that the installation of all steel beams and columns followed by concrete casting shows a reduced deflection of 20% than installing composite structures. The deflection may be avoided by increasing the size of the steel beam. However, the cost of the steel beam is increased by 48%, which increases the project budget. As an alternative, we have followed anon-chronological procedure for the safe casting of beam and slabs.

After careful study of the actual situation, the following sequences of work activity (as illustrated in Fig. 3) decisions were taken with pre-measure activities.

IV. Site Access Difficulties

After this, the actual site access difficulties were studied as follows,

i. The constraints of the overhead crane girder installations.
ıi. The stability of the steel beam and steel columns. Since, these are 16 meters elevated from the natural ground level and 20.5 meters elevated from the actual location.

A. Non-Chronological Procedure to Overcome the Overhead Crane Installation Constraints

The overhead crane installation access path was studied and it was observed that the following activities must be delayed until the installation.

1. Two room's block work and floor finish will be done after the installation.
2. 20-meter (approx.) length HVAC duct has to be done after the installation.

These activities were checked in the project schedule whether these were the critical activities or not and it was found as non-critical activities.

B. The Stability of the Steel Columns and Beams

The structural model was created and analyzed by considering the wind loads. The proper supports were preferred. The whole method was prepared and distributed to all concern engineers and managers.

The structural team completely guided and monitored the complete installation activities. The ground floor steelbeam was installed. Followed by that, the steel columns were installed. Then, the first level steel beams were installed and then, the columns at the first level. Similar procedures were followed in second floor also. Then, the cast-in-site concrete composite beam along with slabs and other beams in ground floor were installed. The remaining floors steel beams and columns were installed. Finally, the overhead crane girder was installed below the ground level.

V. Results and Discussion

We started with the installation of steel beams and steel columns starting from ground floor based on our proposed approach, as illustrated in Fig. 3. The steel beams are of 400 X 1400 mm, 400 X 1700 mm, and 400 X 2000 mm. The columns are of 400 X 1600 mm, 400 X 1400 mm, and 400 X 1000 mm. The overhead crane girder is of 19 m long.

The installation of steel beams and steel columns from ground floor view is illustrated in Figs. 4 (a) and (b). The complete structure after the installation of overhead crane girder is illustrated in Fig. 5. The spacing between the top of the overhead crane girder and the bottom of the beam is 250 mm.

The scheduling of the sequential construction activity and the change from sequential to parallel activity, are demonstrated as in Figs. 6 (a) and (b), using the partial planning chart. Hereby, it is observed that the sequential construction activity leads to a 12-month time period, whereas the proposed parallel activity reduced the time span to eight months. Our creative approach saved 33% (approx.) of the time span.



Fig. 4 (a) Installation of steel beams and columns (basement view)



Fig. 4 (b) Installation of steel beams and columns (ground floor view)



Fig. 5 Installation of overhead crane girder

The Work carried out after installation of the Over head Crane girder

S.No	Description	Month-1	Month-2	Month-3	Month-4	Month-5	Month-6	Month-7	Month-8	Month-9	Month-10	Month-11	Month-12	Month-13
1	Crane Order													
2	Crane Design and Supply													
3	Crane Installation													
4	Ground Floor Structural Works													
5	First Floor Structural Works													
6	Second Floor Structural Works													
7	Penthouse Floor Structural Works													

Fig. 6 (a) Chronological project planning

The Work carried out Prior to installation of the Over head Crane girder

S.No	Description	Month-1	Month-2	Month-3	Month-4	Month-5	Month-6	Month-7	Month-8	Month-9	Month-10	Month-11	Month-12	Month-13
1	Crane Order													
2	Crane Design and Supply													
3	Crane Installation													
4	Ground Floor Structural Works													
5	First Floor Structural Works													
6	Second Floor Structural Works													
7	Penthouse Floor Structural Works													

Fig. 6 (b) Non-chronological approach with creative Project planning

VI. Conclusion

The issue of delay in construction is common in construction industries. In our project, we have adapted a non-chronological approach with creative ideas in overhead crane girder installation and steel composite structure, where the structural integrity is ensured with a savings of 33% of time span.

References

[1] D. McGeorge, and P. Zou, *Construction management: new directions,* Wiley-Blackwell, Oxford, UK, 2013.

[2] F.J Drewin, *Construction Productivity*, Elsevier, New York, USA, 1982.

[3] N. Hamzah, M.A. Khoiry, I. Arshad, W.H.W. Badaruzzaman, and N. M. Tawil, "Identification of the Causes of Construction Delay in Malaysia," International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering, vol. 6, No. 12, 2012.

[4] F. Fugar, A. Agyakwah-Baah, "Delays in building construction projects in Ghana," Australasian Journal of Construction Economics and Building, vol. 10, pp.103–116, 2010.

[5] R. F. Aziz, "Ranking of delay factors in construction projects after Egyptian revolution," Alexandria Engineering Journal, vol. 52 no. 3, pp. 387–406, 2013.

[6] Sadi A. Assaf and Sadiq Al-Hejji, "Causes of delay in large construction projects," International Journal of Project Management, vol. 24, no.4, pp. 349-357, 2006.

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