Incremental Launching of Steel Girders for the Construction of Bridges

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Abstract: ***The development in the field of transportation by means of railway, roadway, waterway and airway has made everything easy in terms of tourism, growth of business and has made human beings socially active. In the present paper, efforts have been laid to understand the execution aspect for the construction of Railway over Bridge (ROB) by using Incremental Launching of steel girders. Emphasis has been given to methodology, project management and quality assurance procedure, machinery and equipment required for the effective launching of steel girders by using Incremental Launching Method.***

I. INTRODUCTION

Bridges play animportant role in channelizing socio-economic development of the country. Though, with recent advancement in bridge construction have made the construction process easy and less time consuming. In the present study, Incremental launching method (ILM) or Cantilever method have been studied to understand the mechanism and construction procedure. In this method, the bridge superstructure is assembled on one side of the support to be crossed and then it is pushed longitudinally with the help of crane into its final position. The launching is done in single or multiple increment, but it need to be fully assembled before launching. Such method of construction is more economical if proper procedure, design expertise and special construction equipment'sare used. This method may be the most reasonable way to construct a bridge over an inaccessible or environmentally protected obstacle. Figure 1 shows the Incremental Launching Method being used on site.

Figure 1 Incremental Launching Method

Following are the significant advantages of ILM to both owner and contractor as given below

- Minimal disturbance to nearby surrounding.
- Smaller, but more concentrated area required for superstructure assembly
- Increased worker safety since all erection work is performed at a lower elevation
- Increased worker & project safety since all erection work is performed at a lower elevation and launching performed in controlled conditions.
- No need to stop or very small blocks are required for the railway trains during construction of ROBs.
- Improves the quality of work.
- Speedy completion of the work.

II. LITERATURE REVIEW

In order to understand the modern practices, in depth study of the literature review and code of practice has been done to understand the execution of bridge construction by ILM. Some of the prominent literature review have been discussed which signifies the use of such method in the construction of bridge in short and economized manner with better safety and quality control. Starting from late ninetieth century the construction industry have been updating in terms of technology and modernized

machineries, because of which, it is possible to construct such bridges in stipulated amount of time.

Zellner and Svensson (1983) investigated the use of Incremental Type Method for the construction of segmental types of bridge for concrete structure. The whole superstructure is longitudinally jacked forward incrementally to make space for the next segment in the stationary form. This method combinesthe advantages of pre-casting with those of cast-in-place methods, resulting ina high concrete quality and low costs.

Granath (1998) experimentally analyzed and also studied the finite element modellingconcerning the distribution of the reaction force of an I-shaped steel girder launched on a launching shoe with a slide bearing. A girder placed on launching shoe, consisting of a tiltable steel bearing with a polythene slide plate on its top,is investigated. The design calculations for the pertinent load case are generally performedwith equations valid for the case of a uniformly distributed load. The investigations showed the support reaction has a non-uniform distribution of bearing stress.

Sasmal and Ramanjaneyulu (2006) studied the transfer-matrix method which uses a mixed form of the element force–displacement relationship and transfers the structural behavior parameters(state array) from one section to the other. Hence, the transfer matrix method produces a system of equations that are simpler in comparison to those produced by the stiffness method. In this paper, a simplified transfer matrix technique is proposed to evaluate the state of stress at each cross-section of prestressed concrete bridge decks during incremental launching. Prestressing force induces additional equivalent loads on the deckin upward as well as downward directions depending on the profile of the prestressing cable. Further, the effect of bearing stiffness makes theconstruction phase analysis more complex. With theproposed method of 'Transient Transfer Matrix' (TTM), so named to indicate its transient nature during the launching process, these problemscan be handled efficiently with minimal computational effort.

Marzouk et al. (2007) presented a special purpose simulation model to capture the uncertainty associated with bridge construction. The model accounts for the interaction between the different involved resources in construction of bridges using incremental launching technique. The researchers describe two methods (single form and multiple forms) of execution used for the segment's fabrication. The proposed simulation model utilizes STROBOSCOPE as a simulation engine and is coded by Visual Basic 6.0. Actual case study is presented to illustrate the capabilities of the developed model and validate its performance.

Pan et al. (2008) studied full-span Pre-cast Launching Method (FPLM) which has been implemented in many sections of Taiwan's High-Speed Rail (THSR) Project. The study applied Dynamic Simulation (DS), and a DS software named "SIMPROCESS", to create a dynamic model taking five sections of THSR Project which implemented FPLM as case studies. The study via SIMPROCESS differentiated the resources used and the performance of five cases which the FPLM was adopted. Also, the study identified the critical factors in the operating process of FPLM which influence the performance of the project execution by using cross-tabulate and sensitivity analysis, and presented better alternatives to improve those cases which could be useful for future applications.

Xu and Shao (2012) investigated a new beam element for the static and dynamic analysis of incrementally launched bridges. The element can describe the deformation subjected to a transverse constraint at an arbitrary point on the beam, thus enabling direct simulation of the super structure with a continuously position-varying support during the incremental launching of bridges. This element significantly simplifies the finite element modeling of launched bridges and greatly reduces the computational cost.

Zhang and Luo (2012)considered the case study of Yandangshan Bridge which is a tied-arch bridge of double-line railway with a (90+90) m continuous steel boxgirder and passes over a very busy highway in China. The incremental launching of the steel box girder of thisbridge was a big challenge for bridge Engineers, mainly because of the patch loading caused by large self-weight, largecamber, unsymmetrical and flexible temporary transverse beams. The launching process is simulated as finite element method. The results have shown that significant local stress concentration would occur inthe web plate and bottom plate of the girder if no improved measures are applied. Four measures to reduce the local stress of the girder are presented andput into practice: to add two slide shoes on every pier; weld six short launching noses at the diaphragm at leading end of the box girder; pre-lift the 6 slide shoes on one temporary pier at different positions to eliminate part of the deflection of the temporary transverse beams, and use special adjustable slide shoes inone span. The whole launching process has been monitored and the measured stress and deformationcoincide with the results of finite element analysis. Proper results have been observed by the application of fourimproved measures.

Granata et al. (2013) presentedthe structural behaviour of incrementally launched bridges in the construction stages, since temporary stresses in the deck, during launching, are

different from those occurring in service life. In case of horizontally curved launched bridges, the effects of torsion is induced by geometric curvature. A parametric study is presented in order to analyse the influence of design parameters on the construction of these bridges. Effects of curvature, nose deck ratios of length and load, bending and torsional stiffness ratio were taken into account. The results show that maximum torsion values increase with the decrease in the curvature radius R and with the decrease in the ratio between bending and torsional stiffness. With variation in the nose weight, a significant increase in bending moment and torsion can be observed during cantilever launching of girder.

Alonso-Martinez (2014) presented a numerical study of the structural interaction between a bridge and a new continuous device for launching heavy structures using the force of friction. A non-linear finite element model is considered to study interaction between the bridge and the new device. This technique allows the selection of the best arrangement for two mechanism models placed under the webs of the bridge: two parallel arrangements where external device is opposite or behind the internal one, and other arrangement with devices in series.

Navarro-Manso et al. (2016) The main objective of this research paper is to numerically analyze the best stiffener combination and distribution along the length of bridge, both longitudinally and transversally, in order to avoid the patch loading phenomenon in the slender webs. An optimum design of a triangular cell along the lower plate is also presented. A three-dimensional finite element model (FEM) is built and the design of experiments technique (DOE) is applied to obtain the best stiffener configuration. The numerical simulation allows the exact evaluation of the response of the structure to be achieved, covering the gaps and limits which are common in some national and international codes. Appropriate response has been obtained, in terms of deflection, patch loading resistance and vertical load distribution on the support section.

III. CONCLUSION

From the above literature review, it may be inferred that the use of Incremental launching method results in construction of bridge within stipulated time, although it requires the concept of pre-engineered structure along with proper planning with design expertise and management is required. Such method of construction might not be economical for small projects since the cost of machineries and equipment is too high. It is very safe, fat and time bound method of launching of superstructure. The superstructure is prefabricated and hence space required at site for construction activity is less. Moreover, such construction practice may be adopted without disturbing the current traffic situation on roads, hence found to be better options of constructing the bridges within stipulated time which saves direct as well as indirect cost of construction.

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