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# Launching of Bridge by Incremental Launching Method

**Omkar Gaikwad[1], Akshay Mane[2], Jishan Mulani[3], Asst. Prof. Balram Lagad[4] , Dr. Sachin Pore[5]**

[1-5]*Department of Civil Engineering*
[1,2,3,4,5]*Dr. Babasaheb Ambedkar Technological University Lonere, Maharashtra, India*

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**Abstract -** *Launching techniques method will never become the most economical procedure for constructing every bridges. The incremental launching method (ILM) requires a considerable amount of analysis and design expertise and specialized construction equipment for launching. Here the data should be content incremental launching methods and benefits. It must be easier and fast working process. In upcoming future it use mostly because it have not required large spaces in site. But it's not required most spaces in site. But it's not working in small area because is also risky technique. The launching process of the long span arch bridge is much complicated with sensitive and frequent changing structure loading performance. When the incremental launching method is used, the advantages of in-situ and precast concrete construction are combined. The incremental launching method for bridge construction may offer advantages over conventional construction, including creating minimal disturbance to surroundings, providing a more concentrated work area for superstructure assembly, and Increase the safety for environment.*

***Key Words***: **Launching techniques, Incremental launching method, Design considerations, ILM Applications and design parameters**

## 1. INTRODUCTION

Bridges have been constructed using the incremental launching method for many of the years. In this method of construction, the bridge superstructure is assembled on one side of the obstacle to be crossed and then pushed longitudinally into its final position. The launching is performed in a series of increments so that additional sections can be added to the rear of the superstructure unit prior to subsequent launches. The launching method has been applied to tied-arch although these are fully assembled prior to launching. The incremental launching method will never become the most economical procedure for constructing all types of bridges. The Incremental Launching Method requires a considerable analysis and design expertise and specialized construction equipment for launching. However, the Incremental Launching Method may often be the most reasonable way to construct a bridge over an inaccessible area. The first bridge was launched incrementally. The Waldshut–Koblenz Rhine Bridge, a wrought iron lattice truss railway bridge, completed in 1859. The second bridge was incrementally launched in the Rhine Bridge, a railway bridge that spanned the Upper Rhine between Kehl, Germany and Strasbourg, France, completed in 1861.

### 1.1 Incremental launching equipment system control

I. Working Principle of the Launching Equipment:
The launching process of the long-span arch bridge is most complicated with sensitive and frequent changing structure loading performance. Therefore, a set of tracked incremental launching system is specially developed with highly modular equipment and automatic control system. The set of incremental launching system has adjusting capacity in vertical, longitudinal and transverse direction, power given by hydraulic jack and automatically controlled by computer programming.

**Table-1:** Bridge launching process

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|---|---|
| **Step 1**<br>**Lifting** | The lifting of oil cylinder is activated to uplift the entire steel arch-girder structure from the pad beam. |
| **Step 2**<br>**Launching** | The launching of oil cylinder is activated to move the steel arch-girder structure and the upper part of the launching system forward. |
| **Step 3**<br>**Descending** | The lifting oil cylinder is released and descended, the steel arch-girder structure is laid down on temporary pad beam |
| **Step 4**<br>**Withdrawing** | The launching oil cylinder is released and the whole launching system back to initial state, a launching cycle completed and prepare for next repetition. |

II. Structure of the Launching Equipment:

This set of tracked ILM system is composed by upper sliding part, lower supporting part and hydraulic equipment. The core structure upper sliding part of the launching system is the support steel base box, the bottom of which is fixed with a 3mm-thick stainless steel plate with the slide plate in the lower support part to form the friction pair and the friction coefficient is reduced. The support steel base box is stiff enough to prevent large deformation and huge stress in the main girder bottom plate during the launching process. The core structure of the lower support part is the laterally lifting and incremental launching oil cylinders. Four lifting oil cylinders has been designed at the four sides of the support structure to form the supporting system of the entire equipment. For reduce the equipment height, the lifting oil cylinder is installed inversely inner side the support structure with spherical hinge bearing installed for slope self-adjustment. The ascending and descending of the arch-girder structure while the launching process can be achieved by the support lifting oil cylinder, or separately adjusting the height of four lifting oil cylinders, to suit for different horizontal and transverse bridge slopes, with deformation requirements of the arch-girder structure automatically satisfied. Four dual-head hydraulic oil cylinders, two at both front and back sides, are internally installed inner side at the lower support part of the launching equipment. Horizontal incremental movement of the upper sliding part and lower support part can be achieved by the left and right movement control of the oil cylinders.

III. Equipment Control of the Launching Process: Centralized computer control is used to ensure the simultaneous operation of the entire launching system, with control strategy of synchronized position and tracked loading adopted. With help from different sets of sensors, including mainly pressure sensors to measure working pressure of lifting oil cylinder, displacement sensors for a launching oil cylinder travel distance measurement, and angle sensors to record the hybrid girder longitudinal slope with accuracy up to ±0.05°, the synchronized state of the lifting oil cylinder, launching oil cylinder and transverse adjusting oil cylinder can be simultaneously recorded and monitored to limit the horizontal force of the support pier within the allowable limit and ensure a steady launching process. The reaction of load lifting oil cylinder at pier position is used as basic reference, and the launching force and displacement of the launching oil cylinder as control parameter, to achieve a both load and displacement comprehensive control.

### 1.2 Objectives

1. To choose the most appropriate method for bridge launching
2. To minimum disturbance to the environmentally sensible areas.
3. To priorities the safety during the construction.
4. To economies the cost of transportation and reduction in the cost of construction elements.
5. To provide desirable working condition

## 2. DESIGN PARAMETERS

### 2.1 Design considerations during launching of bridge by ILM

I. Substructure Effects Caused by Launching Forces The forces applied to a substructure element because of the launching a bridge include three vector components which include the following:

1. Vertical loads are representing due to the dead load support reaction at the pier.
2. Horizontal loads generated by the friction and other resistance forces in the bearings as well as the local grade of the launch surface
3. Transverse horizontal component generated by the lateral guide of a system.

II. Lateral Guidance and Steering Control during Launching

An adequate lateral guidance system should be provided for the superstructure during launching operations. It is well-known that steel girder bridges are subject to sun-induced curvature prior to the placement of the concrete deck. The girder face exposed to the sun warms considerably quicker than the face which is shaded. This phenomenon is not problematic on a conventional bridge construction project and is commonly ignored. When this curvature occurs while a launching event, there can be significant problems in maintaining the alignment of the girders and providing a means to keep them tracking along the desired path. A guidance system is recommended which provides resistance of at least 10 percent of the vertical reaction at a given pier during the entire launching process. This resistance also contributes to resist the lateral forces due to wind forces which are applied to the length of the girders and any fabrication and assembly tolerances that may exist.

III. Wind Forces during Launching

The effect of both static and dynamic wind forces during the construction of the bridge using incremental launching should be considered, particularly in the case of a lighter-weight steel superstructure. An analysis of the static wind forces has applied to the superstructure at maximum cantilever is not sufficient to include the possible effects of buffeting caused by a blunt body. There in some cases for longer spans the use of wind fairings to help improve the aerodynamic performance of the cantilever span is used with reasonable success. In order to eliminate potential problems with wind effects while a launching operation, a clause is suggested to be included in the project special provisions which prohibit launching of the bridge when forecast conditions indicate a likelihood of wind speeds on a given day in excess of a particular threshold may be 20 to 30 miles per hour.

IV. Reversible Launching System

In order to reduce the chance that a bridge is left in a vulnerable position with a long cantilever for an extended period of time the utilization of a launching system that is reversible is recommended. It will be ensure that each launch event be suspended at a stable position with only a minimum cantilever extended.

V. Lateral Bracing System for Steel Girder Spans

The modern concept for incremental launching was developed in the year 1960 primarily for use on concrete box girder superstructures. These girders are inherently stiff and provide the considerable resistance against torsional buckling while the launching phase. This same resistance is not pertinent for a steel I-girder bridge. The benefit of a steel superstructure is a significant savings in dead load resulting in potentially smaller rollers and bearings. The reduced jacking force needed to launch the superstructure. A system of upper and lower lateral bracing is mostly recommended to be included in the design of steel girder superstructures in order to provide the necessary torsional stiffness while launching operations. This bracing should be designed as a primary member for calculated loads at the cantilever stage. In the bracing is of critical importance in the leading span which undergoes reverse bending while the cantilever stage of construction. Due to the cost and difficulty of this operation it may be more economical to simply leave the bracing in place for the final condition. This makes these an attractive alternative for moderate spans

VI. Temporary Supports and Auxiliary Piers Temporary Supports and Auxiliary Piers. The need for temporary piers constructed at mid span of the permanent crossing can rarely be justified except in the case of extremely long spans. The Millau Viaduct, which was recently completed in southern France, utilized temporary piers to reduce the cantilever length but the cost of these towers was significant. The design team was able to justify the cost because the extreme wind forces which have been recorded in the Tarn Valley. The desire of the design team was to reduce the free cantilever length. A review of the literature fails to show the use of these temporary supports on spans less than 450ft till it is necessary to launch the span alonga horizontal curve. The cost of these temporary towers can quickly increases the cost of a longer launching nose.

VII. Steel Girder Flange Contact Stresses and Girder Web during Launching

Steel Girder Flange Contact Stresses and Girder Web during Launching There has been considerable research into the subject of contact stresses on the bottom flange of heavily loaded steel girder bridges which is presented elsewhere in it. It should be noted that large contact stresses must be considered during design and appropriate consideration should be given to both localized effects on the bottom flange as well as web buckling and crippling concerns. When launching a bridge superstructure over a series of roller supports which are fixed in position essentially any point along the length of each girder line works as a support point at some point in between the launching operation for the non-composite steel dead load. It is critical that the girder web be stiffened to resist this loading without the risk of local web buckling because of the combined flexure/shear acting at this point

VIII. Required Jacking Forces to Overcome Friction and Longitudinal Grade

The use of a low friction roller system is recommended for use on all upcoming launched girder bridge projects. These rollers are assumed to provide a frictional resistance of 5% when rolling across a surface covered with steel plating sufficient to resist deformations because of the heavily concentrated load. Laboratory testing has shown this friction coefficient may be as low as 1 to 2 % under static conditions. It is rarely possible for a bridge to be launched along a longitudinal grade of up to several percent in either positive or negative grade. The idea of launching the bridge along a positive grade offers some advantages in that there is no concern of allowing the bridge to roll unencumbered in the event of a mechanical failure during a launch event. The extra force required to overcome not only the inherent friction in the roller system along with the energy to raise the mass of the bridge superstructure during the launching must be designed into the jacking system and perhaps require larger equipment. Decision as to which end of the bridge will be best accommodate the jacking system is a function of the local access an derestriction sand should not be seen as being controlled by the mechanics of the launching system.

IX. Analysis of Erection Stages

Analysis of Erection Stages Much has been written about the challenges of analyzing a bridge for incremental launching. An envelope of flexural moment and shear forces must be calculated over an infinite number of support conditions as the superstructures has launched. These calculations are cumulated in the case of a bridge constructed with post- tensioned concrete as the additional effects of creep and shrinkage must be included along with thermal gradient concerns.

X. Design of Specialized Bridge Components

Design of Specialized Bridge Components Due to the significant number of these projects which have been completed in the Europe there has been an opportunity to develop standard bridge launching equipment which has to be commonly specified. Particular components to be selected as:

1. Design or selection of bearings. Past projects have typically used rollers but a few projects were constructed using rollers which were custom-made for the specific application.
2. Design of launching nose.

3. Design of lateral guides.
4. Design of king post and cable-stay system.
5. The need for additional girder stiffeners at the location beneath the king post must be considered.

### 2.2 General considerations for incremental launching methods

For monitoring of upcoming launched bridges, contract language should be included to provide reasonable access and assistance to the monitoring staff.

1. A comprehensive monitoring program, which alerts the contractor of potential problems, should be implemented to insure that allowable stresses are not exceeded. The designer should develop a design model showing the stresses and the anticipated load distribution launch the launch. These values for allowable stresses.
2. A pre-launch and post-launch survey of the structure should be performed.
3. Use a set of mirrors to monitor the plumb of the piers during and after launching Operations.
4. Cross frame members of the superstructure are particularly vulnerable to unusual launch forces and potential monitoring should be considered if the cross frame members, girders and connections have not been designed to support the weight of one girder supported only by the cross frame connections to the adjacent girder.
5. Designers should develop a launching system that is reversible. There should be a method of retracting the cantilevered girders in the event of an unexpected problem. Monitoring of the cantilevered portion of the superstructure could provide useful information regarding potential problems during launch.
6. It may be advisable to monitor the structural response of the piers to the touchdown forces during the launch and during the passage of the superstructure over the pier.
7. A number of other behaviors that would be useful to monitor would be
    1. Girder flexural behavior during launch events, including contact stress and bending
    2. Load transfer mechanism between girders
    3. Horizontal force necessary to launch various construction stages.

### 2.3 Limitations of ILM

During the launching of a bridge the superstructure acts as a continuous beam supported on roller and is transversely restrained by lateral guides that prevent drifting movement. Any constraint eccentricity will cause unintended secondary stresses and may cause launching problems such as excessive wear of bearing devices. Nearly all the sections of the deck would be experience both sagging and hogging moments during launching that are higher than the moments in an instantaneously built deck. Deck has to be straight. Special bearings are required at the supports.

### 2.4. Procedure of incremental launching method

The principle of the incrementally launched bridge consists of building the superstructure segments in a casting yard located behind the abutment. Each and every segment is match cast against the previous one and pre-stressed to the section of superstructure already built. The entire structure is then jacked forward a distance equal to the length of this segment. This process is continuously done until the bridge is in its final position. The secondary is then installed and the temporary bearings are replaced by the permanent bearings. This form of construction used for bridges having constant cross sectional shape throughout their length. The bridge must be straight or have a constant horizontal and vertical curvature.

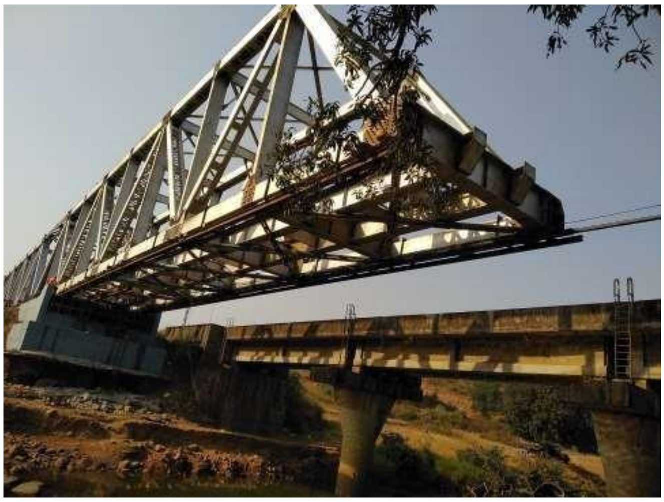

**Fig-1:** Launching of Bridge by Incremental Launching Method

This method, This is virtually a “factory” for bridge construction in segments with advantages like maximum productivity, reinforcement assemblages along the whole length of segment, minimum form work and others. It offers and successfully provides the optimization of the load bearing structure design and stabilization of piers against effects of horizontal forces the design of technological equipment for launching and casting yard, in cooperation with the designer and owner or contractor and according to the scope of required works. Particularly the casting yard, with respect to the control of the load bearing structure’s geometry with less tolerances, and safe launching device are crucial for successful realization of launching. The concept of launching is based on flexible casting yard and hydraulic strand units maximally reduces the risks associated with this method. The scope of works offered by it, besides the participation in design, includes pre-stressing works, delivery of special sliding pot bearings convertible to permanent ones, delivery and operation of the launching equipment and additional hydraulics related, and lifting works necessary for replacement or conversion of sliding bearings.

## 3 DESIGN OUTPUTS

### 3.1 Features of incremental launching method

Construction is carried out completely without false work, so that there is no problem in passing over obstacles below, such as roads, railways, rivers, buildings or conservation areas (see also. - The fabrication yard is stationary makes is located behind one abutment, which makes accurate construction possible. The concentration of plant in one area also keeps the site investments and overheads lower and the transportation distances extremely short. - The superstructure is made up of units of 15 to 25 m length, each completed per week; there are no joints, since each unit is concreted directly against the preceding one. - At the construction stage the superstructure is centrally pre-stressed, to limit the tensile stresses produced by the bending moments. Small tensile stresses should be permitted, even if such stresses are not permitted in the completed structure; they considerably improve the economics of the method, without detracting from the safety of the structure. - A lightweight nose is fitted to the cantilever end of the superstructure to minimize the cantilever moment during launching. A hydraulic jacking device for launching is located at the abutment.

### 3.2 Applications:

The average rate of construction using the bridge launching method is 30m within a week. The bridge launching method of construction becomes the Perfect consideration for project sites that face some challenges. The challenges are:

1. Steep slows or deep valleys. This makes the delivery of materials difficult.
2. Deep water crossings.
3. Limited or prevention of access due to environmental restrictions.

There is limited access to area beneath the bridge construction. This could be because of heavy traffic on roadways or railways.

### 3.3. Advantages of ILM

1. Minimum disturbance to surrounding.
2. Smaller, but more concentrated area required for superstructure assembly
3. Increased worker safety.

The incremental launching method is used for straight bridges, or where the superstructure has a spatial curve of constant radius throughout the length. It means, it is even possible to construct bridges which are curved both horizontally and vertically, provided that the radii are constant. The superstructure should consist of a beam of constant section, for which the slenderness ratio, that is the span-to-depth ratio, should not be more than 17 when completed. Generally, the ratio lies between 12 and 15, the first value applying to larger, the second to smaller spans. It is of advantage, with regard to design and detailing, if all the spans, except the end ones are equal in length; the length of the end spans should not exceed 75 % of that of the standard spans. The most suitable cross-sections are the single-cell box section or the double T- beam double- cell box sections have also been used, but their construction is somewhat more complicated in it is clear that a sufficient area of suitable load bearing ground must be available behind one abutment for the construction yard. If the bridge has a longitudinal gradient, it is better for the construction yard to be behind the lower abutment, so that no braking equipment is necessary during launching. If some of the preconditions for the use of the incremental launching method do not already exist, the modifications required are frequently quite small. However it is to be hoped that in the future increased attention will be paid at the design stage to the possible use of the incremental launching method.

## 4. CONCLUSION

Bridge construction over deep valley, water crossing with steep slopes, or environmentally protected regions can offer many challenges. The study of launching sequence of bridges accomplishes that the construction of bridges with proper sequence makes the work smoother and economical without wastage of time and benefits to all the workers engaged to the work. The choice of method for the launching of bridge depends upon the topography and condition of the traffic flow. The earlier and safer bridge launching benefits to the place in all way. Launching of bridge facilities the people by shortening the distance to travel. It saves the fuel hence saving in their time in this era of the modern world and technology.

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