SELF-LAUNCHING MOVABLE SCAFFOLDING SYSTEM

Inventor: Martin Pedro Bae, Kristiansund (NO)

Assignee: NRS Consulting Co., Ltd., Bangkok (TH)

Appl. No.: 14/350,338
PCT Filed: Oct. 7, 2011
PCT No.: PCT/TH2011/000046
§ 371 (c)(1), (2), (4) Date: Sep. 5, 2014

Publication Classification

Int. Cl. E01D 21/00 (2006.01)

U.S. Cl.
CPC ........................................ E01D 21/00 (2013.01)
USPC ........................................... 182/129

ABSTRACT

A self-launching movable scaffolding system comprising: a main girder which transfers loads to supports; a front nose which transfers load of the system to support during launching; a rear nose which transfers load to a rear support during casting and launching, which is equipped with a rail system; hanger trusses which transfer load from a formwork to the main girder during casting; a rear support which provides support to the system during rebar cage installation, casting, and launching; a front support which provides support to the system during rebar cage installation and casting; a front and a middle launching support which provide support to the system during launching; a launching wagon for providing support and movement of the system; a trolley system which provides relocation to the front and middle launching supports and provides rebar cage delivery; and a formwork which is a mold for forming concrete to a shape.
SELF-LAUNCHING MOVABLE SCAFFOLDING SYSTEM

TECHNICAL FIELD

[0001] Construction Engineering

BACKGROUND ART

[0002] Bridge construction especially for a whole span cast in-situ concrete bridge, over deep valleys, water crossings with steep slopes, over highway or railway, or environmentally protected regions can offer many challenges. The Movable Scaffolding System (MSS) for bridge construction may offer advantages over conventional construction (Conventional Scaffolding), including creating minimal disturbance to surroundings, providing a more concentrated work area for superstructure assembly, and possibly increased worker safety given the improved erection environment.

[0003] Conventional Scaffolding or Formwork was formerly built in place, used once and wrecked. Because of high labor cost and material costs, the trend today is toward increasing prefabrication, assembly in large units, erection by mechanical means such as “movable forms” and continuing modify and reuse the forms for other projects.

[0004] Movable Scaffolding Systems are conceived to be used in the construction of cast in-situ concrete bridges and they are travelling steel structures supporting the formwork that gives shape to the bridge. The MSS is built to be backed off from the hardened concrete, moved to a new position, and precisely adjusted for concrete forming next span.

[0005] The Movable Scaffolding System was developed in the mid 1970’s. The system has been further developed and has become a very popular system for constructing bridges worldwide. The ability to adapt the MSS to different cross sections allows the contractor to use the equipment for different projects elsewhere.

[0006] MSS System

[0007] The MSS consists of a support structure spanning between two piers from which formwork is either supported or suspended. The inner formwork (core form) is collapsible and can run on a rail system to allow easy relocation to the next span. The system is designed so that the outer formwork can be opened sufficiently to allow it to pass around the bridge columns during the launching process. After launching the formwork is closed again and after setting to the correct alignment, placement of reinforcement can start.

[0008] Type of MSS

[0009] The MSS can be divided into two types, namely, (i) underlane (or underslung) and (ii) overlane (or overhead). The underlane type of MSS has two parallel girders which supports the formwork. The overlane type of MSS has one or two main girders from which the formwork is suspended.

[0010] The choice of which type to be used depends on site conditions such as height restrictions, type of bridge deck (e.g. single cell, twin cell, double T) and height of columns.

[0011] The Self-Launching MSS

[0012] NRS is the first in the world to develop the Self-launching MSS (SL-MSS) in order to solve the problems related to the difficulties in handling pier support brackets over water as well as on high piers. This system is able to transfer forward and mount the pier support brackets without any need of an independent crane. The SL-MSS has been successfully used in the construction of several major bridge projects worldwide and is widely sought after due to its cost and operational efficiency.

[0013] However, the existing problems related to current MSS include requirement of long cycle time, inability to deliverable whole rebar cage simultaneously or all at once, requirement of several block-outs in the superstructure, requirement of hanging bars passing through the superstructure deck to support the formwork, requirement of other equipment necessary for relocation of the supports and, last but not least, the complexity of its operation as well as the labor intensive work.

[0014] Moreover, most of the movable scaffolding systems at present have limitations in their operation regarding the high costs of construction manpower and the cost of assembling, disassembling and re-assembling.

[0015] This invention provides a new MSS with the self-launching system used for cast-in-situ bridges which can offer many cost-saving advantages to the bridge construction project.

BRIEF DESCRIPTION OF DRAWING

[0016] FIGS. 1-A and 1-B show General Arrangement: Elevation and Plan

[0017] FIGS. 2-A and 2-B show Section A at Hanger Truss: Rebar cage installation & Concrete positions

[0018] FIGS. 3-A and 3-B show Section A at Hanger Truss: Launching position at typical pier & portal pier

[0019] FIGS. 4-A, 4-B and 4-C Section B at Rear Support: Rebar cage installation, concreting and launching positions

[0020] FIGS. 5-A and 5-B show Section C at Front Support: Rebar cage installation and concreting positions

[0021] FIGS. 6-A and 6-B show Section C at Front Support: Launching position at typical pier & portal pier

[0022] FIGS. 7-A and 7-B show Section D at Middle launching support: Launching and relocating positions

[0023] FIGS. 8-A and 8-B show Section E at Front launching support: Launching and relocating positions

[0024] FIGS. 9-A and 9-B show Launching sequence: Stage 1 and 2

[0025] FIGS. 10-A and 10-B show Launching sequence: Stage 3 and 4

DISCLOSURE OF THE INVENTION

[0026] The self-launching movable scaffolding system (SL-MSS) according to this invention comprises of

[0027] Rear Nose (120), as shown in FIG. 1-A, which provides a transfer of load to Rear support (400) during casting and launching is equipped with the mono-rail (701) for electrical lifting hoist (702) used for rebar cage (900) loading.

[0028] Hanger Trusses (200) which provides a transfer of load from formwork (800) to main girder (100) during casting. There is the second folding function on the upper part of the said hanger trusses (200) which creates the wider opening and the higher position as shown in FIG. 3-B. This will allow the MSS to pass the portal pier area (416) or other obstructions.

[0029] Rear Support (400) which provides support to the MSS during rebar cage (900) installation, casting, and launching. The said rear support (400) can be opened in the center for rebar cage (900) to pass through as shown in FIG. 4-A and unlike the other previous systems
require the additional rear support for casting, the said Rear support (400) of this invention is now designed to take the casting load. The foldable legs (401), parts of the Rear support (400), are folded up to support directly to the main girder (100) during casting and launching. As shown in FIG. 4-B, Rear support (400) is set for casting stage. The rear support main jacks (402) are activated and transferred load to existing bridge. During MSS launching as shown in FIG. 4-C, The rear support main jacks (402) are deactivated and load is transferred pass through the express rollers (403) to the existing bridge. There are rear support side shifting cylinders (404) equipped at top of the rear support (400) and the main girder (100). They are used for transverse adjusting of the main girder during launching pass through curve spans and for transverse adjusting of the rear support (400) itself before casting. The said Rear Support (400) is fixed to the main girder (100). No other external equipment is required for its relocation.

Front Support (410) which provides support to the MSS during rebar cage (900) installation and casting. As shown in FIG. 5-A, The said Front Support (410) is opened at the center for rebar cage (900) to pass through. Once finish placing the rebar cage (900), tension bars (415) are installed and engaged to the front support (410) as shown in FIG. 5-B to confine the deflection of the front support (410) during casting stage. Unlike the other previous systems that require the block-outs in bridge structure, there is no any part of the Front support (410) pass through the bridge structure. Therefore, block-outs are not required.

During casting, the front support main jacks (413) are activated and transferred load from main girder (100) to the front support (410). The Front support legs (412), which are parts of the front support (410) provide a transfer of load further to column footing. There are front support side shifting cylinders (414) as shown in FIG. 5-B equipped at top of the front support (410) and the main girder (100) to allow the transverse adjusting of the main girder. As shown in FIG. 6-A, the locking arms (411) at the lower part can be opened to pass the pier during launching. The Lower parts of the front support (410) as shown in FIG. 6-B can be disconnected when launching pass the portal area (416). The said front support (410) is fixed to the main girder (100). No other external equipment is required for its relocation.

Front Launching Support (420) provides support to the MSS during launching operation.

The said front launching support (420) is set and secured on the pier top (425) as shown in FIG. 8-A with the launching wagon (500) at top which allows the front nose (110) and the main girder (100) to glide or move over to the new set position. The said front launching support (420) can be disassembled from pier and suspended to front nose (110) as shown in FIG. 8-B in order to relocate to the next pier.

Middle Launching Support (430) provides support to the MSS during launching operation. The said middle launching support (430) is suspended to the front nose (110) as shown in FIG. 1-A during casting. The said middle launching support (430) is moved back and set on already cast concrete, as shown in the dotted line in FIG. 1-A, and activated to support the MSS during launching. The cross section FIG. 7-A and 7-B show the middle launching support (430) in active and inactive stages respectively.

Front Launching Support (440) provides relocation to the said Middle launching support (430) and the said Front launching support (420) and also provides the rebar cage (900) delivery. The said trolley system is composed of the mono-rail (701) set along the rear nose (120), main girder (100), and front nose (110) and the electrical lifting hoist (702).

Formwork (800) which is supported by formwork support frame (801) according to this invention does not require hanging bars for its hanging. Therefore, there is no obstruction during the rebar cage (900) installation and concreting, refer to FIGS. 2-A and 2-B.

In order to operate the said SL-MSS, the assembling and erecting sequence of the said SL-MSS can be described as the following:

1. Install the temporary tower (501) at the front pier of the span being cast.
2. Install and secure the middle launching support (430) over the temporary concrete foundation behind the abutment (417).
3. Assembly the main girder (100) on ground.
4. Install the said main girder (100) on to the said temporary tower (501) and the said middle launching support (430).
5. Install the front support (410) and front support legs (412), and rear support (400) to the said main girder (100). Activate both supports to take load.
6. Remove the said temporary tower (501) and the said middle launching support (430).
7. Install the hanger trusses (200) to the said main girder (100).
8. Install formwork support frame (801) and formwork (800) on hanger trusses (200).
9. Assembly the front nose (110) on ground. Install the said front nose (110) to the said main girder (100).
10. Install trolley system (700).
11. Install other miscellaneous parts i.e. hydraulics equipment, pumps, working platform to complete.

The launching sequence of the said SL-MSS comprises of the concreting and launching stages as the following:

Stage 1 (as shown in FIG. 9-A)

1.1 MSS is set at the concreting position.
1.2 Front support (410) and rear support (400) are activated.
1.3 Middle launching support (430) is suspended to the front nose (110).
1.4 Front launching support (420) is ready set on top of the next pier.
1.5 Install rebar cage (900) and cast the span.

Stage 2 (as shown in FIG. 9-B)

2.1 Move back and install the middle launching support (430) on the already cast deck.
2.2 Release the main jacks (413 and 402) at front support (410) and rear support (400) respectively. Rear support (400) is now on the express rollers (403).
2.3 MSS is supported by middle launching support (430) and rear support (400).
2.4 Open the hanger trusses (200).
2.5 Prepare for launching forward to the next span.
3.1 Launch forward the MSS to the new span until the front support (410) is in same line with the front launching support (420). During launching, the MSS is supported by front launching support (420), middle launching support (430) and rear support (400).

3.2 Activate the main jacks (413 and 402) at front and rear supports (410 and 400) to take load of the MSS. Middle launching support (430) and front launching support (420) are now free.

Stage 4 (as shown Fig. 10B)

4.1 Relocate the front launching support (420) to set on the next pier.

4.2 Relocate the middle launching support (430) to suspend to the front nose (110).

4.3 Close up the hanger trusses (200). Prepare the MSS for the casting.

4.4 Repeat the stage 1-4 to complete the cycle for the next span.

The dismantling process of the said SI-MSS can be described as the following; Process of this operation is depended on the actual condition at site and varied from job to job. A careful planning and drawings should be done before actual dismantling begins.

The general steps to dismantle the MSS after the last span has been completed are as follows:

1. Install temporary tower (501) at rear of main girder (100) to take load of MSS.
2. MSS is supported by temporary tower (501) at the rear and the middle launching support (430) at the front.
3. Dismantle the front nose (110) and front launching support (420).
4. Fold down the bottom hangers (200) & start dismantling the formworks (800) and formwork support frame (801).
5. Dismantle the hanger trusses (200).
6. Dismantle the front support (410) and front support leg (412).
7. Dismantle the rear support (400).
8. Bring down the main girder (100) and dismantle each module.
9. Dismantle the middle launching support (430) and the temporary tower (501).

The advantages of the movable scaffolding system when compared to conventional scaffolding or launching gantries are as the following:

- High efficiency in achieving rapid cycles
- Lightweight
- Easy to assemble
- Reduce manpower
- Can be adapted to different cross sections (allowing reuse elsewhere)
- High resistance to torsion
- Maximum deflection=L/400 of span
- Self-launching option (no cranes required for pier bracket relocation)
- Limited interference to road users below during construction (if applicable)
- Pre-stress cost reduction (up to 30%) by reduction of deck pre-stressing amount (no cantilever moments) or reduction in number of anchorages & couplers in the pre-stressing of the deck and reduction in amount of pre-stressing operations in the deck

Reduction in number of high risk operations (movements & launching)

Easier geometry control (span by span construction)

No requirement for scaffolding to support the structure

Prefabricated rebar cage can be lifted and placed by MSS

Less forces in piers

No requirement for segmental casting yard and associated transport costs.

1. A self-launching movable scaffolding system comprising:
   - A main girder which transfer loads to supports;
   - A front nose which is an extension part of the main girder located at a front end of the main girder and used to transfer load of the scaffolding system to support during launching;
   - A rear nose which provides a transfer of load to a rear support during casting and launching wherein the rear nose is equipped with a rail system for a rebar cage delivery and support relocation by a trolley system;
   - Hanger trusses which provide a transfer of load from a formwork to the main girder during casting wherein the hanger trusses have a second folding function on an upper part which creates a wider opening and a higher position for allowing the scaffolding system to pass a portal pier area or other obstructions;
   - A rear support which provides support to the scaffolding system during rebar cage installation, casting, and launching;
   - A front support which provides support to the scaffolding system during rebar cage installation and casting;
   - A front launching support which provides support to the scaffolding system during launching;
   - A middle launching support which provides support to the scaffolding system during launching wherein the middle launching support can be suspended to the front nose during casting;
   - A launching wagon for providing support of the scaffolding system which allows the scaffolding system to move both forward and backward and further allows the scaffolding system to adjust sideways;
   - A trolley system which provides relocation to the middle launching support and the front launching support and further provides the rebar cage delivery; and
   - A formwork which is a mold for forming concrete to a shape.

2. The self-launching movable scaffolding system according to claim 1 wherein the rear support which provides support to the scaffolding system during rebar cage installation, casting, and launching can be opened at a center for the rebar cage to pass through.

3. The self-launching movable scaffolding system according to claim 1 wherein the front support which provides support to the scaffolding system during rebar cage installation and casting can be opened at a center for the rebar cage to pass through.

4. The self-launching movable scaffolding system according to claim 1 wherein the formwork is supported by a formwork support frame with no hanging bars for its hanging.

5. The self-launching movable scaffolding system according to claim 1 further comprising rear support main jacks
which are activated and deactivated in order to transfer load to an existing bridge and pass load through express rollers to the existing bridge, respectively.

6. The self-launching movable scaffolding system according to claim 1 further comprising rear support side shifting cylinders which are equipped at a top of the rear support and the main girder, used for transverse adjusting of the main girder during launching to pass through curve spans and for transverse adjusting of the rear support itself before casting.

7. The self-launching movable scaffolding system according to claim 1 wherein:

the front launching support is set and secured on a pier top with the launching wagon at the top which allows the front nose and the main girder to glide or move over to a new set position; and

the front launching support can be disassembled from a pier and suspended to the front nose in order to relocate to a next pier.

8. The self-launching movable scaffolding system according to claim 1 further comprising tension bars which are installed and engaged to the front support in order to confine a deflection of the front support during casting, after placing of the rebar cage.

9. The self-launching movable scaffolding system according to claim 1 further comprising front support main jacks which are activated to transfer load from the main girder to the front support during casting.

10. The self-launching movable scaffolding system according to claim 1 further comprising front support legs which provide a transfer of load further to a column footing.

11. The self-launching movable scaffolding system according to claim 1 further comprising front support side shifting cylinders which are equipped at a top of the front support and the main girder in order to allow transverse adjusting of the main girder.

12. The self-launching movable scaffolding system according to claim 1 further comprising a mono-rail which is set along the rear nose, the main girder, the front nose and an electrical lifting hoist.

* * * * *