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PRECAST FLOOR SLAB REPLACING PROCESS

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a precast bridge floor slab replacing process by removing an existing floor slab from a bridged composite girder and placing thereon a new precast floor slab.

Prior Art

As concrete bridge floor slab of viaduct, etc. are damaged with aging under a severe condition such as incessant traffic of cars and trucks, weathering and the like, damaged precast floor slabs have to be repaired or replaced. A slightly damaged floor slab can be reinforced by fitting a steel plate, but heavily damaged one should necessarily be replaced as a whole.

There are two kinds of processes for replacing a damaged floor slab. According to a conventional replacing process, a new concrete floor slab is completed by removing damaged one, subsequently framing a form, arranging bars thereon and finally casting concrete. The other replacing process comprises removing damaged one followed by placing thereon a precast floor slab which has been prepared in a factory.

Such a replacement is conducted on a bridge under a in-service condition and thus, should be completed in a shorter construction period. Accordingly, the precast floor slab which can shorten the period is primarily employed in the replacing process.

The floor slab replacing process with the precast one generally comprises several procedures as in the following.

In the first procedure, stress caused in the main girder is

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improved. As a rule, the floor slab and the girder function as a composite section and possess large flexural rigidity, while the girder only functions as a section and no longer has sufficient flexural rigidity after the deck is removed. As a countermeasure to this, improvement of the girder by means of an outer cable is practiced.

In such a method for improving stress caused in the girder by means of the outer cable, a cable made of steel or new material such as carbon is arranged on an under or side surface of the girder to the axial direction and stressed to add a negative bending moment to the girder and balance thereof against a positive bending moment caused by load to be loaded.

However, a cable anchoring bracket is connected to the girder by means of a bracket flange and bolts after bolt holes are perforated through a girder flange or fixed thereto by welding, thereby reducing a sectional area or properties of the girder.

In the second procedure, the floor slab placed on the girder is removed. According to conventional removing methods, after a construction site is occupied by controlling the traffic, floor slab concrete is crushed in order from peripheral portions thereof by means of a crusher such as a concrete breaker, or cut to blocks of appropriate sizes for taking out of the site by means of a concrete cutter or a concrete breaker, then the blocks are put on a truck by truck crane, and take out of the site.

However, the floor slab concrete thus crushed tends to fall down in the former method, which should be collected on scaffolds in the case of a river bridge, while it requires many hands and



cost to pick up and take out the fallen concrete. On the other hand, as the floor slab concrete is generally anchored to the bridge girder by means of steel bars or members called as slab anchors, it is difficult to pull up the floor slab by a crane unless such anchored portions are broken and released therefrom by a concrete breaker, etc. Accordingly, the floor slab should be crushed to smaller sized blocks than expected in the latter case, while a considerable amount of concrete is fallen down on the scaffolds, which disposal requires many hands and cost similarly as described above. Further, if the floor slab is pulleyed by a crane to break the concrete as it is, a significant impact shock from the floor slab upon releasing thereof from the slab anchors would cause a dangerous turnover of the crane due to a counteraction of the shock. In addition, in case of through type bridge, performance of the crane is not always fully exhibited at an obtuse elevation angle of the boom.

In the third procedure, the precast floor slab is placed. A lateral buckling of the girder does not occur because the floor slab to be placed is fixed to the main girder by means of shear connectors. While, under a condition where the aged floor slab is already removed from the girder and the precast is merely placed thereon, construction vehicles used for floor slab replacing or other cars and trucks passing through the secondary construction side affect an upper flange portion as a compressive side so that a change in buckling length is observed between cross beams, which would cause the lateral buckling of the main girder. In order to prevent the lateral buckling upon the floor slab replacement on the



composite girder with the precast floor slab, there have been practiced various countermeasures such as the struts additional method, false-work method, and a girder section reinforcing method.

However, each of the above mentioned countermeasures has intrinsic disadvantages. the struts additional method allow to inconveniently increase gross weight of the bridge. The false-work method is difficult depending on bridge constructing conditions especially on lakes or valleys. Reinforcement of the girder section is restricted by other existing members.

Finally, the precast floor slab is permanently fixed to the main girder in the fourth procedure.

According to the present invention, problems intrinsic to each procedure of conventional precast floor slab replacing processes are solved as a whole.

SUMMARY OF THE INVENTION

There is provided a precast floor slab replacing process which comprises reinforcing a main girder by introducing enough prestress to cause a bending moment to a negative direction of the main girder, sequentially cutting the floor slab placed on the girder to plural pieces of blocks, scrapping and removing the pieces of blocks by means of a jack-up system, followed by placing the precast floor slab so that cut-off box portions formed thereon are allocated on an upper flange of the main girder, temporarily fixing the precast floor slab and the main girder at the cut-off box portions with a fixing space left between the cut-off box portions to the main girder direction to prevent lateral backling thereof, releasing such a temporary fixture after the precast floor slab has been



placed, and permanently fixing the main girder and the precast floor slab while releasing the prestress introduced to the main girder.

As has been described above, the present invention produces the following effects.

Because of such constitution that prestress is introduced to the negative direction of the girder prior to scrapping aged floor slabs and is released after new floor slabs and the girder are fixed, this construction resists against external force as a composite section after the prestress is released, thereby allowing the bridge to behave as an indirect dead-live load composite girder and improve the stress balance. No timbering is required during reconstruction of the composite girder. Further, as brackets can be removed, an external appearance of the bridge under reconstruction is quite neat. In addition, because of the flange provided with no bolt hole therethrough nor welded portion thereon, the girder section is kept without any decrease in sectional area and effect on quality of the material.

As the floor slab is cut to plural blocks which are perforated through both surfaces for pulling-up thereof, while reaction leg portions provided with reaction jacks are allocated on blocks adjacent both sides of a block to be released so that a removing girder is laid on the reaction leg portions, the block to be released is pulled up when the reaction jacks are actuated after the removing girder and the block are connected by means of hanger bolts through pulling-up holes, thereby concrete around slab anchors of anchor portions are urged to be stretched and sheared. Accordingly, concrete in the vicinity of the slab anchors is



broken, thereby separating blocks from the bridge girder. As the blocks thus separated can be easily moved by means of a crane, etc., the present process is much safer than a conventional method in which floor slabs themselves are pulled-up and broken.

As the precast floor slab is fixed with a fixing space left between cut-off box portions formed thereon so as to shorten the fixing space and improve the bending stress-strain tolerance limits of an upper flange, lateral buckling can be prevented. Further, because of the fixing space left between the cut-off box portions, problems such as an inconvenient increase in gross weight of the bridge due to transverse supports temporarily applied between existing lateral struts or crossflames in conventional processes, difficulty in constructing conditions in the case of the false-work process and difficulty in reinforcement in the case of the girder section reinforcement process can be avoided.

As has been described above, the present invention provides a markedly convenient precast floor slab replacing process.

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 is a schematic transverse sectional view of a bridge which main girder is reinforced by outer cables.

Fig. 2 is a side view of a bridge which main girder is reinforced by outer cables.

Fig. 3 is a detailed view of main portions of a bridge which main girder is reinforced by outer cables.

Fig. 4 is a sectional view taken on line A-A in Fig. 3.

Fig. 5 is a transverse sectional view of a bridge together with a jack-up system for removing floor slab blocks.



Fig. 6 is a side view of a bridge together with a jack-up system for removing floor slab blocks.

Fig. 7 is a detailed plan view of a bridge together with a jack-up system for scrapping floor slab blocks.

Fig. 8 is a fragmentary detailed broken view of a jack-up system.

Fig. 9 is another embodiment of a jack-up system.

Fig. 10 is still another embodiment of a jack-up system.

Fig. 11 is an embodiment showing a situation where a block is pulled up by a jack-up system.

Fig 12 is a schematic transverse sectional view after a part of existing floor slabs are removed.

Fig 13 is a schematic side view after a part of existing floor slabs are removed.

Fig. 14 is an enlarged view of a main portion of a temporarily fixing portion of placed precast floor slabs.

Fig. 15 is a plan view of placed precast floor slabs.

Fig. 16 is a side view of placed precast floor slabs.

Fig. 17 is a sectional view taken on line B-B in Fig. 16.

DETAILED DESCRIPTION AND THE PREFERRED EMBODIMENTS

Referring now to the drawings, the present invention will be described in detail.

A procedure to improve stress caused in a main girder is detailed in the following by referring to Figs.1, 2, 3 and 4, in which

Fig. 1 is a transverse sectional view of a bridge which main girder is reinforced by outer cables;

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Fig. 2 is a side view of a bridge shown in Fig. 1;

Fig. 3 is a detailed view of main portions of a bridge shown in Fig. 2; and

Fig. 4 is a sectional view taken on line A-A in Fig. 3.

As shown in Fig. 2, a conventional steel cable 3 is anchored to brackets 4 and 4 fixed to an under (or side) surface of the main girder 1. 2 designates a floor slab.

The brackets 4 and 4 are frictionally joined to the main girder 1 as shown in Figs. 3 and 4. More precisely, an under-girder bracket 11 is attached under the main girder 1 to superimpose a bottom flange 1a of the main girder 1 on a top flange 11a of the under-girder bracket 11, both flanges 1a and 11a being frictionally joined by means of high tension vises 7. The anchor bracket 4 is provided with a conventional take-up unit 13 consisting of a center hole jack 8, a ram chair 9 and a load cell 10 and is joined to a bottom flange 11b of the under-girder bracket 11 through a top flange 4a by means of bolts 12. The other anchor bracket allocated under the opposite end of the main girder 1 is indirectly fixed thereto through the under-girder bracket in a similar manner as described above, although such a bracket is not shown in Fig. 3. Numeral 11c designates reinforcing plates. It should be understood that the anchor bracket 4 may be frictionally joined to the main girder at first hand by means of the high tension vises.

The main girder 1 is thus attached with the cable 3 anchoring brackets 4 and 4 for introducing prestress enough to cause a bending moment to the negative direction of the main girder 1. Prestress of desired degree is then introduced to the main girder



through the cable 3, followed by scrapping the floor slab.

A scrapping procedure of the floor slab is described below by referring to Figs. 5, 6, 7 and 8, in which

Fig. 5 is a transverse sectional view of a bridge together with a jack-up system 21 for scrapping floor slab blocks;

Fig. 6 is a side view of a bridge shown in Fig. 5;

Fig. 7 is a detailed plan view of Fig. 6; and

Fig. 8 is a fragmentary detailed broken view of a jack-up system 21.

By means of a concrete cutter, the floor slab 2 to be scrapped is cut to plural pieces of blocks 23, which are then drilled to form pulling up holes 24, as shown in Figs. 5, 6 and 7. In the figures, cutting-off portions are shown by 22. The above mentioned cutting and drilling order may be reversed.

As shown in Fig. 8, reaction leg portions 27 provided of reaction jacks 28 comprising pistons 28a and cylinder tubes 28b are allocated on blocks 23b and 23b adjacent to a block 23a to be released from the girder. A removing girder 26 of H steel is laid over the reaction jacks 28 so as to move upward and downward by means of pistons 28a.

In this embodiments, the reaction leg portion 27 and the removing girder 26 are integrally fitted to slidable cylinders 26a and 27a so as not to deviate therefrom. In this embodiments, these cylinders 26a and 27a may be omitted.

Alternatively, a pair of reaction leg portions 27 together with the removing girder 26 laid thereon may be allocated in advance on the blocks 23b adjacent to both sides of the block 23a to be



released and provided with travelling casters so as to function as a bridge floor slab scrapping system as a whole.

The removing girder 26 and the block 23a to be released are connected by hanger bolts 29 pierced through pulling-up holes of the block 23a and through holes 26b of the removing girder 26 and secured by nuts 20.

After a preparatory process for releasing the block 23a from the bridge girder is thus completed, the reaction jacks 28 are actuated to raise the pistons 28a, thereby forcing up the removing girder 26. At the same time, the block 23a is pulled up by the removing girder 26, thereby separating the block 23a from the bridge girder.

Fig. 9 shows another embodiment of a jack-up system for scrapping a floor slab block. In this system, reaction leg portions 27 and 27 subjected to reaction are allocated on blocks 23b and 23b adjacent to both sides of a block 23a to be released, while a removing girder 26 is laid on the reaction leg portions 27 and 27 together with center hole jacks 28' and 28' mounted thereon at positions corresponding to pulling-up holes 24 perforated through the block 23a. Hanger bolts extended from the center hole jacks 28' and 28' are pierced through the girder 26 into the pulling-up holes 24 of the block 23a and secured by means of nuts 20 on an under surface of the block 23a.

After a preparatory process for releasing the block 23a is thus completed, the center hole jacks 28' and 28' are actuated to raise the hanger bolts 29, thereby separating the block 23a from the bridge girder.

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Fig. 10 shows a further embodiment of a jack-up system for scrapping a floor slab block. In this system, reaction leg portions 27 and 27 provided with reaction jacks 28 comprising pistons 28a and cylinder tubes 28b are allocated on blocks 23b and 23b adjacent to both sides of a block 23a to be released, while a removing girder 26 is laid and fixed on the reaction leg portions 27 and 27 together with a pair of lever means 30 and 30 fitted thereon which interlocks with the reaction jacks 28 and 28. Each of the lever means 30 and 30 comprises a support plate 30a and a bar body 30b in which one end thereof is connected to the piston 28a of the reaction jack 28 and functions as a centroid, while the other end acts as a loading point. A block 23a and the lever means 30 and 30 are connected each other through hanger bolts 29 and 29.

After the block 23a and the lever means 30 and 30 are thus connected, the reaction jacks 28 and 28 are actuated as shown in Fig. 11. As the pistons 28a and 28a are forced downward, the bar bodies 30b and 30b are pulled down centering around respective supports and the loading points are pulled up. Thus, the block 23a connected to the removing girder 26 by means of hanger bolts 29 and 29 is forced upward and separated from the bridge girder.

After the block 23a is thus separated from the bridge girder, the hanger bolts 29 connecting the removing girder 26 and block 23a are unscrewed from nuts 20 to remove the removing girder 26.

Blocks to be released are separated from the bridge girder in this manner one by one and removed by pulling-up by a crane, etc.

shear connectors are then removed to place precast floor slabs on the main girder.

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A procedure for placing precast floor slabs will be described in the following by referring to Figs. 12 and 13. Fig 12 is a transverse sectional view after a part of existing floor slabs are removed. Fig. 13 is a side view of Fig. 12.

After the existing floor slabs are removed as shown Fig. 12, the precast floor slabs 33 are place by means of a crane, etc. as shown in Fig. 13.

Structure for preventing a lateral backling is applied prior to placing the precast floor slabs 33.

In Figs. 14, 15, 16, and 17, there is described a procedure how to place the precast floor slabs applied structure for preventing the lateral backling.

Fig. 14 is an enlarged view of a main portion of a temporarily fixing portion of placed precast floor slabs.

Fig. 15 is a plan view of placed precast floor slabs.

Fig. 16 is a side view of Fig. 15.

Fig. 17 is a sectional view taken on line B-B in Fig. 16.

A precast floor slab 33 is placed on rubber pads 32 arranged on a flange 1b of a main girder 1. If necessary, an under surface of the precast floor slab 33 and that of the flange 1b of the main girder 1 are then gripped by tie anchor (spring plate) 34 to halt a vertical motion of the precast floor slab 33.

The precast floor slab 33 has cut-off box portions 35, which are formed to allocate on the upper flange 1b of the main girder. In order to prevent the precast floor slab 33 to move horizontally, the cut-off box portions 35 are used to temporarily fix the precast floor slab 33 and the main girder 1 with a fixing space left



between the cut-off portions to the main girder direction.

In this embodiment, several wholly screwed studs 38 are welded on the upper flange 1b of the main girder and allocated to the cut-off box portion 35 of the precast floor slab 33 on the girder. The studs 38 are fixed by a fixing block 39 made of steel.

The fixing block 39 has through holes 39b for piercine and fixing the studs 38 and is arranged on the upper flange 1b of the main girder 1 after the studs 38 are inserted thereto. The studs 38 are connected to the fixing block 39 by securing protruded portions thereof over the fixing block 39 with nuts 36. 39c designates a plate member which is integrally formed, if necessary, on the surface of the fixing block 39.

A flat jack 37 is inserted between a wall surface 35a of the cut-off box portion 35 and a wall surface 39a of the fixing block 39 and is introduced pressure thereto to strongly press against the wall surface 35a and the fixing block 39, thereby the precast floor slab 33 and the main girder being fixed. Preferably, the flat jack 37 is inserted into both sides of the fixing block 39 and simultaneously introduced pressure thereto.

After the precast floor slabs 33 are fixed to the main girder 1, the traffic control may be temporarily released.

After the precast floor slab 33 is completely placed, the fixing block 39 is removed from the cut-off box portion 35 so that the studs 38 is left to form a shear connector, where concrete is cast to fix the main girder and the precast floor slab 33 permanently. On the other hand, the cables 3 and the brackets 4 used to introduce prestress are removed to release such prestress.



The present process for replacing existing floor slabs from the composite girder with precast floor slabs is thus completed.

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What is claimed is:

1. A precast floor slab replacing process which comprises reinforcing a main girder by introducing enough prestress to cause a bending moment to a negative direction of the main girder, sequently cutting the floor slab placed on the girder to plural pieces of blocks, scrapping and removing the pieces of blocks by means of a jack-up system, followed by placing the precast floor slab so that cut-off box portions formed thereon are allocated on an upper flange of the main girder, temporarily fixing the precast floor slab and the main girder at the cut-off box portions with a fixing space left between the cut-off box portions to the main girder direction to prevent lateral buckling thereof, releasing such a temporary fixture after the precast floor slab has been placed, and permanently fixing the main girder and the precast floor slab while releasing the prestress introduced to the main girder.

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Fig. 1

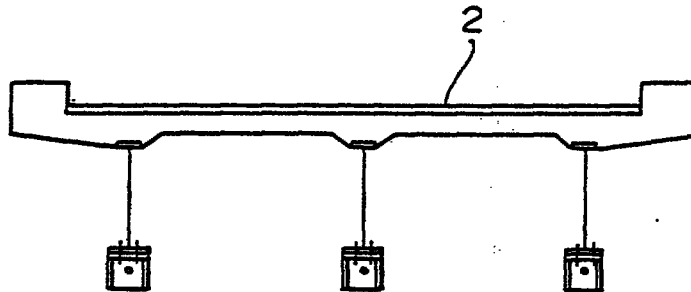


Fig. 2

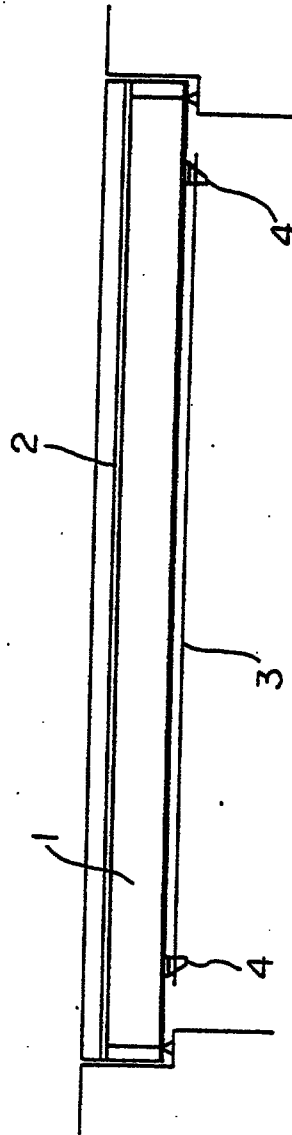


Fig. 3

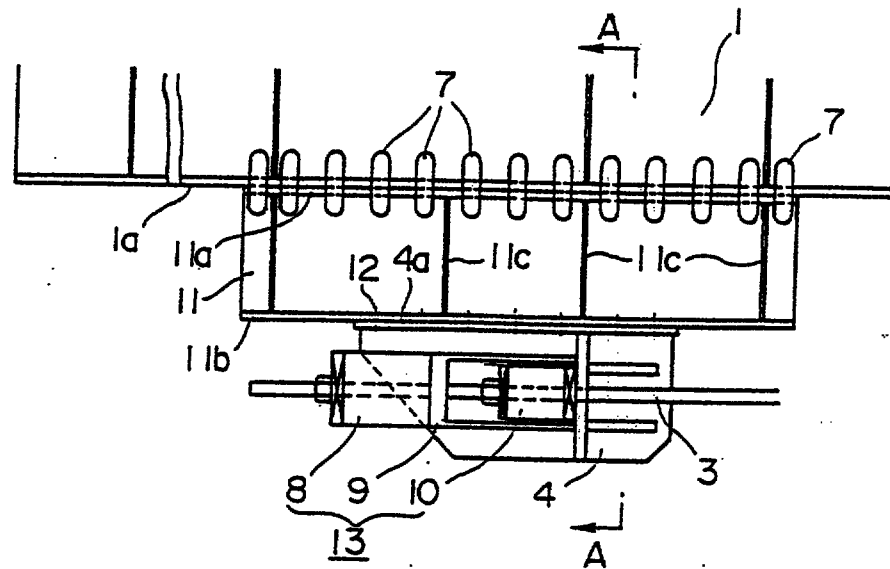


Fig. 4

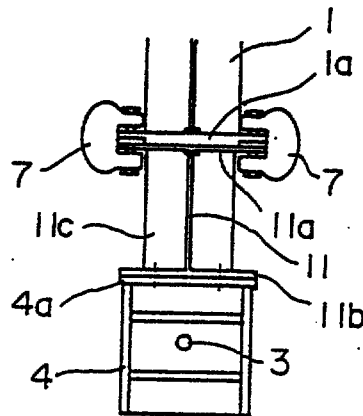


Fig. 5

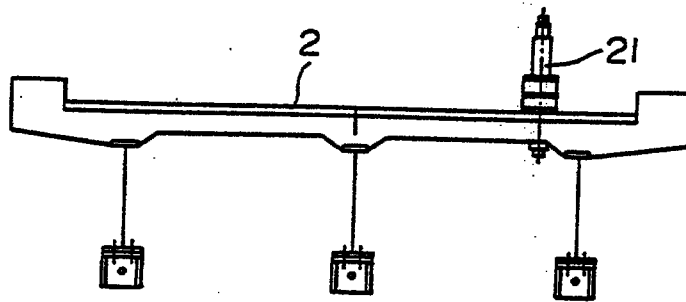


Fig. 6

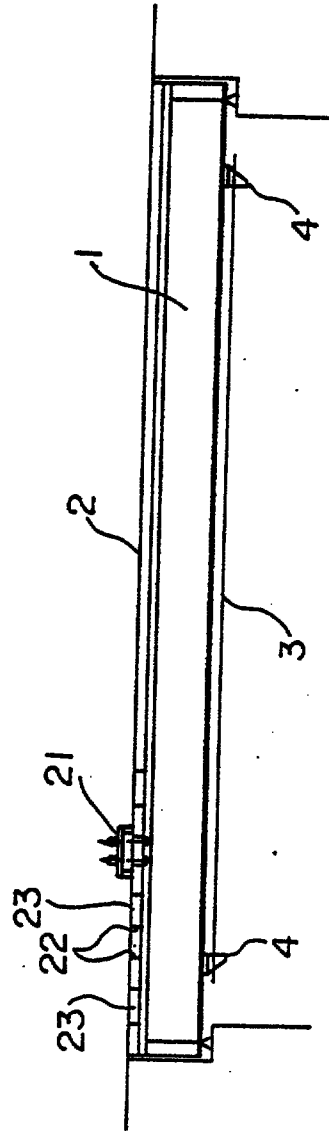


Fig. 7

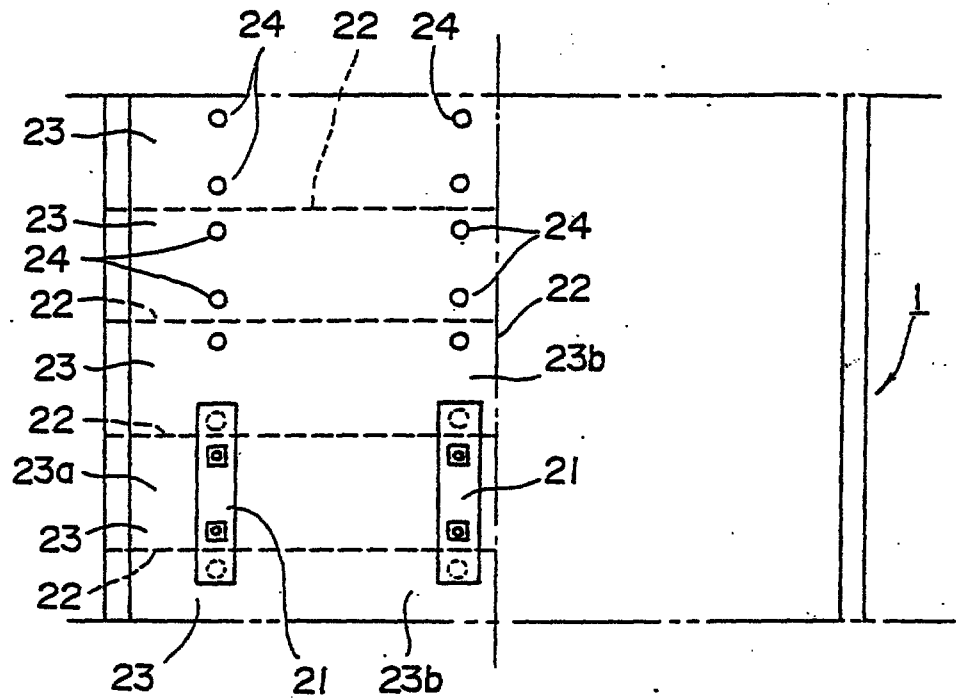


Fig. 8

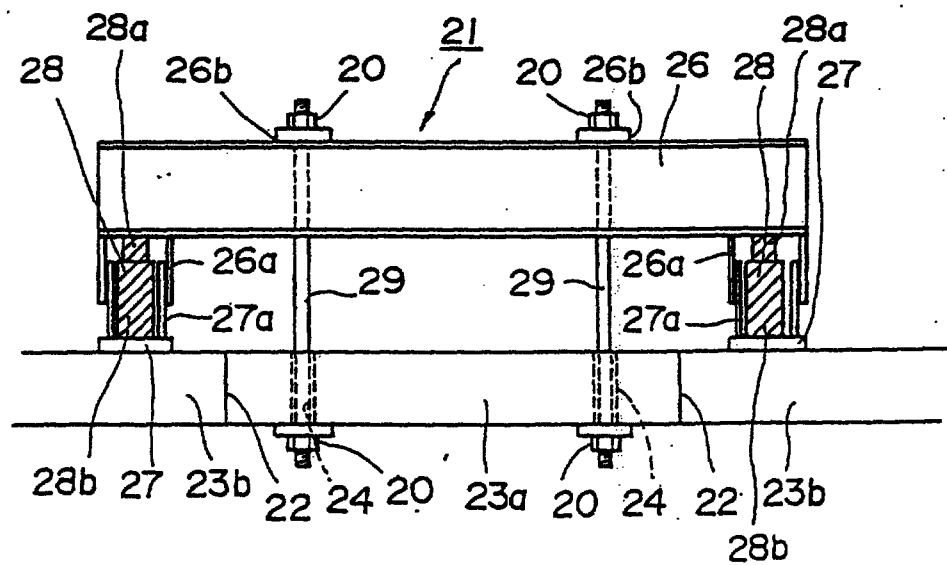


Fig. 9

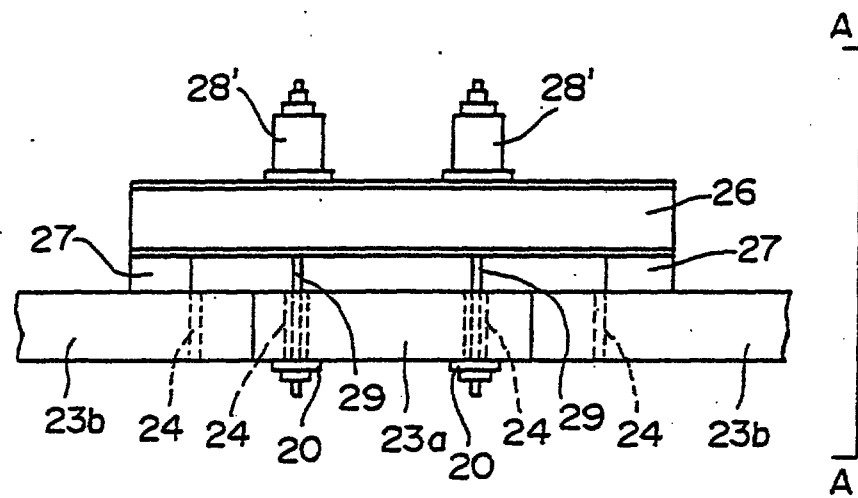


Fig. 10

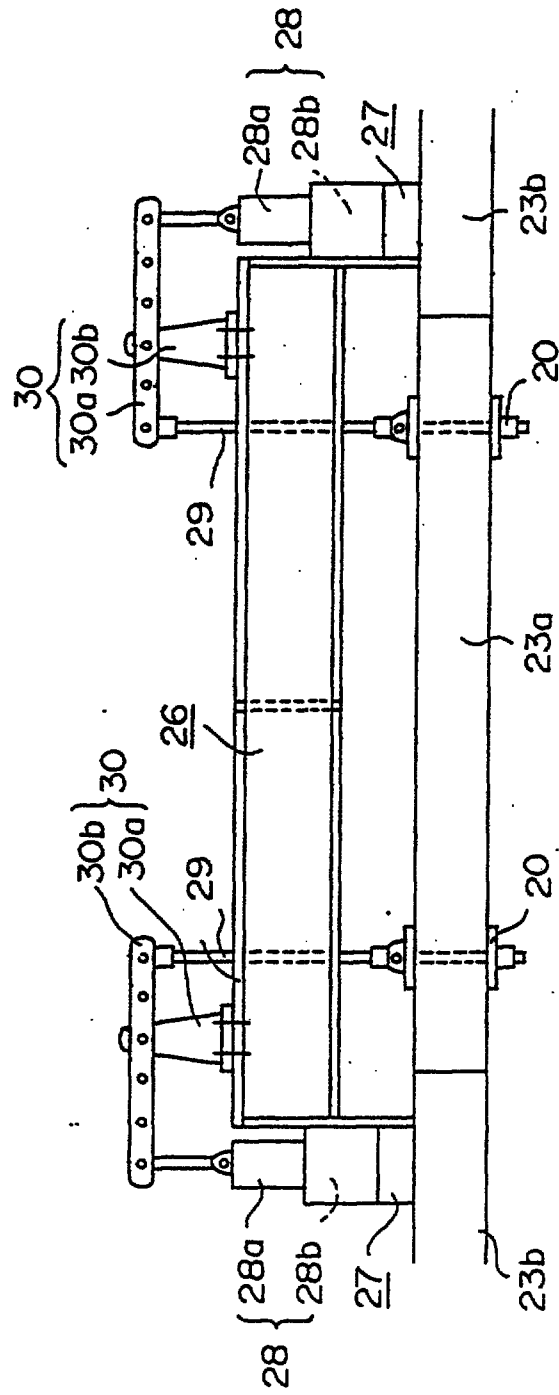


Fig. 11

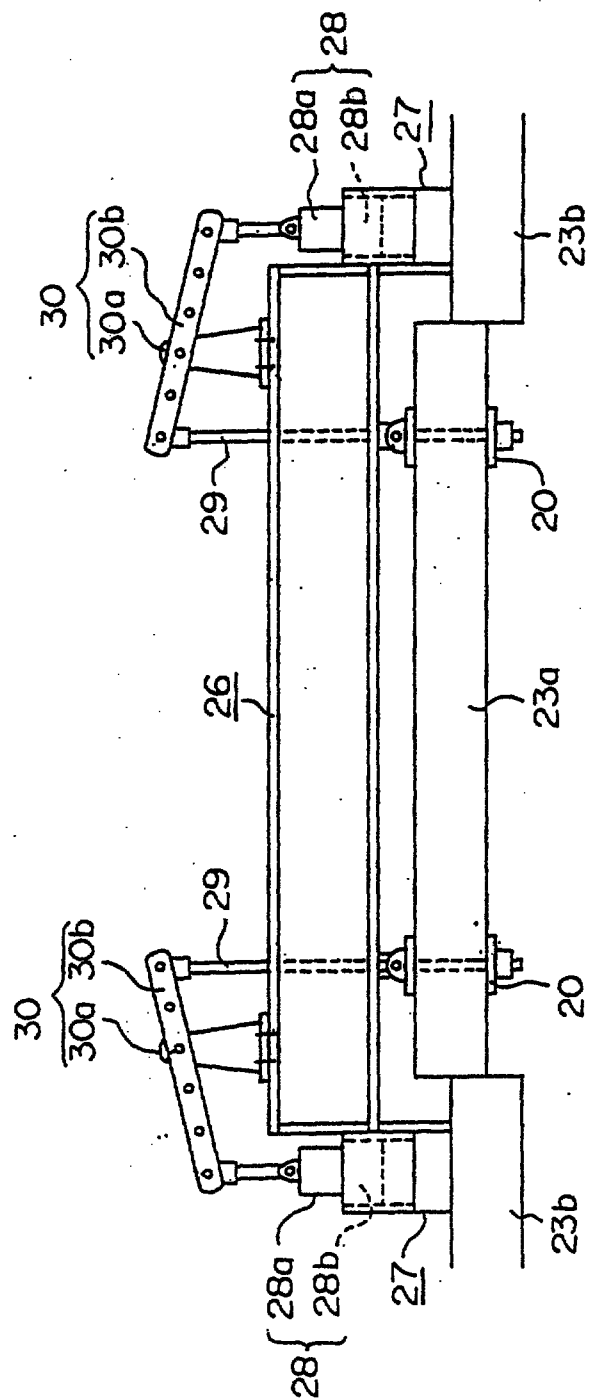


Fig. 12

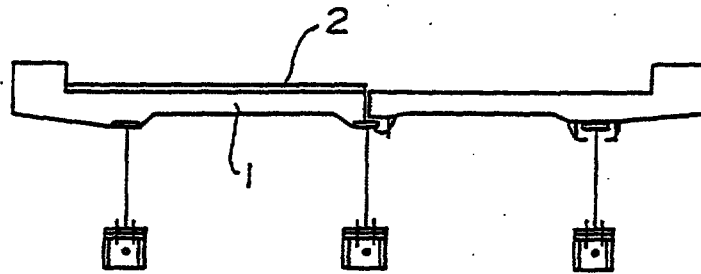


Fig. 13

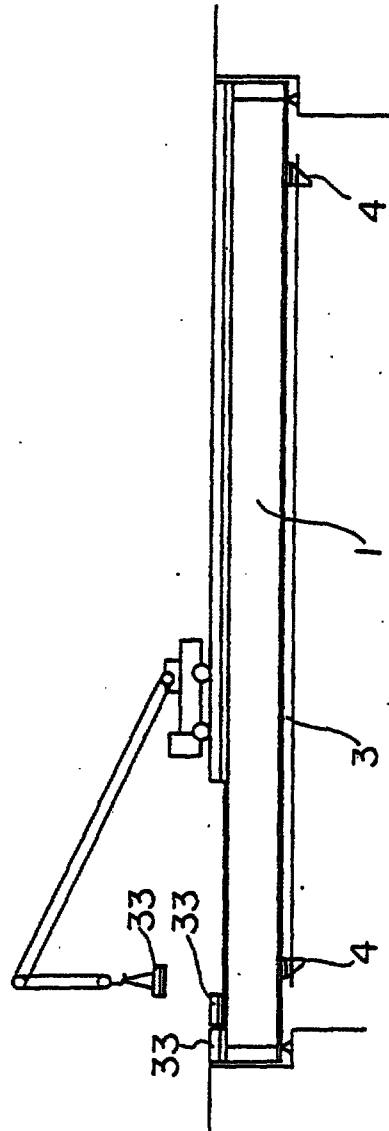


Fig. 14

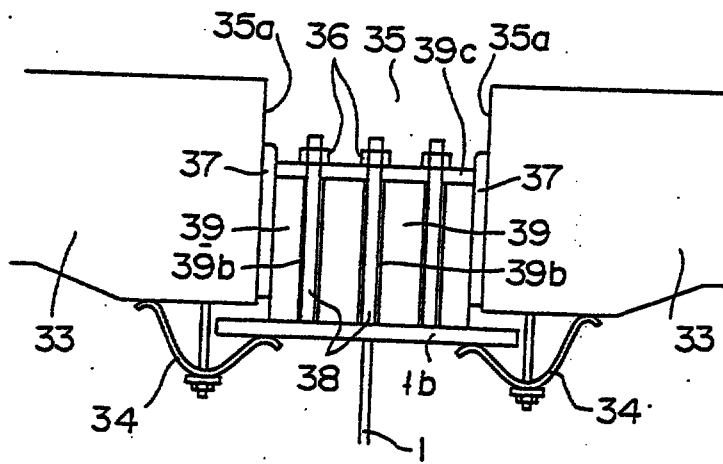


Fig. 15

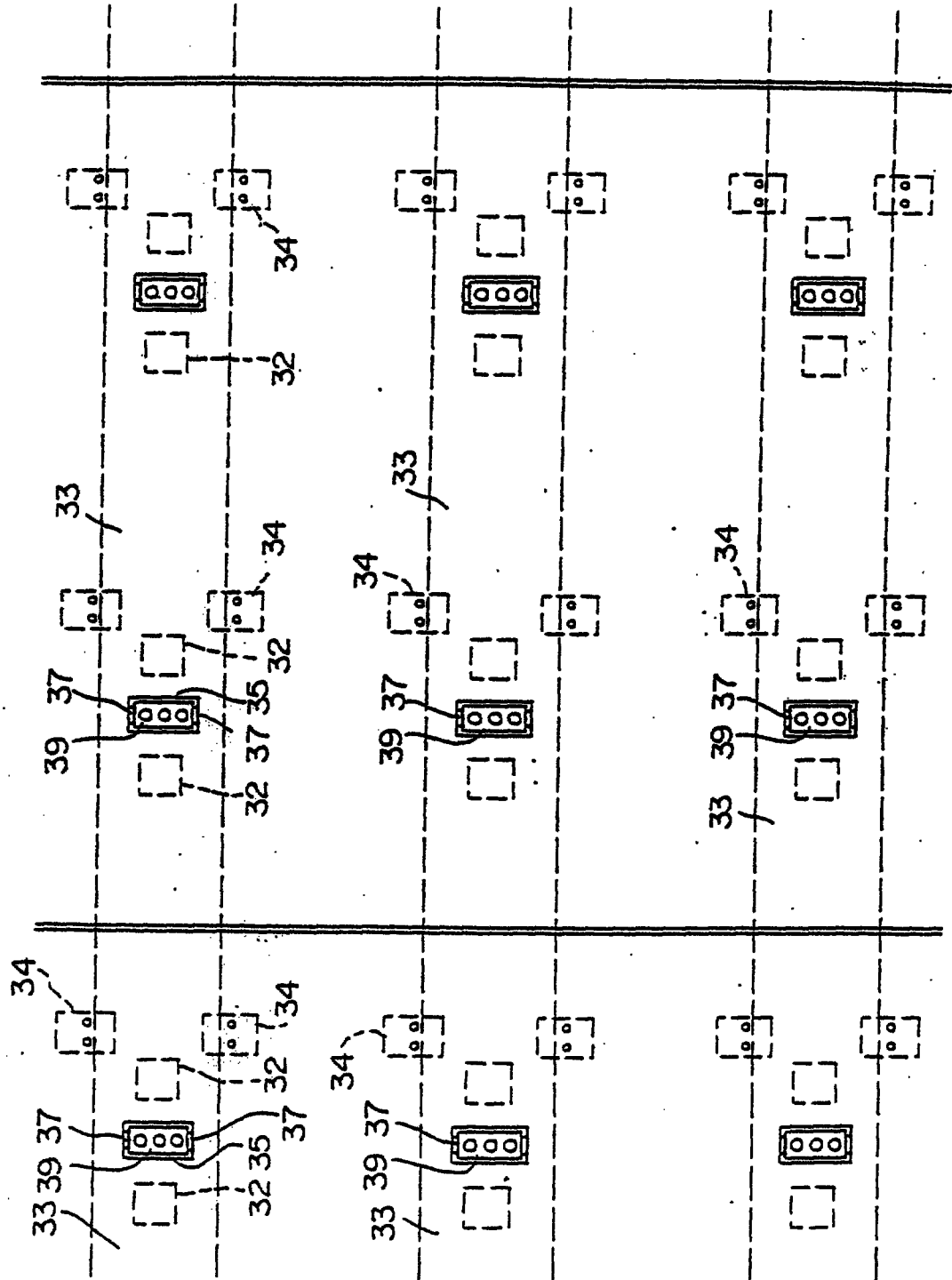
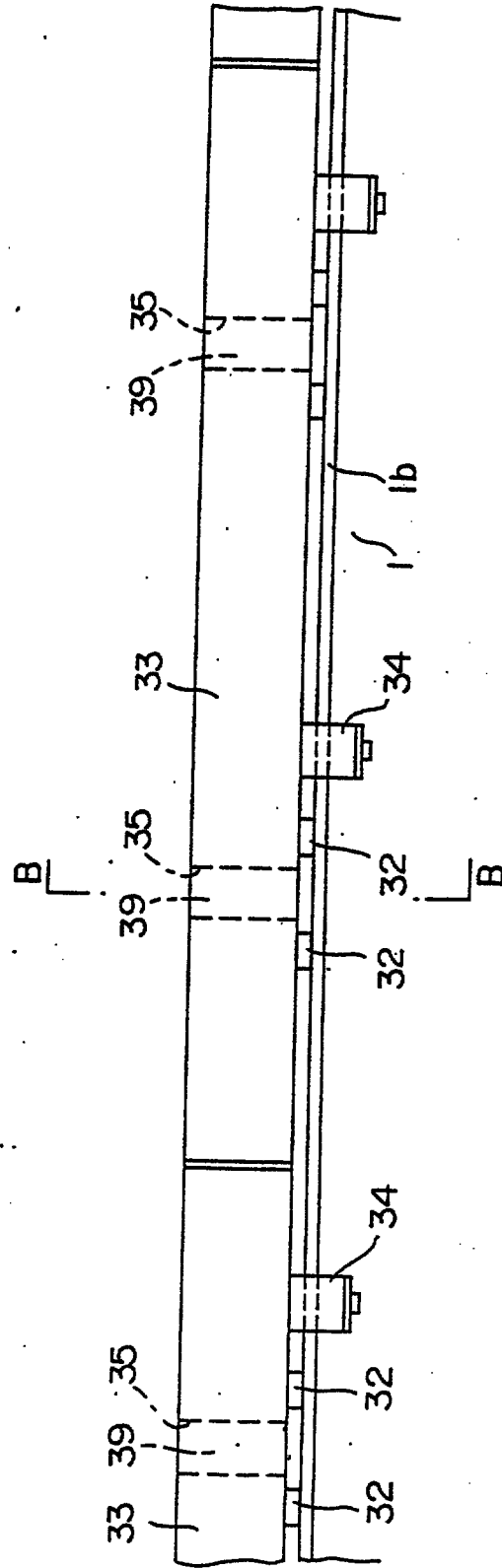


Fig. 16

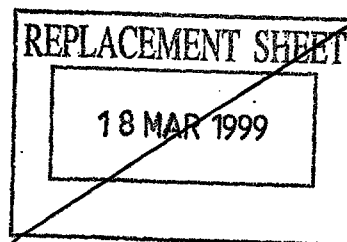


ABSTRACT

PRECAST FLOOR SLAB REPLACING PROCESS

A precast replacing process which comprises reinforcing a main floor slab girder by introducing enough prestress to cause a bending moment to a negative direction of the main girder 1, sequentially cutting the floor slab 2 placed on the girder to plural pieces of blocks, scrapping and removing the pieces of blocks by means of a jack-up system, followed by placing the precast floor slab 33 so that cut-off box portions 35 formed thereon are allocated on an upper surface of the main girder, temporarily fixing the precast floor slab and the main girder at the cut-off box portions with a fixing space left between the cut-off box portions to the main girder direction to prevent lateral buckling thereof, releasing such a temporary fixture after the precast floor slab has been placed, and permanently fixing the main girder and the precast floor slab while releasing the prestress introduced to the main girder.

(Figure 13)



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III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

A precast floor slab replacing process which comprises reinforcing a main floor slab girder by introducing enough prestress to cause a bending moment to a negative direction of the main girder (1) sequentially cutting the floor slab (2) placed on the girder to plural pieces of blocks, scrapping and removing the pieces of blocks by means of a jack-up system, followed by placing the precast floor slab (33) so that cut-off box portions (35) formed thereon are allocated on an upper surface of the main girder, temporarily fixing the precast floor slab and the main girder at the cut-off box portions with a fixing space left between the cut-off box portions to the main girder direction to prevent lateral buckling thereof, releasing such a temporary fixture after the precast floor slab has been placed, and permanently fixing the main girder and the precast floor slab while releasing the prestress introduced to the main girder.

REPLACEMENT SHEET

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Substitute sheet - 3 August 1999

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PRECAST FLOOR SLAB REPLACING PROCESS

The present invention relates to a precast floor slab relacing process, such as a bridge floor slab replacing process involving removal of an existing floor slab from a bridged
5 composite girder and placing thereon a new precast floor slab, for example.

As concrete bridge floor slab of viaduct, etc. are damaged with aging under a severe condition such as incessant traffic of cars and trucks, weathering and the like, damaged precast floor slabs have to be repaired or replaced. A slightly damaged floor slab can be
10 reinforced by fitting a steel plate, but heavily damaged one should necessarily be replaced as a whole.

There are two kinds of processes for replacing a damaged floor slab. According to a conventional replacing process, a new concrete floor slab is completed by removing damaged
15 one, subsequently framing a form, arranging bars thereon and finally casting concrete. The other replacing process comprises removing damaged one followed by placing thereon a precast floor slab which has been prepared in a factory.

Such a replacement is conducted on a bridge under a in-service condition and thus
20 should be completed in a short construction period. Accordingly, the precast floor slab which can shorten the period is primarily employed in the replacing process.

The floor slab replacing process with the precast one generally comprises several procedures as in the following.

25

In the first procedure, stress caused in the main girder is improved. As a rule, the floor slab and the girder function as a composite section and possesses large flexural rigidity, while the girder only functions as a section and no longer has sufficient flexural rigidity after the deck is removed. As a countermeasure to this, improvement of the girder by means of an outer
30 cable is practiced.

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In such a method for improving stress caused in the girder by means of the outer cable, a cable made of steel or new material such as carbon is arranged on an under or side surface of the girder to the axial direction and stressed to add a negative bending moment to the girder and balance thereof against a positive bending moment caused by load to be loaded.

5

However, a cable anchoring bracket is connected to the girder by means of a bracket flange and bolts after bolt holes are perforated through a girder flange or fixed thereto by welding, thereby reducing a sectional area or properties of the girder.

10 In the second procedure, the floor slab placed on the girder is removed. According to conventional removing methods, after a construction site is occupied by controlling the traffic, floor slab concrete is crushed in order from peripheral portions thereof by means of a crusher such as a concrete breaker, or cut to blocks of appropriate sizes for taking out of the site by means of a concrete cutter or a concrete breaker, then the blocks are put on a truck by truck
15 crane, and taken from the site.

However, the floor slab concrete thus crushed tends to fall down in the former method, which should be collected on scaffolds in the case of a river bridge, while it requires many hands and cost to pick up and take out the fallen concrete. On the other hand, as the
20 floor slab concrete is generally anchored to the bridge girder by means of steel bars or members called slab anchors, it is difficult to pull up the floor slab by a crane unless such anchored portions are broken and released therefrom by a concrete breaker, etc. Accordingly, the floor slab should be crushed to smaller sized blocks than expected in the latter case, while a considerable amount of concrete is fallen down on the scaffolds, which
25 disposal requires many hands and cost similarly as described above. Further, if the floor slab is lifted by a crane to break the concrete as it is, a significant impact shock from the floor slab upon releasing thereof from the slab anchors would cause a dangerous turnover of the crane due to a counteraction of the shock. In addition, in case of through type bridge, performance of the crane is not always fully exhibited at an obtuse elevation angle of the boom. In the
30 third procedure, the precast floor slab is placed. A lateral buckling of the girder does not occur because the floor slab to be placed is fixed to the main girder by means of shear

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connectors. While, under a condition where the old floor slab is already removed from the girder and the precast is merely placed thereon, construction vehicles used for floor slab replacing or other cars and trucks passing through the secondary construction side affect an upper flange portion as a compressive side so that a change in buckling length is observed
5 between cross beams, which would cause the lateral buckling of the main girder. In order to prevent the lateral buckling up. In the floor slab replacement on the composite girder with the precast floor slab, there have been practised various countermeasures such as the struts additional method, false-work method, and a girder section reinforcing method.

10 However, each of the above mentioned countermeasures has intrinsic disadvantages. The struts additional method inconveniently increases gross weight of the bridge. The false-work method is difficult depending on bridge constructing conditions especially on lakes or valleys. Reinforcement of the girder section is restricted by other existing members.

15 Finally the precast floor slab is permanently fixed to the main girder in the fourth procedure.

According to the present invention, there is provided a precast floor slab replacing process for a floor slab on a main girder, comprising: reinforcing the main girder by
20 introducing enough prestress to cause a bending moment in a negative direction of the main girder; cutting the floor slab into blocks and removing the blocks; placing a precast floor slab so that apertures formed therein are above the main girder; temporarily fixing the precast floor slab to the main girder at the apertures; releasing the temporary fixture after the precast floor slab has been more completely placed; and permanently fixing the main girder and the
25 precast floor slab while releasing the prestress introduced to the main girder.

Preferably, the blocks are removed by using a jack-up system.

Preferably, the apertures are located above an upper flange of the main girder.

30

Preferably, each aperture is a cut-out box-like aperture.

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Because prestress is introduced in the negative direction of the girder prior to scrapping the aged floor slab and is released after a new floor slab and the girder are fixed, this construction resists against external force as a composite section after the prestress is released, thereby allowing the bridge to behave as an indirect dead-live load composite girder and improve the stress balance. No timbering is required during reconstruction of the composite girder. Further, as brackets can be removed, an external appearance of the bridge under reconstruction is quite neat. In addition, because of the flange provided with no bolt hole therethrough nor welded portion thereon, the girder section is kept without any decrease in sectional area and effect on quality of the material.

10

If the floor slab is cut into blocks which are perforated through both surfaces for pulling-up thereof, while reaction leg portions provided with reaction jacks are placed on blocks adjacent both sides of a block to be released so that a removing girder is laid on the reaction leg portions, the block to be released is pulled up when the reaction jacks are actuated after the removing girder and the block are connected by means of hanger bolts through pulling up holes, whereby concrete around slab anchors of anchor portions is stretched and sheared. Accordingly, concrete in the vicinity of the slab anchors is broken, thereby separating blocks from the bridge girder. As the blocks thus separated can be easily moved by means of a crane, etc., the present process is much safer than a conventional method in which floor slabs themselves are pulled-up and broken.

20

As the precast floor slab is fixed with a fixing space left between cut-off box portions formed thereon so as to shorten the fixing space and improve the bending stress-strain tolerance limits of an upper flange, lateral buckling can be prevented. Further, because of the fixing space left between the cut-off box portions, problems such as an inconvenient increase in gross weight of the bridge due to transverse supports temporarily applied between existing lateral struts or crossflames in conventional processes, difficulty in constructing conditions in the case of the false-work process and difficulty in reinforcement in the case of the girder section reinforcement process can be avoided.

30

As has been described above, the present invention provides a markedly convenient

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precast floor slab replacing process.

BRIEF DESCRIPTION OF THE DRAWING

5 Fig. 1 is a schematic transverse sectional view of a bridge which main girder is reinforced by outer cables.

 Fig. 2 is a side view of a bridge which main girder is reinforced by outer cables.

 Fig. 3 is a detailed view of main portions of a bridge which main girder is reinforced by outer cables.

10 Fig. 4 is a section view taken on line A-A in Fig. 3.

 Fig. 5 is a transverse sectional view of a bridge together with a jack-up system for removing floor slab blocks.

 Fig. 6 is a side view of a bridge together with a jack-up system for removing floor slab blocks.

15 Fig. 7 is a detailed plan view of a bridge together with a jack-up system for scrapping floor slab blocks.

 Fig. 8 is a fragmentary detailed broken view of a jack-up system.

 Fig. 9 is another embodiment of a jack-up system.

 Fig. 10 is still another embodiment of a jack-up system.

20 Fig. 11 is an embodiment showing a situation where a block is pulled up by a jack-up system.

 Fig. 12 is a schematic transverse sectional view after a part of existing floor slabs are removed.

 Fig. 13 is a schematic side view after a part of existing floor slabs are removed.

25 Fig. 14 is an enlarged view of a main portion of a temporarily fixing portion of placed precast floor slabs.

 Fig. 15 is a plan view of placed precast floor slabs.

 Fig. 16 is a side view of placed precast floor slabs.

 Fig. 17 is a sectional view taken on line B-B in Fig. 16.

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DETAILED DESCRIPTION AND THE PREFERRED EMBODIMENTS

Referring now to the drawings, the present invention will be described in detail.

5

A procedure to improve stress caused in a main girder is detailed in the following by referring to Figs. 1, 2, 3 and 4, in which

Fig. 1 is a transverse sectional view of a bridge which main girder is reinforced by
10 outer cables;

Fig. 2 is a side view of a bridge shown in Fig. 1;

Fig. 3 is a detailed view of main portions of a bridge shown in Fig. 2; and

15

Fig. 4 is a sectional view taken on line A-A in Fig. 3.

As shown in Fig. 2, a conventional steel cable 3 is anchored to brackets 4 and 4 fixed to an under (or side) surface of the main girder 1. 2 designates a floor slab.

20

The brackets 4 and 4 are frictionally joined to the main girder 1 as shown in Figs. 3 and 4. More precisely, an under-girder bracket 11 is attached under the main girder 1 to superimpose a bottom flange 1a of the main girder 1 on a top flange 11a of the under-girder bracket 11, both flanges 1a and 11a being frictionally joined by means of high tension vises
25 7. The anchor bracket 4 is provided with a conventional take-up unit 13 consisting of a centre hole jack 8, a ram chair 9 and a load cell 10 and is joined to a bottom flange 11b of the under-girder bracket 11 through a top flange 4a by means of bolts 12. The other anchor bracket allocated under the opposite end of the main girder 1 is indirectly fixed thereto through the under-girder bracket in a similar manner as described above, although
30 such a bracket is not shown in Fig. 3. Numeral 11c designates reinforcing plates. It should be understood that the anchor bracket 4 may be frictionally joined to the main

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girder at first hand by means of the high tension vises.

The main girder 1 is thus attached with the cable 3 anchoring brackets 4 and 4 for introducing prestress enough to cause a bending moment to the negative direction of the main girder 1. Prestress of desired degree is then introduced to the main girder through the cable 3, followed by scrapping the floor slab.

A scrapping procedure of the floor slab is described below by referring to Figs. 5, 6, 7 and 8, in which

Fig. 5 is a transverse sectional view of a bridge together with a jack-up system 21 for scrapping floor slab blocks;

Fig. 6 is a side view of a bridge shown in Fig. 5;

Fig. 7 is a detailed plan view of Fig. 6; and

Fig. 8 is a fragmentary detailed broken view of a jack-up system 21.

By means of a concrete cutter, the floor slab 2 to be scrapped is cut to plural pieces of blocks 23, which are then drilled to form pulling up holes 24, as shown in Figs. 5, 6 and 7. In the figures, cutting-off portions are shown by 22. The above mentioned cutting and drilling order may be reversed.

As shown in Fig. 8, reaction leg portions 27 provided of reaction jacks 28 comprising pistons 28a and cylinder tubes 28b are allocated on blocks 23b and 23b adjacent to a block 23a to be released from the girder. A removing girder 26 of H steel is laid over the reaction jacks 28 so as to move upward and downward by means of pistons 28a.

In this embodiments, the reaction leg portion 27 and the removing girder 26 are integrally fitted to slidable cylinders 26a and 27a so as not to deviate therefrom. In this embodiments, these cylinders 26a and 27a may be omitted.

Alternatively, a pair of reaction leg portions 27 together with the removing girder

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26 laid thereon may be allocated in advance on the blocks 23b adjacent to both sides of the block 23a to be released and provided with travelling casters so as to function as a bridge floor slab scrapping system as a whole.

- 5 The removing girder 26 and the block 23a to be released are connected by hanger bolts 29 pierced through pulling-up holes of the block 23a and through holes 26b of the removing girder 26 and secured by nuts 20.

After a preparatory process for releasing the block 23a from the bridge girder is
10 thus completed, the reaction jacks 28 are actuated to raise the pistons 28a, thereby forcing up the removing girder 26. At the same time, the block 23a is pulled up by the removing girder 26, thereby separating the block 23a from the bridge girder.

Fig. 9 shows another embodiment of a jack-up system for scrapping a floor slab
15 block. In this system, reaction leg portions 27 and 27 subjected to reaction are allocated on blocks 23b and 23b adjacent to both sides of a block 23a to be released, while a removing girder 26 is laid on the reaction leg portions 27 and 27 together with centre hole jacks 28' and 28' mounted thereon at positions corresponding to pulling-up holes 24 perforated through the block 23a. Hanger bolts extended from the centre hole jacks 28'
20 and 28' are pierced through the girder 26 into the pulling-up holes 24 of the block 23a and secured by means of nuts 20 on an under surface of the block 23a .

After a preparatory process for releasing the block 23a is thus completed, the centre hole jacks 28' and 28' are actuated to raise the hanger bolts 29, thereby separating
25 the block 23a from the bridge girder.

Fig. 10 shows a further embodiment of a jack-up system for scrapping a floor slab block. In this system, reaction leg portions 27 and 27 provided with reaction jacks 28 comprising pistons 28a and cylinder tubes 28b are allocated on blocks 23b and 23b
30 adjacent to both sides of a block 23a to be released, while a removing girder 26 is laid and fixed on the reaction leg portions 27 and 27 together with a pair of lever means 30 and 30

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fitted thereon which interlocks with the reaction jacks 28 and 28. Each of the lever means 30 and 30 comprises a support plate 30a and a bar body 30b in which one end thereof is connected to the piston 28a of the reaction jack 28 and functions as a centroid, while the other end acts as a loading point. A block 23a and the lever means 30 and 30 are
5 connected each other through hanger bolts 29 and 29.

After the block 23a and the lever means 30 and 30 are thus connected, the reaction jacks 28 and 28 are actuated as shown in Fig. 11. As the pistons 28a and 28a are forced downward, the bar bodies 30b and 30b are pulled down centering around respective
10 supports and the loading points are pulled up. Thus, the block 23a connected to the removing girder 26 by means of hanger bolts 29 and 29 is forced upward and separated from the bridge girder.

After the block 23a is thus separated from the bridge girder, the hanger bolts 29
15 connecting the removing girder 26 and block 23a are unscrewed from nuts 20 to remove the removing girder 26.

Blocks to be released are separated from the bridge girder in this manner one by one and removed by pulling-up by a crane, etc.
20

Shear connectors are then removed to place precast floor slabs on the main girder.

A procedure for placing precast floor slabs will be described in the following by referring to Figs. 12 and 13. Fig. 12 is a transverse sectional view after a part of existing
25 floor slabs are removed. Fig. 13 is a side view of Fig. 12.

After the existing floor slabs are removed as shown Fig. 12, the precast floor slabs
33 are place by means of a crane, etc. as shown in Fig. 13.

30 Structure for preventing a lateral backling is applied prior to placing the precast floor slabs 33.

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In Figs. 14, 15, 16, and 17, there is described a procedure how to place the precast floor slabs applied structure for preventing the lateral buckling.

Fig. 14 is an enlarged view of a main portion of a temporarily fixing portion of
5 placed precast floor slabs.

Fig. 15 is a plan view of placed precast floor slabs.

Fig. 16 is a side view of Fig. 15.

10

Fig. 17 is a sectional view taken on line B-B in Fig. 16.

A precast floor slab 33 is placed on rubber pads 32 arranged on a flange 1b of a main girder 1. If necessary, an under surface of the precast floor slab 33 and that of the
15 flange 1b of the main girder 1 are then gripped by tie anchor (spring plate) 34 to halt a vertical motion of the precast floor slab 33.

The precast floor slab 33 has cut-off box portions 35, which are formed to locate on the upper flange 1b of the main girder.

20

In order to prevent the precast floor slab 33 to move horizontally, the cut-off box portions 35 are used to temporarily fix the precast floor slab 33 and the main girder 1 with a fixing space left between the cut-off portions to the main girder direction.

25 In this embodiment, several wholly screwed studs 38 are welded on the upper flange 1b of the main girder and allocated to the cut-off box portion 35 of the precast floor slab 33 on the girder. The studs 38 are fixed by a fixing block 39 made of steel.

The fixing block 39 has through holes 39b for piercing and fixing the studs 38 and
30 is arranged on the upper flange 1b of the main girder 1 after the studs 38 are inserted thereto. The studs 38 are connected to the fixing block 39 by securing protruded portions

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thereof over the fixing block 39 with nuts 36. 39c designates a plate member which is integrally formed, if necessary, on the surface of the fixing block 39.

A flat jack 37 is inserted between a wall surface 35a of the cut-off box portion 35
5 and a wall surface 39a of the fixing block 39 and is introduced pressure thereto to strongly press against the wall surface 35a and the fixing block 39, thereby the precast floor slab 33 and the main girder being fixed. Preferably, the flat jack 37 is inserted into both sides of the fixing block 39 and simultaneously introduced pressure thereto.

10 After the precast floor slabs 33 are fixed to the main girder 1, the traffic control may be temporarily released.

After the precast floor slabs 33 is completely placed, the fixing block 39 is removed from the cut-off box portion 35 so that the studs 38 is left to form a shear
15 connector, where concrete is cast to fix the main girder and the precast floor slab 33 permanently. On the other hand, the cables 3 and the brackets 4 used to introduce prestress are removed to release such prestress.

The present process for replacing existing floor slabs from the composite girder
20 with precast floor slabs is thus completed.

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CLAIMS

1. A precast floor slab replacing process for a floor slab on a main girder, comprising:
 - 5 reinforcing the main girder by introducing enough prestress to cause a bending moment in a negative direction of the main girder;
cutting the floor slab into blocks and removing the blocks;
placing a precast floor slab so that apertures formed therein are above the main girder;
 - 10 temporarily fixing the precast floor slab to the main girder at the apertures;
releasing the temporary fixture after the precast floor slab has been more completely placed; and
permanently fixing the main girder and the precast floor slab while releasing the prestress introduced to the main girder.
- 15 2. A process according to claim 1, wherein the blocks are removed by using a jack-up system.
3. A process according to claim 1 or 2, wherein the apertures are located above an
20 upper flange of the main girder.
4. A process according to any one of claims 1 to 3, wherein each aperture is a cut-out box-like aperture.



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