

METHOD FOR STRENGTHENING A CONCRETE DECK



The present invention relates to a method for strengthening a concrete deck, e.g. of an existing bridge structure.

Generally, in cases of bridge structures such as an elevated road, etc., concrete decks have structure enough to withstand a dynamic load due to a traffic volume of cars.

Strength of the concrete decks of existing aged bridge structures, however, relatively decreases with rapid increases in the traffic volume of cars after construction thereof and in load and collision load due to heavier weight of vehicles. It is therefore necessary to strengthen such concrete decks.

Recently, on the other hand, noise barriers are further fixed on edges of overhang portions of existing bridge structures in order to control the noise of cars on the bridge structures. It is thus necessary to strengthen around overhang supports, i.e., sites where tensile strength acts on upside of decks.

Generally, strengthening of the concrete decks is done by removing an asphalt pavement layer 2 laid on an upper surface of a concrete deck 1 as shown in Fig. 7, newly placing a strengthening concrete layer 3 on the upper surface of the concrete deck 1 to thicken a concrete portion as shown in Fig. 8. Then, the asphalt pavement layer 2 is again applied thereon.

In such a strengthening method, however, connection

between the existing concrete layer and the newly placed strengthening concrete layer is not necessarily sufficient, which often causes poor results from a viewpoint of integral structure of the existing and new concrete layers. In addition, strengthening of a site where tensile strength acts on upside of the deck is not complete in the conventional strengthening method.

Further, it is necessary to use large-sized concrete placing facilities in such a method, which causes complexity of construction.

According to the present invention, there is provided a method for strengthening a concrete deck which comprises applying an adhesive on a concrete deck in which a pavement layer has been removed, followed by laying and adhering thereon a plurality of block shaped precast panels made of a material having strength similar to or stronger than that of the concrete deck to form first strengthening layer, adhering sheet like stuff made of a material having higher tensile strength on the first strengthening layer to a site where tensile strength acts to an upside of the deck to form a tensile resistant layer, further applying the adhesive on the first strengthening layer and the tensile resistant layer, laying thereon a plurality of the block shaped precast panels made of the material having the strength similar to or stronger than that

of the concrete deck so that joints thereof are not overlapped with those of the first strengthening layer to form second strengthening layer, and applying the pavement layer.

As the first strengthening layer is formed by applying the adhesive on the upper surface of the concrete deck in which the pavement layer has been removed and laying thereon a plurality of the block shaped precast panels, roughness of the upper surface of the concrete deck can be controlled depending on an extent of the adhesive application and a degree of laying pressure of the first strengthening layer.

While, in the second strengthening layer, as a plurality of each block shaped precast panel is laid on that of the first strengthening layer so that joints of each panel of the first and the second strengthening layers are not overlapped each other so as to integrate the second layer with the first one, each of precast panel has a continuity, thereby stress added thereto being transmitted throughout the deck.

As each of the precast panel of the first and the second strengthening panels is made of a material having strength similar to or stronger than that of the concrete deck and is firmly integrated each other as well as with the concrete deck by means of the adhesive, a sufficient strengthening can be obtained.

As the sheet like stuff made of a material having higher tensile strength is applied between the first and the second strengthening layers at sites where tensile strength acts to the upside of the deck, i.e., around the overhang supports or above the girders of the bridge, a sufficient

strengthening can be achieved at tensile strength acting sites.

Non-limiting embodiments of the invention will now be described with reference to the accompanying drawings, in which:-

Fig. 1 is a partially cutaway view in perspective showing part of an example of the present invention.

Fig. 2 is a transverse axial cross section illustrating the start of a strengthening procedure for a concrete deck.

Fig. 3 is a transverse axial cross section illustrating the next step of the procedure shown in Fig. 2.

Fig. 4 is a transverse axial cross section illustrating the next step of the procedure shown in Fig. 3.

Fig. 5 is a transverse axial cross section illustrating the next step of the procedure shown in Fig. 4.

Fig. 6 is a transverse axial cross section illustrating the next step of the procedure shown in Fig. 5.

Fig. 7 is a transverse axial cross section illustrating an example of an existing concrete deck to be strengthened.

Fig. 8 is a transverse axial cross section illustrating an example of conventional method for strengthening an existing concrete deck.

Fig. 1 is a partially cutaway view in perspective of a main part of a bridge structure whose concrete deck is strengthened according to the present invention. Figs. 2 to 6 are transverse axial cross sections illustrating a

strengthening procedure of a concrete deck according to the present invention. Fig. 7 is a cross section illustrating an example of an existing concrete deck to be strengthened.

In Fig. 7, a concrete deck 1 to be strengthened is put on the girders 4 and a pavement layer 2 is applied on an upper surface of the concrete deck.

An example of a strengthening procedure of the concrete deck 1 will now be described.

First of all, as shown in Fig. 2, the pavement layer 2 applied on the upper surface of the concrete deck 1 shown in Fig. 7 is removed. If a degraded portion 1a exists on the concrete deck 1, the portion 1a is removed or repaired as shown in Fig. 1.

An adhesive is then applied on the upper surface of the concrete deck 1 as shown in Fig. 1 to form an adhesive layer 5. A plurality of block shaped precast panels 6 are laid thereon to adhere and integrate the concrete deck and the precast panels 6, thereby forming first strengthening layer 7.

Sheet-like reinforcement 8 is then adhered with the adhesive around overhang supports of the overhang portions 1b and above the girders 4, on the first strengthening layer 7 formed by laying a plurality of the block shaped precast panels 6, as shown in Fig. 4. When sites where tensile forces act on upside of the deck are only around the overhang supports, the reinforcement 8 may be applied merely therearound.

Further, the adhesive is applied both on the upper surface of the first strengthening layer 7 comprising the block

shaped precast panels adhered and integrated with the concrete deck 1 and on the upper surface of the reinforcement 8 to form an adhesive layer 9, as shown in Fig. 5. A plurality of block shaped precast panels 10 are laid thereon similarly as in the case of formation of the first strengthening layer 7 so that joints 13 of neighboring precast panels do not overlap joints 12 of the precast panels 6 of the first strengthening layer 7, thereby forming second strengthening layer 11. The first strengthening layer 7 and the second one 11 are thus adhered and integrated.

Finally, the pavement layer 2 is again formed to complete the strengthening method, as shown in Fig. 6.

The bridge structure wherein concrete deck is completely strengthened comprises the pavement layer 2, the second strengthening layer 11 (consisting of the precast panels 10 and the adhesive layer 9), reinforcement 8, the first strengthening layer 7 (consisting of the precast panels 6 and the adhesive layer 5) and the concrete deck 1, as shown in Fig. 1.

Epoxy resin mortar was used as the adhesive in the example. Other adhesives which can securely adhere the concrete deck and the precast panels may also be used. An example of particularly preferable adhesives includes an epoxy resin adhesive.

Non-asbestos slate boards were used as the precast panels. The precast panels should be made of a material having strength similar to or stronger than that of the concrete deck, including such materials as glass-fiber reinforced cement, cement mortar, ceramics and the like other than the slate

boards described above. Although the dimension of the precast panels is not particularly restricted, panels of 300 mm to 400 mm x 400 mm to 500 mm are preferable from a viewpoint of applicability.

Carbon fiber was used as the reinforcement. Other materials useful herein and having high tensile strength include, for example, glass fiber, aramid fiber, or if necessary thin steel plate and the like.

As described above, the present invention has following favorable effects.

As first strengthening layer is formed by applying the adhesive on the upper surface of the concrete deck from which the pavement layer has been removed and laying thereon a plurality of the block shaped precast panels, it is possible to lay these panels evenly without being affected by roughness of the concrete deck or formation of foam on the adhesive surface.

As the second strengthening layer is formed by laying a plurality of block shaped precast panels so that the joints thereof do not overlap those of the first layer, the precast panels have a continuity with each other, whereby stress is transmitted smoothly.

As the precast panels of the first and the second strengthening layers are made of a material having a strength similar to or stronger than that of the concrete deck and are firmly integrated with each other as well as with the concrete deck by means of the adhesive, a sufficient strengthening can be obtained.

As the sheet-like reinforcement made of a material having high tensile strength is applied between the first and the second strengthening layers at sites where tensile forces act on the upside of the deck, a similar effect as steel reinforcing results, whereby the tensile sites such as around the hangover portions of the bridge or above the girders are strengthened.

Further, as large-sized facilities are not required in the present strengthening method, the construction can be done effectively.



CLAIMS

1. A method of strengthening a concrete deck, comprising:
applying adhesive onto a concrete deck from which a pavement layer has been removed;
laying on and adhering to the adhesive a plurality of panels made of a material having a strength similar to or stronger than that of the concrete deck, to form a first strengthening layer;
adhering sheet-like reinforcement to the first strengthening layer at site(s) above part(s) of the concrete deck which is or are in upper-surface tension;
applying adhesive above the first strengthening layer and the reinforcement, and laying thereon a plurality of panels made of a material having a strength similar to or stronger than that of the concrete deck, to form a second strengthening layer; and
reinstating the pavement layer.
2. A method according to claim 1, wherein each panel is a tile-like precast panel.
3. A method according to claim 1 or 2, wherein, in a first surface direction of the deck, a first line of the panels of the second strengthening layer is arranged so that its panels bridge joints between panels of the first strengthening layer.
4. A method according to claim 3, wherein, in a second surface direction of the deck which is transverse to the first surface direction, a second line of the panels of the second strengthening layer is arranged so that its panels bridge joints between panels of the first strengthening layer.
5. A method according to any one of claims 1 to 4, wherein the concrete deck is supported on beams and the reinforcement is in the form of strips which overlies and track the beams.



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6. A method according to claim 5 when dependent on claim 3 or 4, wherein the beams and strips are transverse to the first surface direction.
7. A method according to claim 1 or 2 or claim 5 when dependent on claim 1 or 2, wherein the panels of the first strengthening layer form a first mosaic-like pattern and the panels of the second strengthening layer form a second mosaic-like pattern, with panels of the second strengthening layer bridging joints between panels of the first strengthening layer.
8. A method according to claim 7, wherein the first and second mosaic-like patterns are substantially the same and are offset relative to each other.
9. A method according to any one of claims 1 to 8, wherein each panel is substantially the same shape and size in plan view and each panel of the second strengthening layer overlies at least two of the panels of the first strengthening layer.
10. A method according to claim 9, wherein each panel of the second strengthening layer overlies four of the panels of the first strengthening layer.
11. A method according to any one of claims 1 to 10, wherein each panel is substantially rectangular in plan view.
12. A method of strengthening a concrete deck, substantially as herein described with reference to Figures 1 to 7 of the accompanying drawings.