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(54) **CAVITIES FILLING VACUUM POST TREATMENT HSB BRIDGE DRIVING DECK**

(57) Method for post treatment of an onto a substrate cast, cured layer (1) of an initially form free bulk material, such as cement concrete, whereby in the layer (1) a supply (2, 5) and drain (3, 6) channel are made which at a distance from each other end up in the layer (1) and debouch into a cavity (4) present in the layer, which cavity (4) is possibly filled with a gas or liquid, and wherein a

source of liquid material is connected to the supply channel (2, 5) and the material flows through the supply channel (2, 5) and into the cavity (4) while a to the drain channel (3, 6) connected suction source causes inside the cavity (4) a by suction provided pressure reduction and maintains this and optionally sucks the material from the cavity (4).

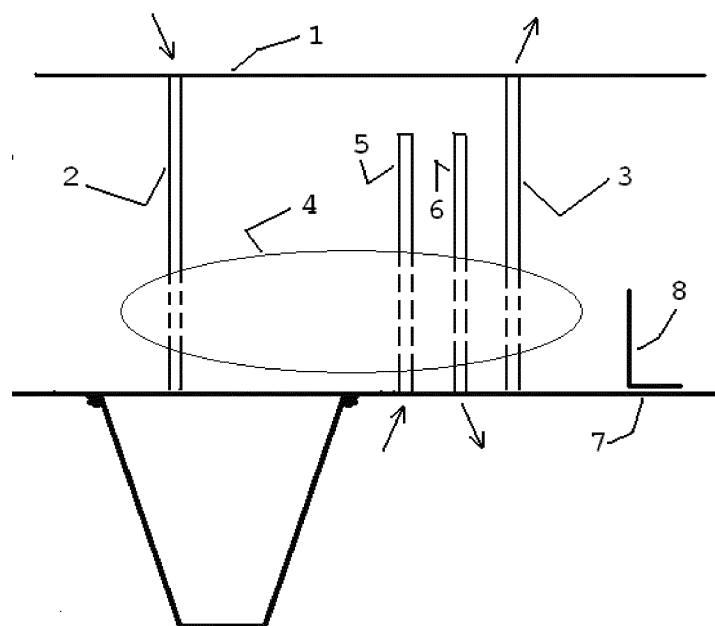


Fig. 2

Description

[0001] The present invention relates to a post treatment of a construction of initially shape free, stone-like material, such as cement concrete, for example, high strength concrete (hereinafter called: HSB), in particular of a bridge driving deck.

[0002] Hereinafter, the invention will be described with reference to HSB, however, the invention is also applicable to other constructions of initial shape free, stone-like material (preferably cast in situ), whether or not supported by a bridge driving deck.

[0003] Especially by heavy truck traffic a steel deck (also called: bridge driving deck), in particular an orthotropic steel bridge driving deck (e.g. the Galecoppenburg in the A12 near the city of Utrecht in the Netherlands) increasingly suffers from cracking due to fatigue. By removing the usually on top of the bridge driving deck present driving face, for example, asphalt paving of asphalt concrete, from the bridge deck, the steel surface is exposed to be inspected and repaired if necessary.

[0004] Fig. 1 shows a cross-section of a bridge deck and Fig. 2 shows a detail thereof on an enlarged scale. The drawing is added in order to better explain the invention.

[0005] Fig. 1 shows a schematic cross-sectional view of an example bridge deck, a horizontal steel plate 7 with at the bottom to it welded V-shaped or trough shaped stiffeners (stiffener trough).

[0006] Recently on the steel plate (the on its top present asphalt layer or other drive face is removed) a reinforcement net is applied and then HSB 1 is poured. The reinforcement net is, for example, mounted on the steel plate via the steel plate welded strips or L-profiles 8 (only one of the many profiles 8 is shown in fig. 1 for illustration). Preferably, the steel sheet over the entire upper surface is coated with an adhesive layer, for example a glue (e.g. epoxy, e.g. 2 mm thick), onto which granules (dia. bigger than the adhesive thickness, for example, between 3 and 6 mm) are distributed (e.g. bauxite).

[0007] The HSB is in a thickness of between 5 and 15, e.g. 9 cm, poured in situ over the reinforcement net, so that the reinforcement net is fully embedded under sufficient coverage of HSB (e.g., at least 1 or 2 cm coverage). The HSB contains for example, steel fibers as reinforcement. During casting the HSB is relatively dry and spreads or flows not, or hardly by itself such that the poured HSB must be mechanically loaded to spread well, and intensively compressing with vibrating tools is needed, it should also be done quickly due to the relatively rapid curing of the HSB. After curing a wear layer is applied on the HSB, for example, an adhesive (such as epoxy), which is covered with granules, for example, bauxite. The wear layer bears the cars.

[0008] After curing the HSB should be examined for cavities 4 (see FIG. 1) which inevitably arise because of the awkward processing of the HSB, as a rule, in the

lower half of the HSB and / or close to the steel plate 7. With the current detection methods, at most, one is able to determine the shape and location of a cavity by approximation. These cavities have often a jagged shape, a bit like a stalactite cave. The height of the cavity, that is to say the dimension in the thickness direction of the HSB layer, measures typically between 0.5 and 3 cm. Cavities were found which in plan view at the driving face have a shape as the letter M. One tried to fill these cavities by drilling a hole into the cavities from the driving face and to press form free material into the cavities through these drilled channels. Per cavity on average about 50 drilled channels are required in order to achieve adequate filling of a cavity by pressing and almost never one was able to completely fill a cavity.

[0009] The invention aims at making the complete filling of the cavities more reliable and / or reduce the number of drilled channels and / or avoiding that the driving lane is put out of service.

[0010] To this end, it is proposed to suck in instead of or in addition to pressing to get the desired material, preferably a shape-free material which subsequently hardens preferably, such as an epoxy or other plastic or monomer or polymer, into the cavity and substantially completely filling it.

[0011] Sucking provides the ability to supply the material from the underside of the HSB layer to the cavity, whereby the driving face can remain untouched so that the driving face can be kept in service while the cavities are drilled and filled.

[0012] By sealing the HSB, such as by applying a sealing layer above the HSB, for example a foil, it may be better ensured that during the sucking no false air is sucked from above the HSB.

[0013] Fig. 2 shows a detail of Fig. 1. According to the invention, channels are made in the HSB, for example drilled. This may, from the top side (channels 2, 3), or from the lower side (channels 5, 6). One provides that these channels debouch into a cavity 4 beneath the surface of the HSB, such a cavity 4 is located above the steel plate 7, as a rule a minimum of 1 or 2 cm below the top surface of the HSB 1, so it is hermetically sealed from the outdoor. The channels 2, 3 are drilled at the steel plate 7 or end at a distance above it. The channels 5, 6 are drilled through the steel sheet 7, and end at a distance below the top surface 1 of the HSB. By thus ensuring that blind channels are created, it is ensured that the channels 2, 3, 5, 6 have a closed end. Alternatively, these ends can be sealed after the channels are drilled, after the channels have been drilled through, for example, by though the plate 7.

[0014] To a feed channel 2, respectively 5 and a discharge channel 3, respectively 6 are preferably connected a conduit so that a fluid tight communication is created between the channel and conduit, for example, by penetrating a pipe or hose into the channel and to fill the annular space between tube and channel completely with sealing. Via the conduit one sucks at channel 3 resp. 6

by connecting it to a suction source, for example source of vacuum or negative pressure source. Via the conduit, channel 2 resp. 5 is connected to a source of form free filler with which the cavity 4 is to be filled.

[0015] The suction source ensures that the pneumatic or hydrostatic pressure is reduced in the cavity 4, and that this pressure reduction is maintained so that preferably in the cavity 4 an underpressure prevails. The suction source preferably provides for a pressure reduction, preferably with respect to the ambient air pressure or the pressure prevailing in the via the feed conduit supplied material upstream of the cavity, for example, in the supply channel or the mouth of a pressure source, of at least 10 or 100 or 500 Pa or 1 or 5 or 10 or 20 or 50 or 75 kPa (100 kPa = the ambient air pressure on sea level), so that, for example, in the cavity there prevails a pressure of 0.01 or 0.025 or 0.05 or 0.1 or 0.25 or 0.5 or 0.8 bar at the most, for example at a pressure of between 0.95 or 0.99 and 1 bar in the surrounding atmosphere. This pressure reduction is preferably in such a way that the via the channel 2, respectively 5 and inwardly in the cavity 4 flowing filler material is experiencing a negative pressure. Optionally, the sucking is so limited when applied to actively (by a mechanical press source) or passive (only the force of gravity) pressing that only the overpressure by the pressing is compensated for so that in the cavity approximately the same pressure prevails as in the surrounding atmosphere.

[0016] Due to the pressure reduction due to the suction all in the cavity 4 present air or another liquid or gaseous medium, for example, used for the preliminary rinse, is pressed away.

[0017] As a rule, at the start of the treatment, the cavity 4 will be filled with water which is unintentionally present therein due to the inadequate processes during pouring and curing of the HSB. The filler material used is in preferably of a type with high water absorbing capacity, e.g. at least 5 or 10 or 12 vol.% water uptake ability. In a preferred embodiment, first the cavity 4 is rinsed in order to either replace the water by a gas, such as air, or by a liquid for which the filling material is has an even greater water absorbing capacity. When the filler is of 2- or more component type, for example, wherein the curing starts only when two or more components are mixed, one could flush with filling material from which one or more components are omitted so as no curing occurs. Alternatively one could rinse for example, with acetone or with filling material at a temperature such that hardening is considerably slower or even absent. The rinsing is preferably also with sucking, preferably also with the above-indicated pressure values.

[0018] The filler material is preferably during the procedure of sucking into the cavities, easily flowing, e.g. substantially comparable to liquid water, e.g. a viscosity of about 1 mPa.s. The filler material has preferably a viscosity that satisfies the following conditions: at least 0, or 0.01 or 0.1 mPa.s and / or up to 50 or 100 or 1000 or 10,000 or 100,000 mPa.s (the values in this paragraph

at 20 degrees Celsius).

[0019] Optionally, via two or more inlet channels 2, 5, and / or drainage channels 3, 6, the filler material is supplied to the cavity respectively fluid is sucked from the cavity.

[0020] Preferably, the vacuum is after completion of the with filler material filling of the cavity maintained, to which for example, upstream and downstream of the cavity in the feed and discharge a fluid-tight seal is provided, for example, by adding in the to channels 2, 3, 5, 6 connected lines a shut-off valve. Consequently the filling material will cure while in the cavity a pneumatic and / or hydrostatic negative pressure prevails.

[0021] In case the fluid medium which via the feed channel flows to the cavity tends to flow naturally (passive pressing), for example, aided by the force of gravity, e.g. when the surface of the fluid material in the source is located at a higher level than the cavity is, it is ensured that the suction source provides sufficient suction so that the fluid medium through the suction source is sucked to the cavity and from the discharge channel so that in the cavity under pressure prevails.

[0022] In an exemplary application, the process comprises one or more of the following steps: the stone-like material is sealed in order to make it more gas-tight, for example, by covering with a film; in the cavities at a mutual distance debouching inlet and outlet channels are made in the cast, preferably in situ, initially form free, cured stone like material; the supply channel is connected to a source of fluid rinsing or filling material; the drain is connected to a, preferably mechanical, suction source; the in the cavity present fluid medium is discharged by suction from the cavity via the drain; fluid medium is by the suction source sucked into the cavity, flowing through the feed channel, possibly this medium is actively or passively pressed into the supply channel, for example by a mechanical press source; while fluid material via the supply channel flows into the cavity, the suction source maintains a pressure reduction, preferably underpressure in the cavity; at the start of the curing of the into the cavity sucked fluid material, a pressure reduction, preferably under pressure, is maintained in the cavity.

[0023] This document discloses many measurements in mutual context and also discloses these measurements separately from this context, as independent measurements. Each of these independent measurements, individually or in combination with one or other independent measurements, constitutes the invention.

Claims

1. Method for post treatment of an onto a substrate cast, cured layer of an initially form free bulk material, such as cement concrete, whereby in the layer a supply and drain channel are made which at a distance from each other end up in the layer and debouch into a cavity present in the layer, which cavity is possibly

- filled with a gas or liquid, and wherein a source of liquid material is connected to the supply channel and the material flows through the supply channel and into the cavity while a to the drain channel connected suction source causes inside the cavity a by suction provided pressure reduction and maintains this and optionally sucks the material from the cavity.
2. Method according to claim 1, wherein the liquid material from the lower side of the cement concrete is fed to the cavity, and preferably the on top of the cement concrete located roadway remains in operation.
 3. Method according to claim 1 or 2, the cement concrete is sealed, for example, by applying a sealing layer onto it.
 4. Method according to any one of claims 1-3, channels are made in the cement concrete, which debouch into a cavity (4) in the cement concrete (1).
 5. Method according to any one of claims 1-4, the suction source ensures that the pneumatic or hydrostatic pressure in the cement concrete, preferably the cavity (4), is reduced and that this pressure reduction is maintained so that preferably in the cement concrete an underpressure prevails.
 6. Method according to any one of claims 1-5, the suction source creates a pressure reduction, preferably with respect to the ambient air pressure or the pressure prevailing in the via the supply channel fed material upstream of the cavity, for example, in the supply channel or the mouth of a pressure source, of at least 10 or 100 or 500 Pa or 1 or 5 or 10 or 20 or 50 or 75 kPa (100 kPa = the ambient air pressure on sea level), so that, for example, in the cavity there prevails a pressure of 0.01 or 0.025 or 0.05 or 0.1 or 0.25 or 0.5 or 0.8 bar at the most, for example at a pressure of between 0.95 or 0.99 and 1 bar in the surrounding atmosphere.
 7. Method according to any one of claims 1-6, the pressure reduction is such that the via a channel (2, 5) and inwards into the cavity (4) flowing filler material is experiencing an under pressure; and / or by the pressure reduction due to the suction all in the cavity (4) located air or another liquid or gaseous medium, for example, used for prior rinsing, is urged away.
 8. Method according to any one of claims 1-7, the used filler material is of a type with high water absorbing capacity, for example, at least 5 or 10 or 12 vol.% water absorbing capacity; and / or first the cavity (4) is rinsed to either replace the water by a gas, such as air, or by a liquid, preferably for which the filling material has a still greater water absorbing capacity.
 9. Method according to any one of claims 1-8, the filler material is during the procedure of sucking into the cavities easily flowing, for example, substantially similar with liquid water, for example, a viscosity of about 1 mPa.s; and / or the filling material has a viscosity which fulfills the following conditions: at least 0 or 0.01 or 0.1 mPa.s and / or up to 50 or 100 or 1000 or 10,000 or 100,000 mPa.s.
 10. Method according to any one of claims 1-9, the reduced pressure is maintained after completion of the filling of the cavity with filling material; and / or the filling material will cure while in the cavity a pneumatic and / or hydrostatic under pressure prevails
 11. Method according to any one of claims 1-10, fluid medium is sucked by the suction source to inside in the cavity (4), flowing through the supply channel, this medium possibly being active or passive pressed into the supply channel, e.g. by a mechanical pressing source
 12. Method according to any one of claims 1-11, applied to a road bridge with steel deck, in particular with a orthotropic steel bridge driving deck and / or V-shaped or trough-shaped stiffeners
 13. Method according to any one of claims 1-12, wherein the driving face is removed first.
 14. Method according to any one of claims 1-13, wherein the cement concrete contains a reinforcement net, preferably by mounting means mounted to the road deck.
 15. Method according to any one of claims 1-14, wherein the cement concrete is cast onto an adhesive layer.

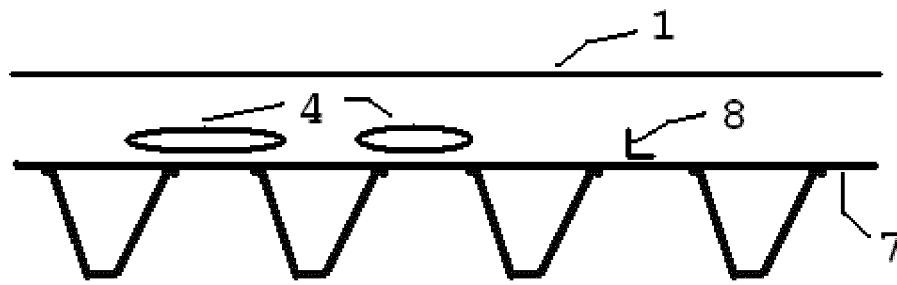


Fig. 1

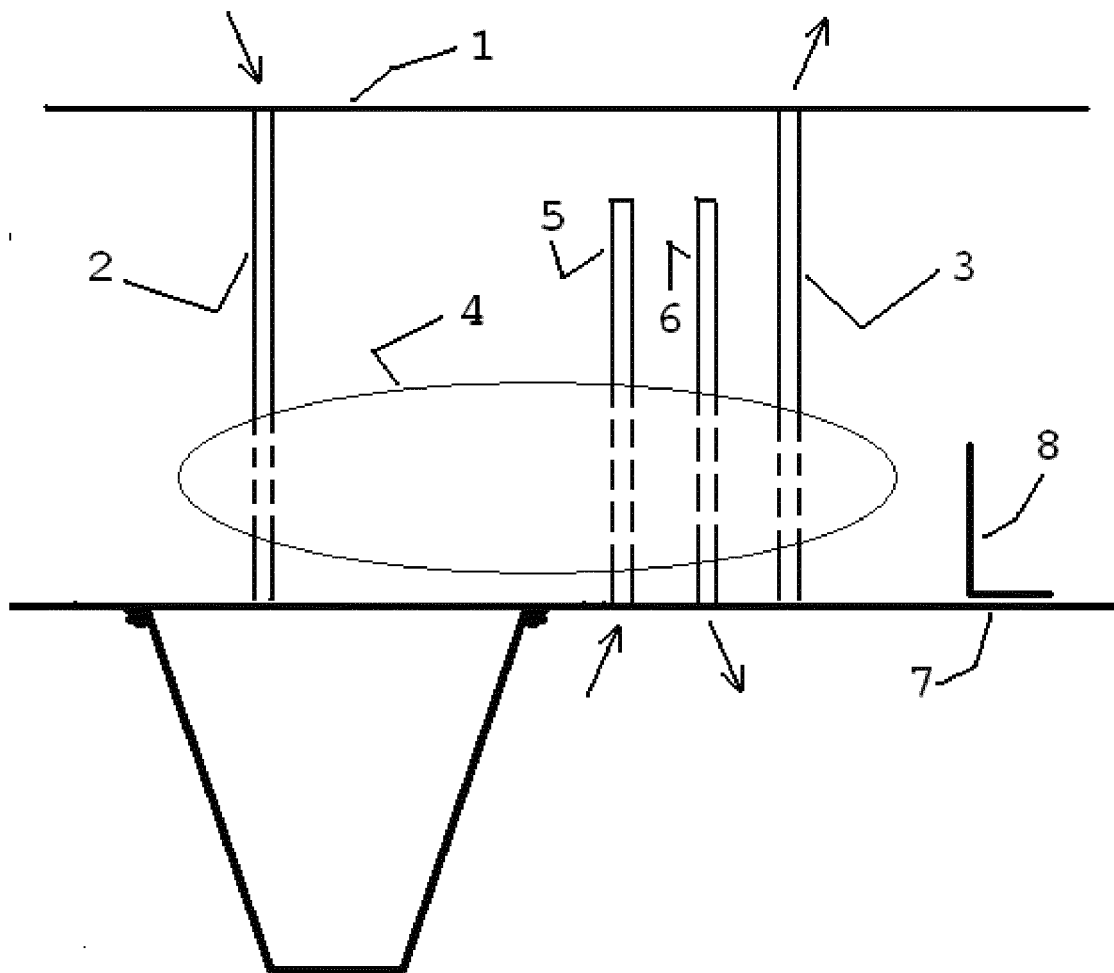


Fig. 2



EUROPEAN SEARCH REPORT

 Application Number
 EP 16 19 3399

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP 2007 277809 A (NIPPON ADOX KK) 25 October 2007 (2007-10-25) * the whole document *	1-3,5-7	INV. E01D22/00 E04G23/02
X	JP 2013 241760 A (PS MITSUBISHI CONSTRUCTION CO) 5 December 2013 (2013-12-05) * the whole document *	1	
A	US 3 865 075 A (KLEIN JAMES H ET AL) 11 February 1975 (1975-02-11) * the whole document *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			E01D E04G
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 15 February 2017	Examiner Beucher, Stefan
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 EPO FORM 1503 03/02 (P04C01)

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ON EUROPEAN PATENT APPLICATION NO.**

EP 16 19 3399

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15-02-2017

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2007277809 A	25-10-2007	NONE	
JP 2013241760 A	05-12-2013	JP 5861963 B2	16-02-2016
		JP 2013241760 A	05-12-2013
US 3865075 A	11-02-1975	CA 1034367 A	11-07-1978
		DE 2447264 A1	10-04-1975
		FR 2246709 A1	02-05-1975
		JP S5061812 A	27-05-1975
		US 3865075 A	11-02-1975

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