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(54) ROTATING CONSTRUCTION PLATFORM BASED ON SINGLE PILE FOUNDATION

(57) The present invention relates to a rotating construction platform based on a single pile foundation, comprising a rotary connecting mechanism which is disposed on the top part of a single pile foundation and a working platform which is disposed on the rotary connecting mechanism. The rotary connecting mechanism comprises an upper connecting cylinder, a lower connecting cylinder, and a rotary support structure located between the upper connecting cylinder and the lower connecting cylinder. The working platform is fixedly connected to the upper connecting cylinder, the lower connecting cylinder is removably fixed to the top part of the single pile foundation, and at least one side of the working platform extends out of a side edge of the single pile foundation. The rotating construction platform of the present invention is stable and reliable, and can replace original methods which require the use of offshore construction work vessels or temporary construction platforms, improving the continuity of construction work, saving construction time and costs, preventing ship machines from being rocked by waves and hitting a single pile foundation when the construction space is small, improving the construction

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positioning accuracy, and ensuring construction quality.

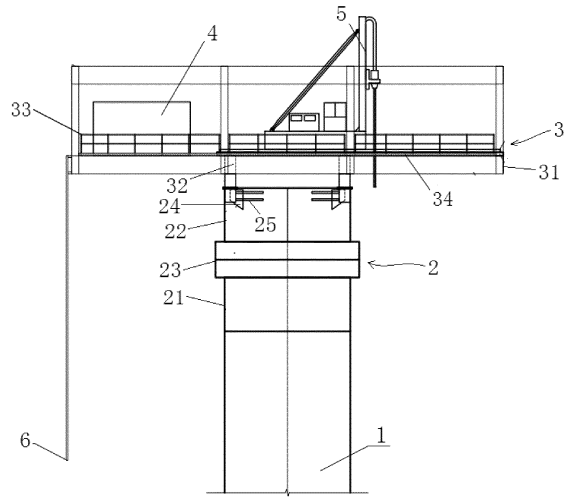

Figure 1

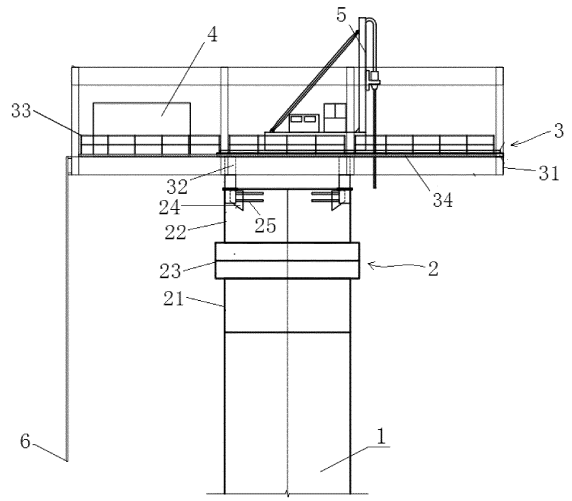

Figure 1

Description

TECHNICAL FIELD

[0001] The present disclosure relates to a construction platform surrounded by water, in particular, to a rotating construction platform based on a monopile.

BACKGROUND

[0002] During the construction, equipment installation and maintenance of offshore structures, it is often necessary to carry out construction around a monopile. At present, there are usually two ways of offshore construction: using conventional temporary multi-pile platforms and using offshore construction vessels. If conventional temporary multi-pile platforms are used, there are usually two ways: one is to build a small temporary platform beside of the monopile, where the temporary platform is supported by multiple steel pipe piles with small diameters, this method requires continuous piling and disassembly of the platform to adjust the position of the temporary platform around the monopile to meet the construction needs; the other is to reserve a hole in the middle of a very large temporary platform and surround the entire monopile in the hole, in this method, the temporary platform is too large, and this method is technically and economically unreasonable. If offshore construction vessels are used, special offshore construction vessels (such as DCM mixing ships) can be used, or construction equipment can be installed on ships, that is, land-based construction machinery are installed and arranged on a barge or a self-elevating platform vessel. Special offshore construction vessels have high construction efficiency, but their size is generally large, their construction period is tight, and their equipment is expensive; in addition, upgrading a vessel generally requires that the relevant equipment be properly configured and fixed. Except for self-elevating platform vessels, other vessels need to be moved constantly by adjusting the length of anchor chain during offshore construction. During offshore construction, environmental factors such as current load, wave load, and sea wind need to be overcome, and it is not easy to control the quality of construction. For self-elevating platform vessels, it is needed to plug and unplug leg piles and adjust their positions, thus the work efficiency is low and the technical economy is unreasonable. Therefore, a new type of construction platform is needed to reduce construction difficulty, save construction time and costs.

SUMMARY

[0003] Given the shortcomings of the prior art described above, the present disclosure aims to provide a rotating construction platform based on a monopile. A new design pattern is proposed to directly set the construction platform on the monopile, which saves construction time and costs, improves the continuity of construction operations, and ensures construction quality.

[0004] To realize the above purpose, the present disclosure provides a rotating construction platform based on a monopile, including a rotary connecting mechanism arranged on a top of the monopile and a working platform arranged on the rotary connecting mechanism. The rotary connecting mechanism includes an upper connecting tube, a lower connecting tube, and a rotary support structure located between the upper connecting tube and the lower connecting tube. The working platform is fixedly connected to the upper connecting tube, and the lower connecting tube is detachably fixed to the top of the monopile. At least one side of the working platform sticks out of a side of the monopile.

[0005] Further, the rotary connecting mechanism further includes a plurality of corbels fixedly connected to the upper connecting tube, and the working platform is fixedly connected to the plurality of corbels.

[0006] Further, a plurality of horizontal braces is fixedly arranged between the plurality of corbels and the upper connecting tube.

[0007] Further, a load-bearing system of the working platform includes a platform underframe. The platform underframe is fixedly connected with a plurality of short columns, each of the plurality of short columns is fixedly connected to one of the plurality of corbels of the rotary connecting mechanism.

[0008] Further, the platform underframe is rectangular and sticks out of one side or two sides of the monopile along a length direction. The platform underframe includes a plurality of main beams arranged along the length direction, a plurality of secondary beams arranged along a width direction, and each steel plate or grating installed on the main beam and the secondary beam. The plurality of short columns is fixedly connected with the plurality of main beams.

[0009] Further, the load-bearing system of the working platform further includes a vertical reinforcement structure fixedly connected with the platform underframe.

[0010] Further, the load-bearing system of the working platform including the platform underframe and the vertical reinforcement structure is a frame structure, a truss structure, a self-stressed arch system, or a cable-stayed structure.

[0011] Further, the rotary connecting mechanism further includes a rotary control system for controlling the rotation of the rotary support structure.

[0012] Further, a berthing and boarding structure is provided at a side of the working platform.

[0013] Further, the working platform includes a plurality of guardrails and a plurality of wheel guard sills installed on the platform underframe.

[0014] As described above, the rotating construction platform involved in the present disclosure has the following beneficial effects:

[0015] By setting up a rotary connecting mechanism on the top of a monopile and a working platform on the

rotary connecting mechanism, a new design pattern is provided to set up the rotating construction platform on the monopile, that is, to use the monopile as a structural support without additional piles. By setting up the rotary connecting mechanism with a rotation function to drive the working platform to rotate, the overall size of the working platform can be effectively reduced under the premise of achieving the same construction scope, which brings convenience to construction. The rotating construction platform of the present disclosure is stable and reliable. It can replace the original method that requires offshore construction vessels or conventional temporary platforms, reduce adverse effects such as tide level, waves and water current in marine environments, improve the continuity of construction operations, save construction time and costs, avoid vessel machinery from hitting the monopile due to waves when the construction space is small, improve construction positioning accuracy, and ensure construction quality.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

Figure 1 is a schematic diagram of a rotating construction platform according to Embodiment 1 of the present disclosure.

Figure 2 is a top view of Figure 1.

Figure 3 is a top view of a rotary connecting mechanism according to Embodiment 1 of the present disclosure.

Figure 4 is a schematic diagram of a platform underframe of a working platform according to Embodiment 1 of the present disclosure.

Figure 5 is a front view of a working platform according to Embodiment 1 of the present disclosure.

Figure 6 is a schematic diagram of a working platform of a rotating construction platform according to Embodiment 2 of the present disclosure.

Figure 7 is a schematic diagram of a working platform of a rotating construction platform according to Embodiment 3 of the present disclosure.

Figure 8 is a schematic diagram of a working platform of a rotating construction platform according to Embodiment 4 of the present disclosure.

Figure 9 is a schematic diagram of a working platform of a rotating construction platform according to Embodiment 5 of the present disclosure.

Figure 10 is a schematic diagram of a working platform of a rotating construction platform according to Embodiment 6 of the present disclosure.

Reference Numbers

[0017]

1	Monopile
2	Rotary connecting mechanism
21	Lower connecting tube
22	Upper connecting tube
23	Rotary support structure
24	Corbel
25	Horizontal brace
3	Working platform
31	Platform underframe
311	Boundary beam
312	Main beam
313	Secondary beam
314	Steel plate and grating
315	Hole
32	Short column
33	Guardrail
34	Wheel guard sill
35	Vertical reinforcement structure
351	Column
352	Bracing system
353	Beam
354	Tie rod
355	Arch
356	Cable tower
357	Cable
358	Upper chord member
359	Web member
4	Material bin
5	Equipment
6	Berthing and boarding structure
7	Guide rail
8	Track beam

DETAILED Description

[0018] The embodiments of the present disclosure will be described below through specific embodiments. Those skilled in the art can easily understand other advantages and effects of the present disclosure according to the contents disclosed by the specification.

[0019] It should be understood that the structures, proportions, sizes, and the like, which are illustrated in the drawings of the present specification, are used to clarify the contents disclosed in the specification for understanding and reading by those skilled, and are not intended to limit the implementation of the present disclosure, thus are not technically meaningful. Any modification of the structure, change of the scale, or adjustment of the size should still fall within the scope of the technical contents disclosed by the present disclosure without affecting the effects and achievable objectives of the present

disclosure. In the meantime, the terms "upper", "lower", "left", "right", "intermediate" as used in this specification are also for the convenience of description, and are not intended to limit the scope of the present disclosure, and the change or adjustment of the relative relationship is considered to be within the scope of the present disclosure without substantial changes in technology.

[0020] Please refer to figures 1 to 10. The present disclosure provides a rotating construction platform based on a monopile 1, which includes a rotary connecting mechanism 2 set on the top of the monopile 1 and a working platform 3 set on the rotary connecting mechanism 2. The rotary connecting mechanism 2 includes an upper connecting tube 22, a lower connecting tube 21, and a rotary support structure 23 located between the upper connecting tube 22 and the lower connecting tube 21. The working platform 3 is fixedly connected to the upper connecting tube 22, and the lower connecting tube 21 is detachably fixed to the top of the monopile 1. At least one side of the working platform 3 sticks out of the side of the monopile 1.

[0021] As the diameter of the offshore monopile 1 increases, the area of the pile top increases, and the bearing capacity of the monopile 1 is enhanced with sufficient rigidity. Some construction machinery (such as high-pressure rotary jet drilling machines and cement grouting machines) have small size, low self-weight, and construction load. Therefore, it is feasible to arrange a rotating construction platform on the pile top of a monopile 1.

[0022] The rotating construction platform involved in the present disclosure adopts a new design pattern, which sets the rotating construction platform on the monopile 1. That is, the monopile 1 is used as the structural support, and there is no need to use additional piles. By setting the rotary connecting mechanism 2 with a rotation function, the upper connecting tube 22 rotates relative to the lower connecting tube 21 through the rotary support structure 23, thereby driving the working platform 3 to rotate. The working platform 3 can rotate according to actual construction needs. Therefore, the working platform 3 only needs to stick a long distance in one direction (referred to as the length direction) from the monopile 1, while the size of the width is small. The working platform 3 can be moved to the position where construction is needed by rotating, which is flexible and can effectively reduce the overall size of the working platform 3 under the condition of achieving the same construction range, thus bringing convenience to construction. The rotating construction platform of the present disclosure is stable and reliable and can replace the original method of using offshore construction vessels or temporary construction platforms, reduce adverse effects such as tide level, waves and water current in marine environments, improve the continuity of construction operations, save construction time and costs, avoid vessel machinery from hitting the monopile 1 due to waves when the construction space is small, improve construction positioning accuracy, and ensure construction quality.

[0023] Please refer to Figures 1 to 10 for further explanation of the present disclosure with several specific embodiments.

Embodiment 1:

[0024] Please refer to Figures 1 to 5. In this embodiment, as a preferred design, the rotary connecting mechanism 2 further includes multiple corbels 24 fixedly connected to the upper connecting tube 22, where the working platform 3 is fixedly connected to the corbels 24. Multiple corbels 24 are provided and reasonably distributed inside and outside the upper connecting tube 22. Multiple horizontal braces 25 are also fixedly connected between the corbels 24 and the upper connecting tube 22 to further stabilize and support. The corbels 24 facilitate the installation between the rotary connecting mechanism 2 and the working platform 3 and increase the support to the working platform 3. Preferably, a flange is provided on the corbels 24, and the working platform 3 is connected to the flanges on the corbels 24 by bolts.

[0025] In this embodiment, referring to Figures 1, 2, and 3, the rotary support structure 23 generally includes two steel seat rings that can rotate relative to each other. The rotary support structure 23 can simultaneously withstand axial force, radial force, and overturning moment. The form of the rotary support structure 23 can be single-row four-point contact ball type, single-row cross roller type, double-row or double-column ball type, three-row roller type, ball-column combination type, etc. As a preferred design, the rotary connecting mechanism 2 further includes a rotary control system that controls the rotation of the rotary support structure 23. The working platform 3 can be efficiently and accurately rotated and positioned to different construction angles and temporarily fixed through the rotary control system.

[0026] In this embodiment, as shown in Figures 2, 4, and 5, as a preferred design, the load-bearing system of the working platform 3 includes a platform underframe 31. The platform underframe 31 is the main structure for carrying equipment 5 and personnel activities. The platform underframe 31 is fixed with multiple short columns 32. The short columns 32 can extend downward to the bottom of the platform underframe 31. The lower end of each of the short columns 32 is fixedly connected to the flange of one of the corbels 24 in the rotary connecting mechanism 2 through a bolt.

[0027] In this embodiment, as shown in Figures 1, 2, and 4, the platform underframe 31 is rectangular. In the length direction, both sides of the platform underframe 31 stick out a long distance of the monopile 1. The width of the platform underframe 31 does not need to be too large, just meet the needs of equipment and technology. Therefore, the area of the platform underframe 31 does not need to be too large. Through the rotation of the rotary connecting mechanism 2, the platform underframe 31 can cover a large construction area. Therefore, the platform underframe 31 can adopt a simplified structure as

much as possible. In this embodiment, as shown in Figure 5, the platform underframe 31 includes multiple main beams 312 arranged along the length direction, multiple secondary beams 313 arranged along the width direction, and a steel plate or grating 314 installed on the main beams 312 and the secondary beams 313. The short columns 32 are fixedly connected to the main beams 312. The boundary beams 311 of the platform underframe 31 ensure that the overall torsional strength of the platform underframe 31. In addition, according to needs, a hole 315 is locally provided on the platform underframe 31 for convenience in construction.

[0028] In this embodiment, as shown in Figures 2, 4, and 5, the working platform 3 includes one or more guardrails 33 and one or more wheel guard sills 34 set at the edge of the platform underframe 31 for safety protection. In addition, a berthing and boarding structure 6 is also provided at the side of the working platform 3 to facilitate personnel boarding and disembarking.

[0029] In the present disclosure, life-saving and escape facilities are also provided on the working platform 3, and necessary sunshade, rainproof and windproof facilities are provided. The working platform 3 is also equipped with basic lightning protection facilities.

[0030] As a preferred design, as shown in Figures 2, 4, and 5, a plurality of track beams 8, a plurality of guide rails 7, a plurality of equipment holders, embedded bolts, etc. are provided on the working platform 3 for installation and movement of a material bin 4 such as an oil tank, a water tank, and a cement silo, as well as for installation and movement of equipment 5 such as a diesel generator, an air compressor, a mud pump, a high-pressure grouting machine, a cement mixing pile driver, a small crane, and a small drilling machine. Lifting points are also set on the working platform 3 for platform lifting and installation. The material bin 4 and equipment 5 can be lifted by a crane ship to the working platform 3 or temporarily fixed on the working platform 3 in advance and then hoisted together with the platform as a whole.

[0031] In the present disclosure, the lower connecting tube 21 of the rotary connecting mechanism 2 is fixedly connected to the monopile by bolts, such that the rotating construction platform can be flexibly removed from the monopile 1 and can be reused without affecting the subsequent use of the monopile 1.

[0032] In this embodiment, as shown in Figure 5, the load-bearing system of the working platform 3 further includes a vertical reinforcement structure 35. The vertical reinforcement structure 35 includes columns 351 and beams 353. Specifically, the number of columns 351 is determined according to actual needs. The lower ends of the columns 351 are fixed on the platform underframe 31, and beams 353 are horizontally fixed on the columns 351. The columns 351 and the beams 353 together with the platform underframe 31 form a frame structure to ensure the strength and rigidity of the entire working platform 3, improve the bearing capacity, and reduce the deformation of the working platform 3 due to loads.

Embodiment 2:

[0033] As shown in Figure 6, this embodiment is an improvement based on embodiment 1. In this embodiment, the vertical reinforcement structure 35 of the working platform 3 includes columns 351, bracing system 352 and beams 353. Adjacent two columns 351 (also known as each span) are fixedly connected by bracing system 352 to improve the stress state of joints of beams and columns. Columns 351, bracing system 352 and beams 353 together with the platform underframe 31 form a braced frame structure to further increase the overall strength and rigidity of the working platform 3.

Embodiment 3:

[0034] As shown in Figure 7, in this embodiment, the vertical reinforcement structure 35 of the load-bearing system of the working platform 3 includes tie rods 354 and an arch 355. Specifically, two ends of the arch 355 are fixedly connected to the platform underframe 31, and the tie rods 354 are fixedly connected between the arch 355 and the platform underframe 31. The tie rods 354 are arranged along the length direction of platform underframe 31. The tie rods 354 and the arch 355 together with the platform underframe 31 form a self-stressed arch system to ensure the strength and rigidity of the entire working platform 3. By adopting this self-stressed arch-type bearing system, the bearing capacity of the working platform 3 can be improved and its deformation due to loads can be reduced.

Embodiment 4:

[0035] As shown in Figure 8, in this embodiment, the vertical reinforcement structure 35 of the load-bearing system of the working platform 3 includes a cable tower 356 and cables 357. Specifically, the cable tower 356 is fixed on the platform underframe 31 and located near the middle of platform underframe 31. Cables 357 are multiple and their upper ends are fixedly connected to the top of the cable tower 356 while their lower ends are fixedly connected to different positions of the platform underframe 31. The cable tower 356 and the cables 357 together with the platform underframe 31 form a cable-stayed structure to ensure the strength and rigidity of the entire working platform 3. By adopting this cable-stayed structure type bearing system, the bearing capacity of the working platform 3 can be improved and its deformation due to loads can be reduced.

Embodiment 5:

[0036] As shown in Figure 9, in this embodiment, the vertical reinforcement structure 35 of the load-bearing system of the working platform 3 includes web members 358 and upper chord members 359. Specifically, multiple web members 358 are set according to actual needs,

including vertical setting and inclined setting. The lower ends of the web members 358 are fixed on the platform underframe 31 while the upper chord members 359 are horizontally fixed on the web members 358. The web members 358 and the upper chord members 359 together with the platform underframe 31 form a truss structure to ensure the strength and rigidity of the entire working platform 3. The bearing capacity of the working platform 3 can be improved and its deformation due to loads can be reduced.

Embodiment 6:

[0037] Refer to Figure 10. This embodiment is basically similar to Embodiment 1, but different in that the platform underframe 31 of the working platform 3 sticks out of one side along the length direction of the monopile 1 for a long distance, and only slightly sticks out of the other side of the monopile 1, that is, the working platform 3 sticks out of one side only. This embodiment can be used in cases where the platform area does not need to be very large, reducing the structure of the working platform 3 and reducing the weight of the platform itself. However, higher technical requirements for the layout of the equipment 5 and the material bin 4 for construction are needed.

[0038] The rotating construction platform of the present disclosure uses the top of the monopile 1 as a supporting foundation. With the increase of the diameter of the offshore monopile, the area of the pile top increases, which has sufficient rigidity and enhances the bearing capacity of the monopile. It can support a rotating platform stably and reliably. Through this rotating construction platform, construction around the monopile 1 can be effectively completed, such as pile foundation reinforcement (such as replacement method, high-pressure rotary spraying method, cement mixing method). It can replace the original method that requires offshore construction vessels or conventional temporary multi-pile platforms, reduce adverse effects such as tide level, waves and water current in marine environments, improve the continuity of construction operations, save construction time and costs, avoid vessel machinery from hitting the monopile 1 due to waves when the construction space is small, improve construction positioning accuracy and ensure construction quality. The rotating construction platform reduces the size of the platform under the premise of achieving the same construction scope, which brings convenience to construction and has practical engineering significance.

[0039] The rotating construction platform of the present disclosure can also be used for construction of anti-scouring facilities around the pile (sand quilt placement, stone throwing around the pile, artificial block throwing around the pile, solidified soil anti-scouring layer), installation of auxiliary facilities, anti-corrosion coating repair and other constructions. It can also be used as a temporary surveying, observation, and testing platform. In addition to being applied to offshore monopiles, based on the same or similar principles, it can also be applied to monopiles in water bodies such as lakes and rivers.

[0040] In summary, the present disclosure effectively overcomes various disadvantages of the traditional technology and has high industrial application values.

[0041] The above-mentioned embodiments are just used for exemplarily describing the principle and effects of the present disclosure instead of limiting the present disclosure. Those skilled in the art can make modifications or changes to the above-mentioned embodiments without going against the spirit and the range of the present disclosure. Therefore, all equivalent modifications or changes made by those who have common knowledge in the art without departing from the spirit and technical concept disclosed by the present disclosure shall be still covered by the claims of the present disclosure.

Claims

1. A rotating construction platform based on a monopile, comprising a rotary connecting mechanism (2) arranged on a top of the monopile (1) and a working platform (3) arranged on the rotary connecting mechanism (2), wherein the rotary connecting mechanism (2) comprises an upper connecting tube (22), a lower connecting tube (21), and a rotary support structure (23) located between the upper connecting tube (22) and the lower connecting tube (21), wherein the working platform (3) is fixedly connected to the upper connecting tube (22), and the lower connecting tube (21) is detachably fixed to the top of the monopile (1), wherein at least one side of the working platform (3) sticks out of a side of the monopile (1).

2. The rotating construction platform according to claim 1, wherein the rotary connecting mechanism (2) further comprises a plurality of corbels (24) fixedly connected to the upper connecting tube (22), and the working platform (3) is fixedly connected to the plurality of corbels (24).

3. The rotating construction platform according to claim 2, wherein a plurality of horizontal braces (25) is fixedly arranged between the plurality of corbels (24) and the upper connecting tube (22).

4. The rotating construction platform according to claim 2, wherein a load-bearing system of the working platform (3) comprises a platform underframe (31), wherein the platform underframe (31) is fixedly connected with a plurality of short columns (32), wherein each of the plurality of short columns (32) is fixedly connected to one of the plurality of corbels (24) of the rotary connecting mechanism (2).

5. The rotating construction platform according to claim 4, wherein the platform underframe (31) is rectangular and sticks out of one side or two sides of the monopile (1) along a length direction, wherein the platform underframe (31) comprises a plurality of main beams (312) arranged along the length direction, a plurality of secondary beams (313) arranged along a width direction, and a steel plate or grating (314) installed on the plurality of main beams (312) and the plurality of secondary beams (313), wherein the plurality of short columns (32) is fixedly connected with the plurality of main beams (312).

6. The rotating construction platform according to claim 4, wherein the load-bearing system of the working platform (3) further comprises a vertical reinforcement structure (35) fixedly connected with the platform underframe (31).

7. The rotating construction platform according to claim 6, wherein the load-bearing system of the working platform (3) including the platform underframe (31) and the vertical reinforcement structure (35) is a frame structure, a truss structure, a self-stressed arch system or a cable-stayed structure.

8. The rotating construction platform according to claim 1, wherein the rotary connecting mechanism (2) further comprises a rotary control system for controlling the rotation of the rotary support structure (23).

9. The rotating construction platform according to claim 1, wherein a berthing and boarding structure (6) is provided at a side of the working platform (3).

10. The rotating construction platform according to claim 1, wherein the working platform (3) comprises a plurality of guardrails (33) and a plurality of wheel guard sills (34) installed on the platform underframe (31).

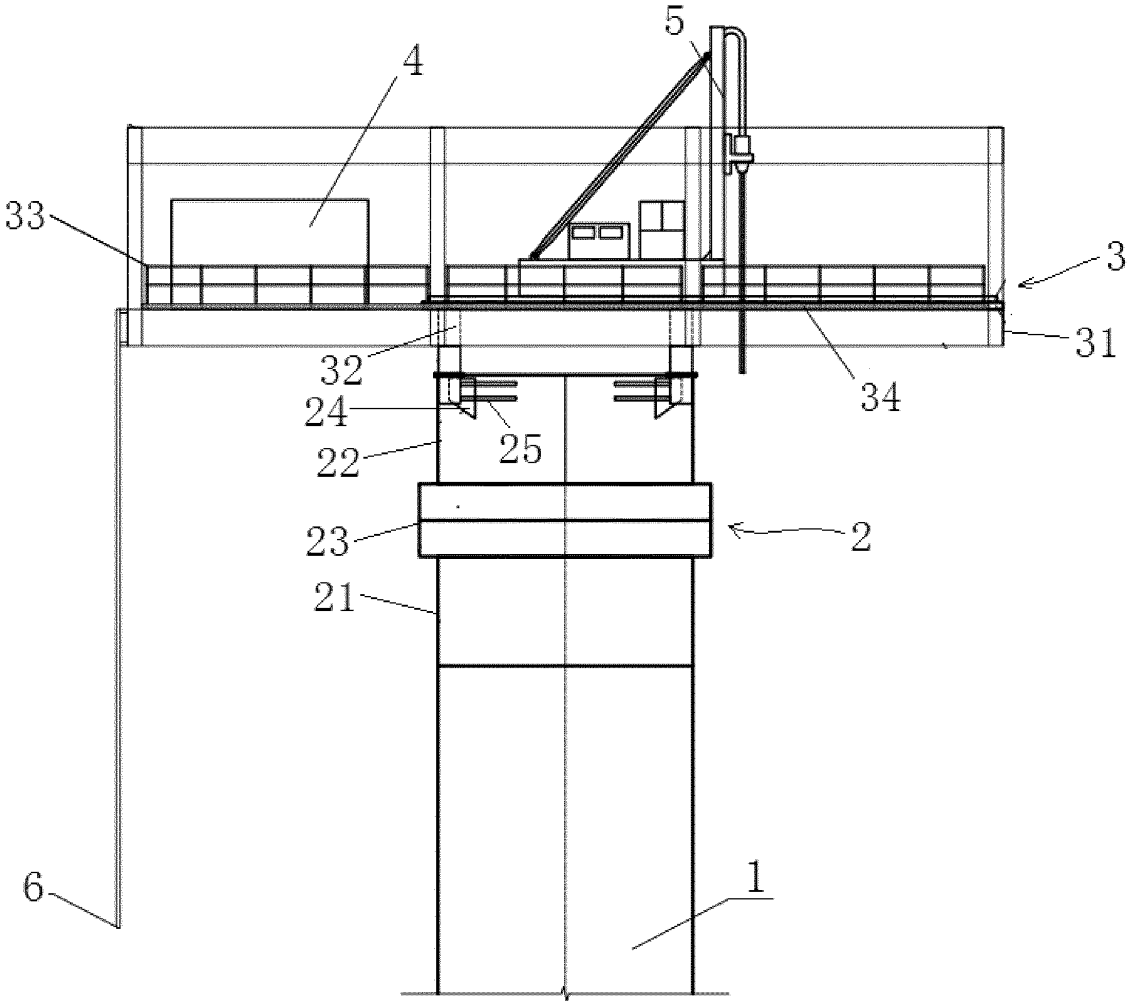

Figure 1

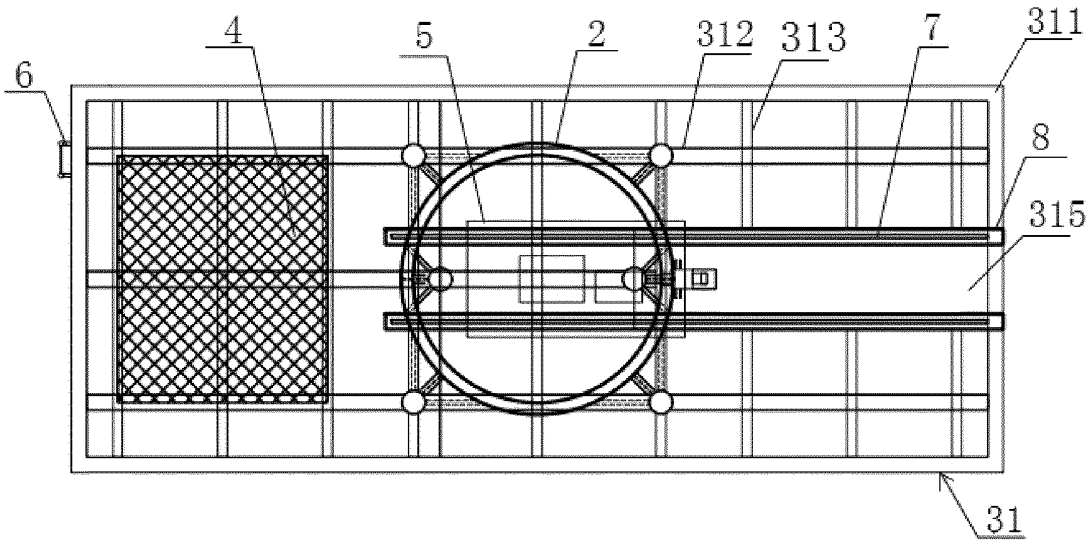

Figure 2

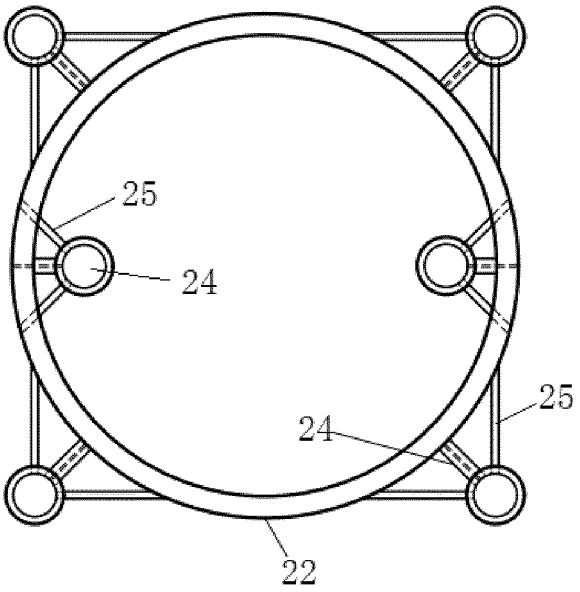

Figure 3

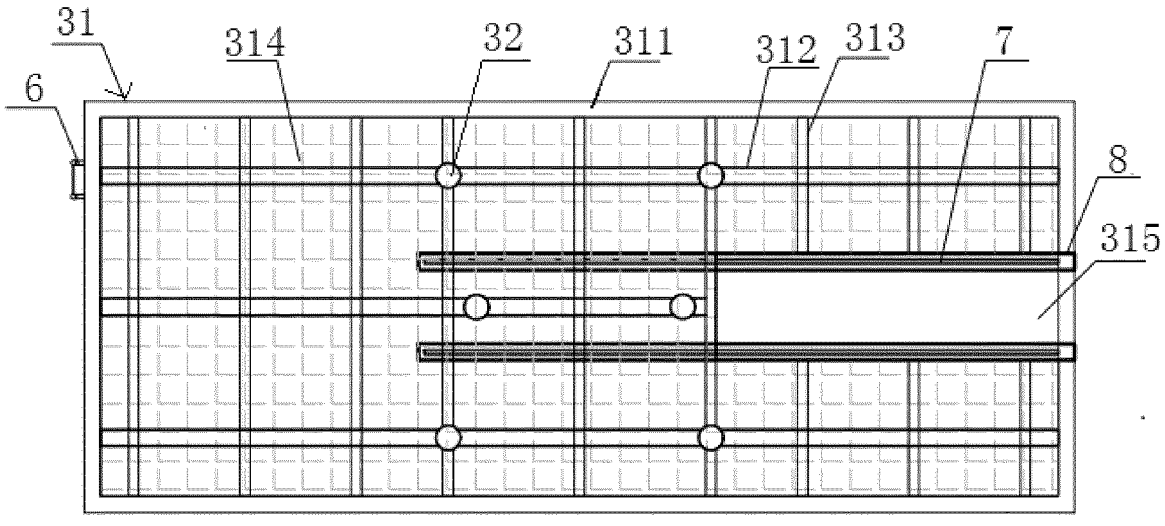

Figure 4

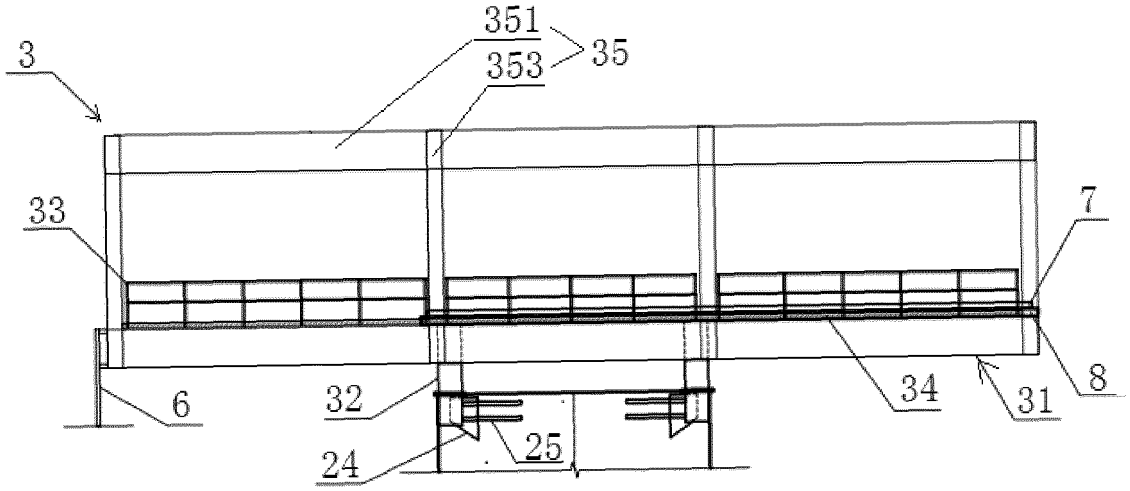

Figure 5

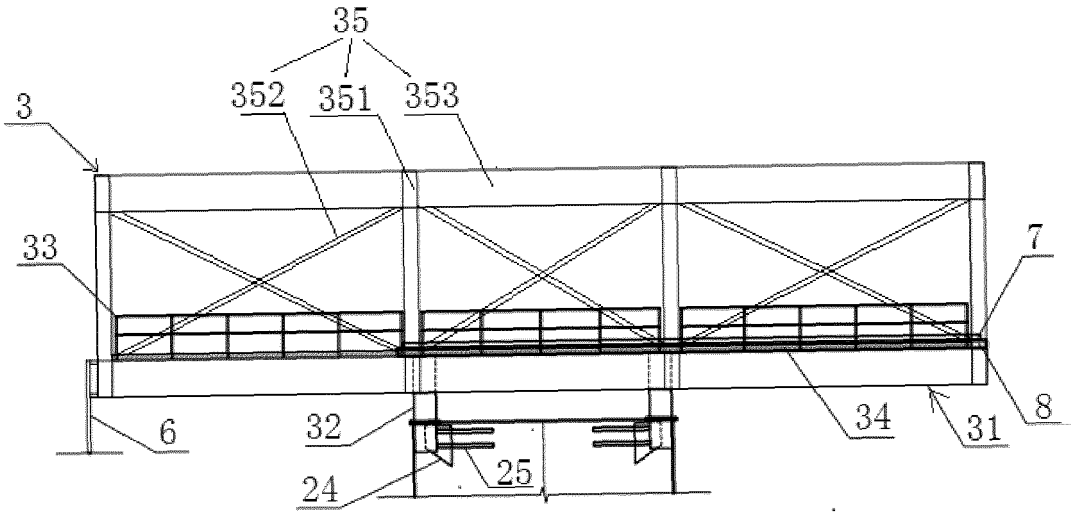

Figure 6

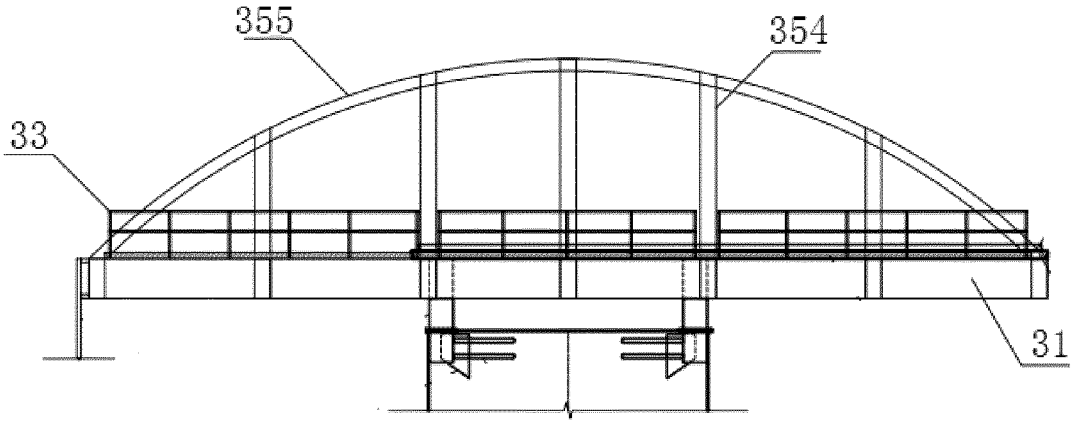

Figure 7

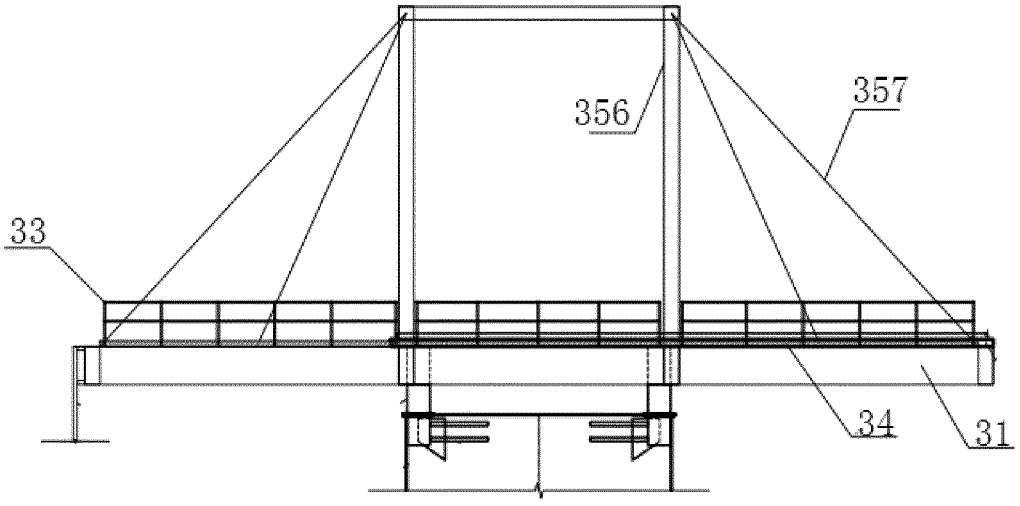

Figure 8

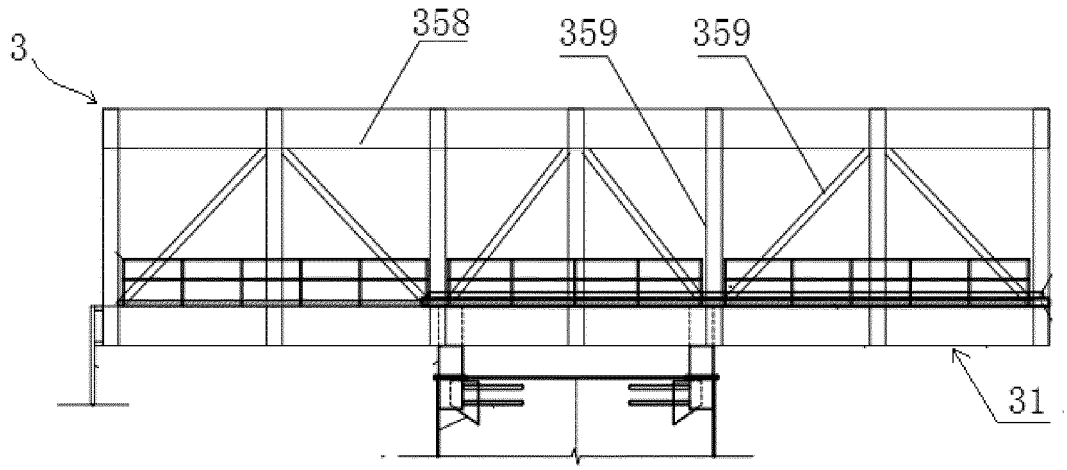

Figure 9

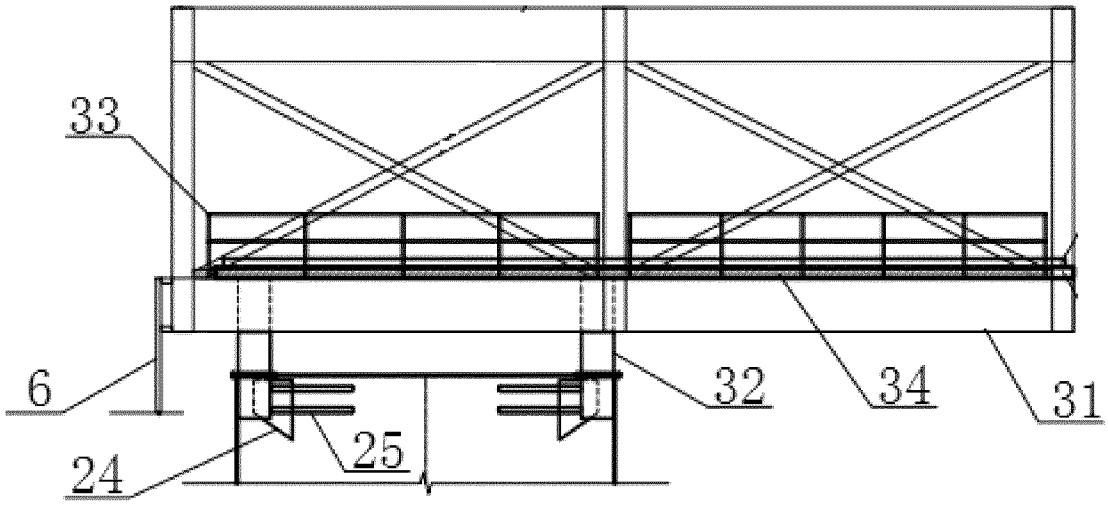

Figure 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/113820

A. CLASSIFICATION OF SUBJECT MATTER

E02B 17/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E02B 17/-;; E02D 27/-; E02B 3/20;; E02B 3/24; B63B 21/-

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNTXT; CNABS; WPABS; ENTXT; DWPI; VEN; CNKI: 单, 桩, 柱, 塔, 筒, 平台, 旋转, 回转, 转动, 回转支承, 施工, 转柱, 转台, 转塔, 单点系泊, pile, column, monopile, platform, rotate, rotary, swivel, slewing, bearing, ring, single, point, mooring

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 110422294 A (SHANDONG DINGSHENG ELECTROMECHANICAL EQUIPMENT INC.) 08 November 2019 (2019-11-08) description, paragraphs [0119]-[0133], and figures 1-3	1-10
A	CN 201746845 U (CHINA NATIONAL OFFSHORE OIL CORPORATION et al.) 16 February 2011 (2011-02-16) entire document	1-10
A	CN 106978800 A (CHINA ENERGY ENGINEERING GROUP GUANGDONG ELECTRIC POWER DESIGN INSTITUTE CO., LTD.) 25 July 2017 (2017-07-25) entire document	1-10
A	CN 104594317 A (JIANGSU JINFENG SCIENCE & TECHNOLOGY CO., LTD.) 06 May 2015 (2015-05-06) entire document	1-10
A	WO 2005054585 A1 (SLP ENGINEERING LTD. et al.) 16 June 2005 (2005-06-16) entire document	1-10
A	US 2017233971 A1 (INNOGY SE) 17 August 2017 (2017-08-17) entire document	1-10

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 January 2022	**26 January 2022**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China**	Authorized officer
Facsimile No. **(86-10)62019451**	Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2021/113820

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	110422294	A	08 November 2019	None			
CN	201746845	U	16 February 2011	None			
CN	106978800	A	25 July 2017	None			
CN	104594317	A	06 May 2015	None			
WO	2005054585	A1	16 June 2005	GB	0327940	D0	07 January 2004
				GB	2408767	A	08 June 2005
				DE	602004023230	D1	29 October 2009
				TN	SN06163	A1	15 November 2007
				EP	1699980	A1	13 September 2006
				EP	1699980	B1	16 September 2009
				AT	443185	T	15 October 2009
US	2017233971	A1	17 August 2017	DE	102014220782	A1	14 April 2016
				WO	2016059007	A1	21 April 2016
				US	9976273	B2	22 May 2018
				EP	3207186	A1	23 August 2017
				EP	3207186	B1	16 June 2021

Form PCT/ISA/210 (patent family annex) (January 2015)