US 20210340713A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2021/0340713 A1**

(43) **Pub. Date: Nov. 4, 2021**

ZHU et al.

(54) **MONORAIL TRANSPORTATION-BASED SPATIAL TRANSPORT SYSTEM**

(71) Applicant: **BEIJING JIAOTONG UNIVERSITY**, Beijing (CN)

(72) Inventors: **Eryu ZHU**, Beijing (CN); **Zhenqiu QIN**, Beijing (CN); **Li ZHU**, Beijing (CN); **Xingyang WEN**, Beijing (CN)

(21) Appl. No.: **17/273,019**

(22) PCT Filed: **Sep. 3, 2019**

(86) PCT No.: **PCT/CN2019/104237**

§ 371 (c)(1),
(2) Date: **Apr. 29, 2021**

(30) **Foreign Application Priority Data**

Sep. 3, 2018 (CN) 201811021460.7
Sep. 3, 2018 (CN) 201811021471.5
Sep. 3, 2018 (CN) 201811021472.X
Sep. 3, 2018 (CN) 201811021615.7
Sep. 3, 2018 (CN) 201811022979.7
Sep. 3, 2018 (CN) 201811023547.8
Sep. 3, 2018 (CN) 201811023550.X

Publication Classification

(51) **Int. Cl.**

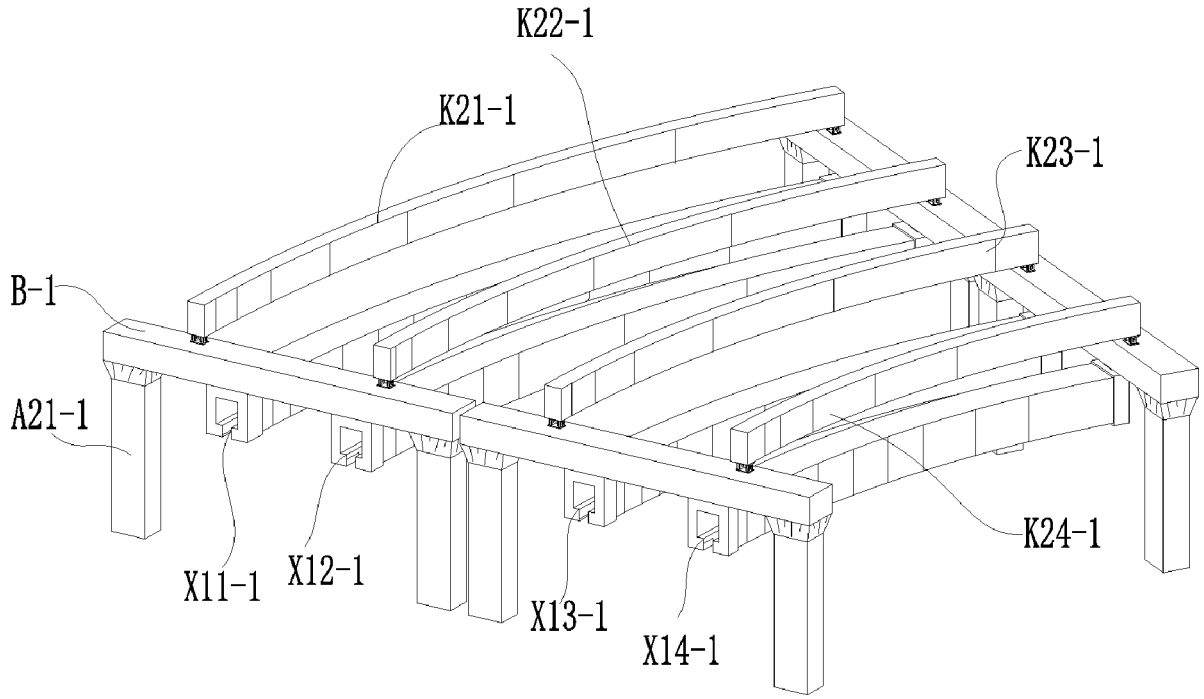
E01C 1/04	(2006.01)
E01B 25/10	(2006.01)
E01B 25/24	(2006.01)
E01B 25/30	(2006.01)
B61B 15/00	(2006.01)
B61B 13/04	(2006.01)

(52) **U.S. Cl.**

CPC ***E01C 1/04*** (2013.01); ***E01B 25/10*** (2013.01); ***E01B 25/24*** (2013.01); *E01B 2204/15* (2013.01); ***B61B 15/00*** (2013.01); ***B61B 13/04*** (2013.01); ***E01B 25/305*** (2013.01)

(57) **ABSTRACT**

A monorail transportation-based spatial transport system, comprising a load-bearing frame system or a load-bearing pier system. The load-bearing frame or pier system divides, by means of bent caps, the spatial transport system into at least two layers (K**1**, K**2**), the two layers (K**1**, K**2**) comprising an odd-numbered layer below the bent cap (B-**1**) and an even-numbered layer above said bent cap, the odd-numbered layer comprising or not comprising suspended monorail transportation, and the even-numbered layer comprising any of straddle-type transportation, magnetic levitation-type transportation, road transportation and railway transportation. The spatial transport system comprises two or more types of monorail transportation or a combination of one or more types of monorail transportation and other types of transportation, and solves the problems of intensive passenger flow, ground transportation congestion and low logistics efficiency.



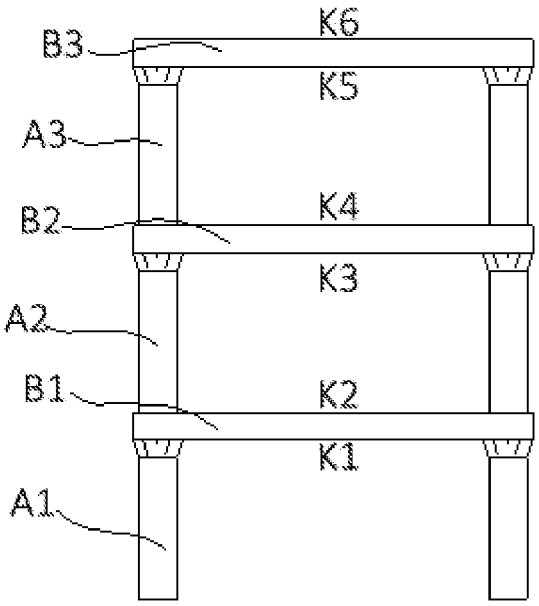

K6
B3
K5
A3
K4
B2
K3
A2
K2
B1
K1
A1

FIG. **1**

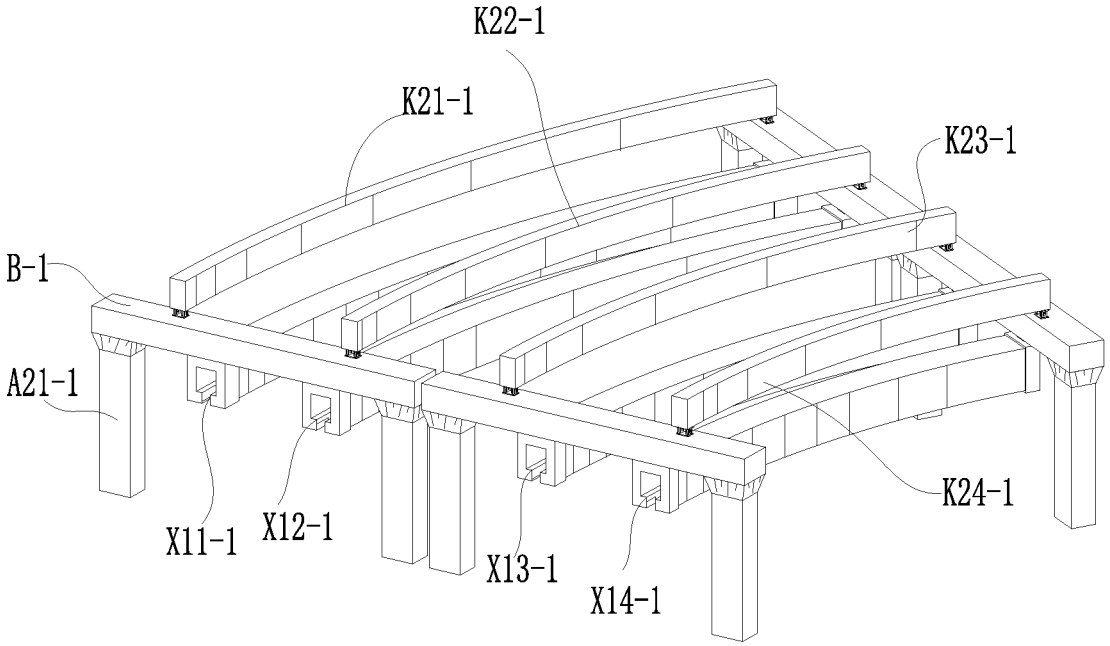

K22-1
K21-1
K23-1
B-1
A21-1
K24-1
X11-1
X12-1
X13-1
X14-1

FIG. **2**

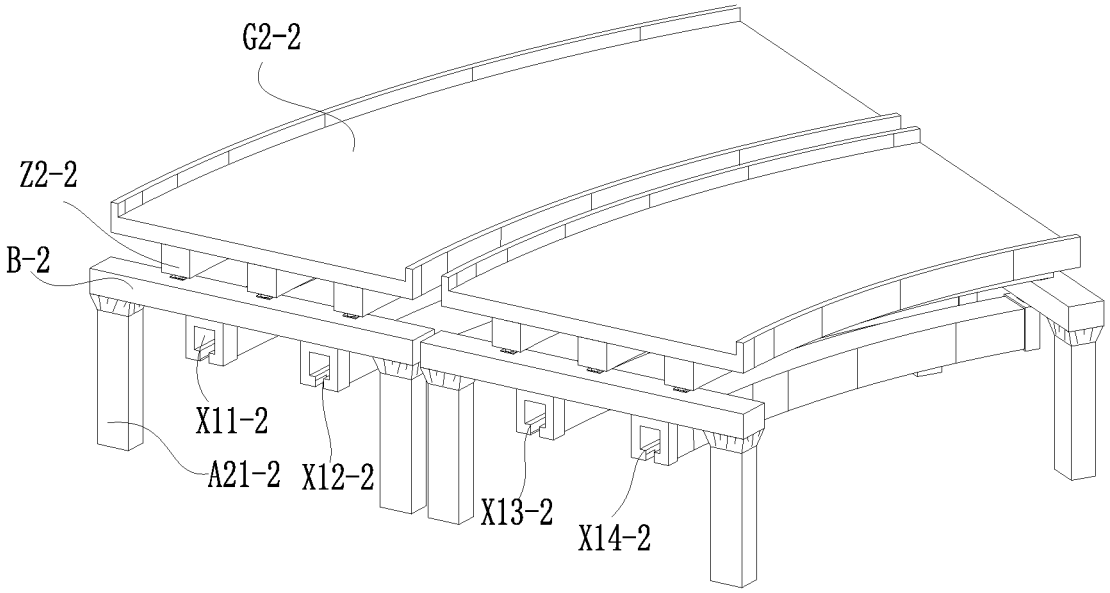

G2-2
Z2-2
B-2
X11-2
A21-2
X12-2
X13-2
X14-2

FIG. **3**

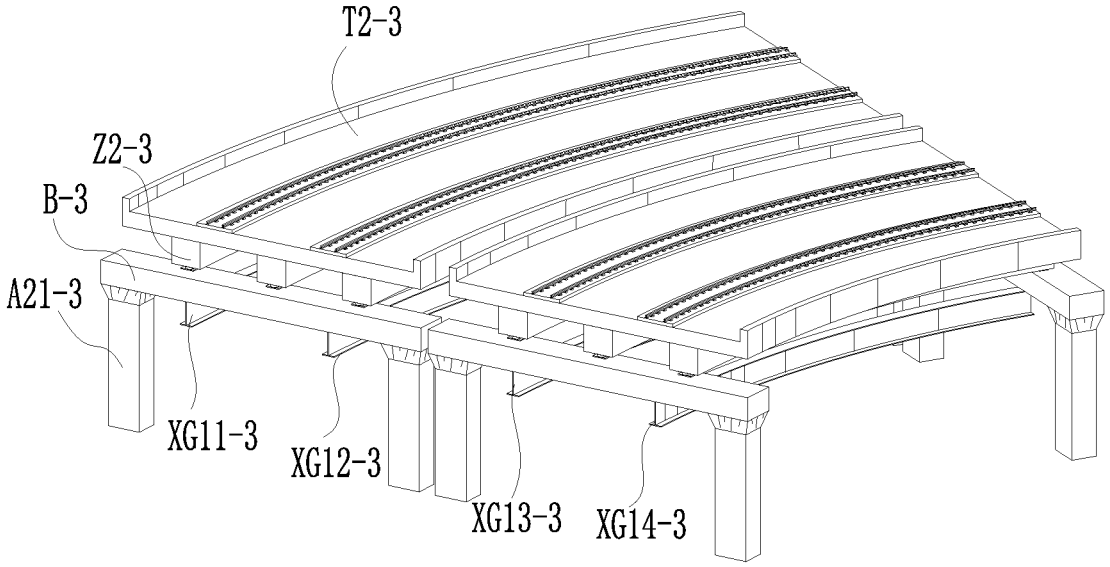

T2-3
Z2-3
B-3
A21-3
XG11-3
XG12-3
XG13-3
XG14-3

FIG. **4**

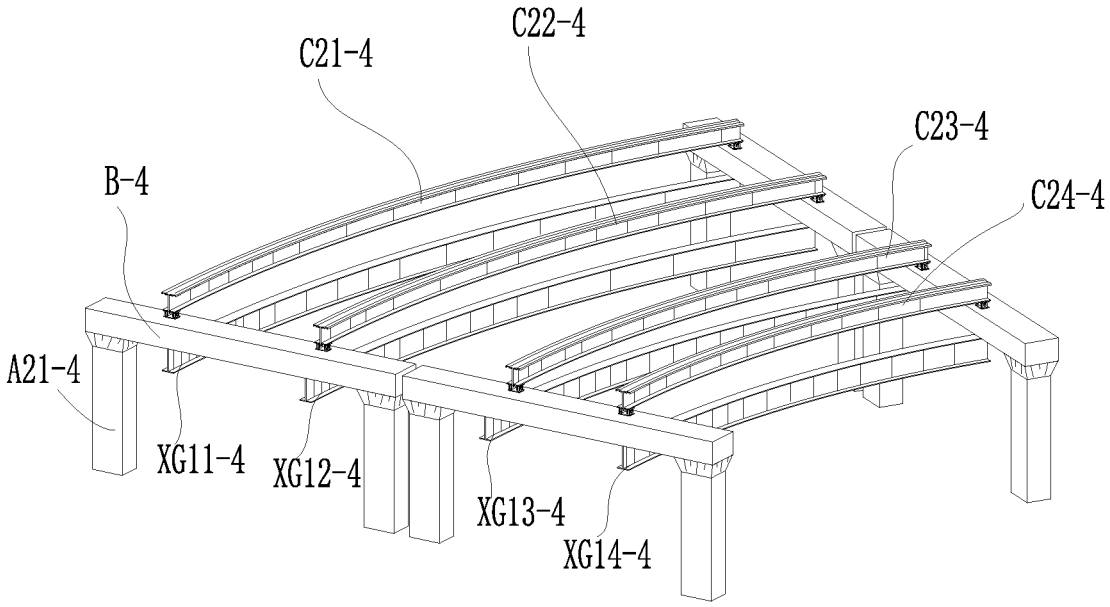

C22-4
C21-4
C23-4
B-4
C24-4
A21-4
XG11-4
XG12-4
XG13-4
XG14-4

FIG. **5**

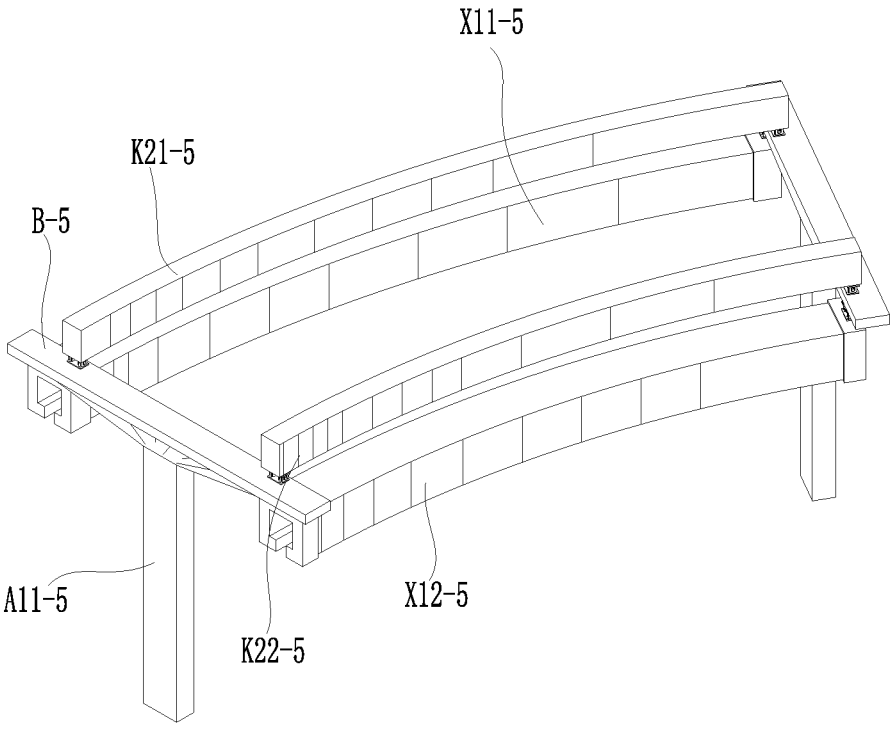

X11-5
K21-5
B-5
A11-5
K22-5
X12-5

FIG. **6**

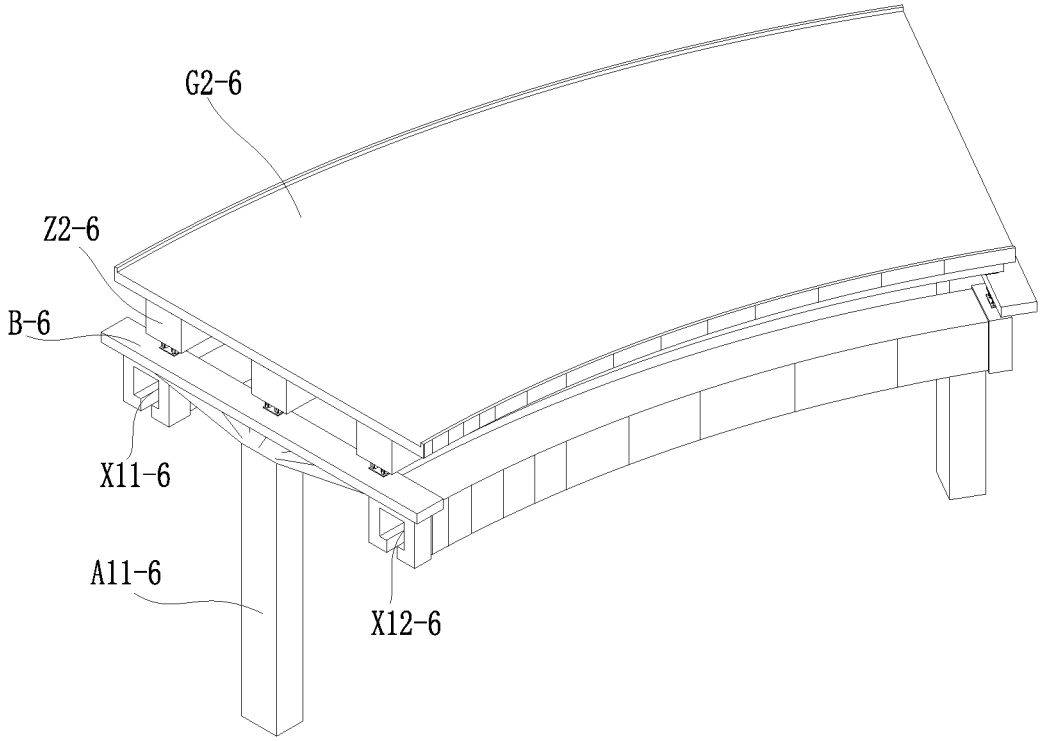


FIG. 7

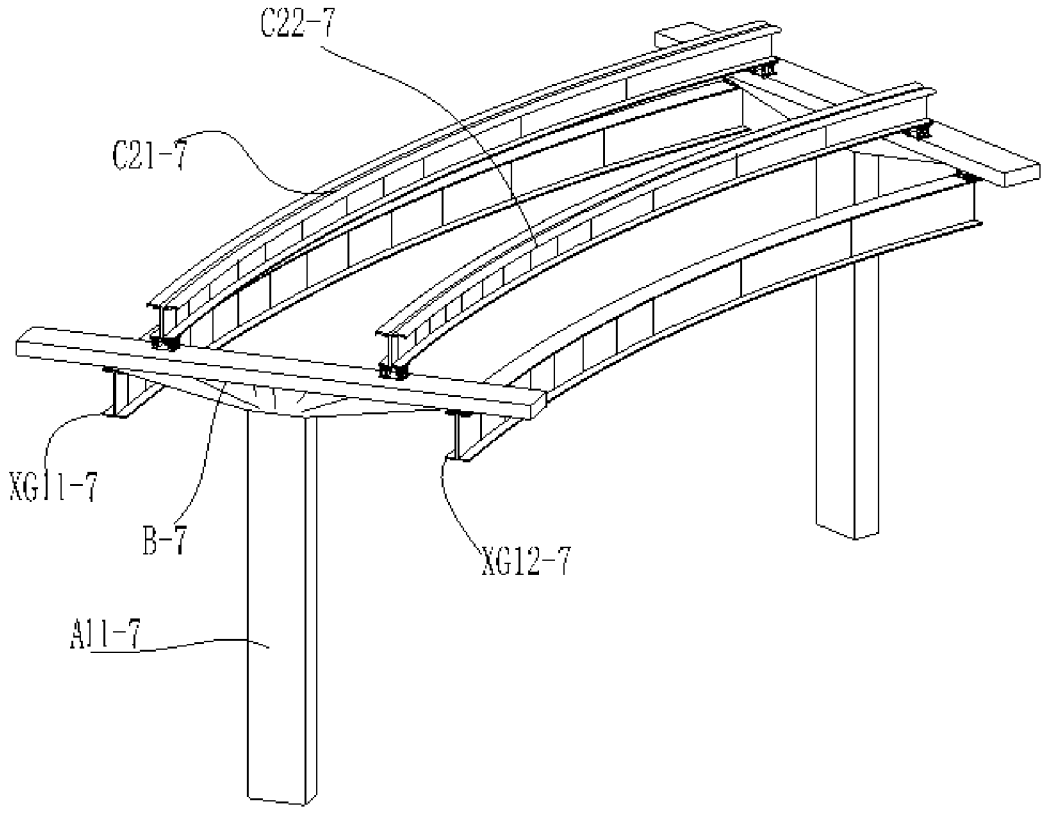


FIG. 8

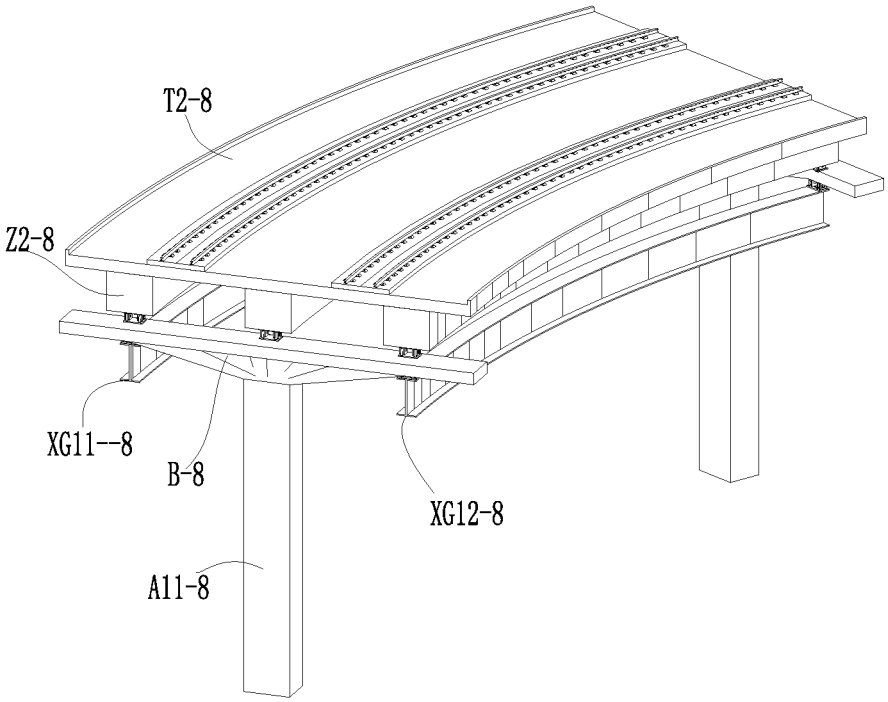

T2-8
Z2-8
XG11--8
B-8
XG12-8
A11-8

FIG. **9**

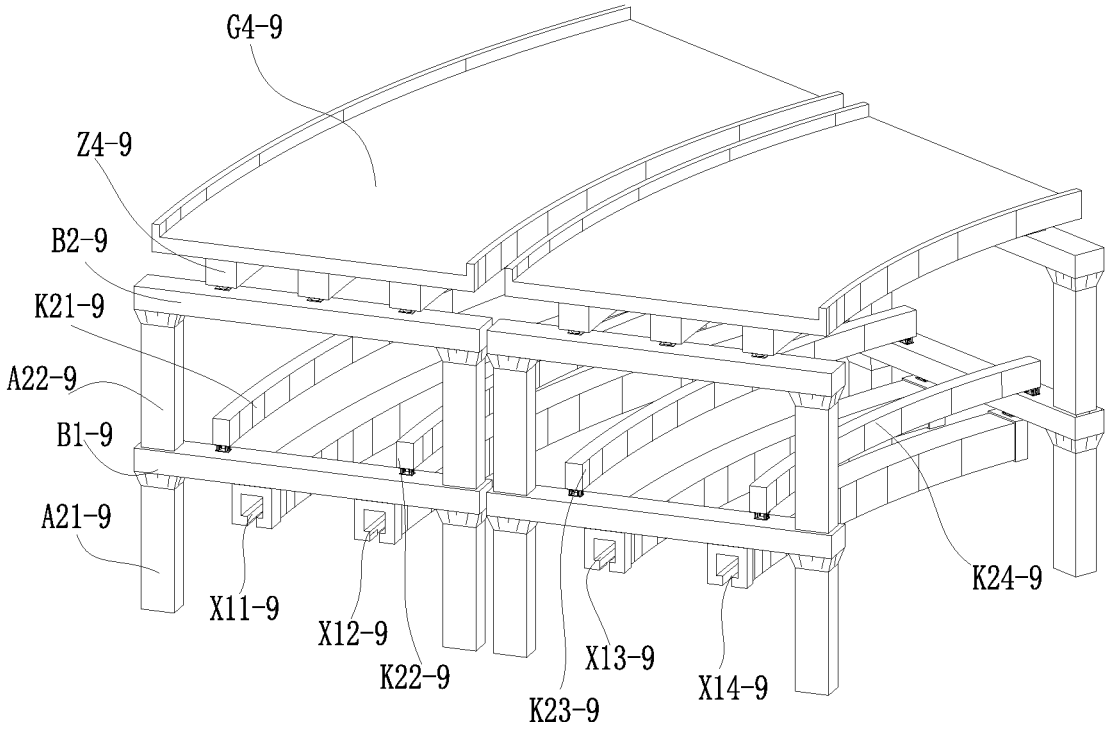

G4-9
Z4-9
B2-9
K21-9
A22-9
B1-9
A21-9
X11-9
X12-9
K22-9
K23-9
X13-9
X14-9
K24-9

FIG. **10**

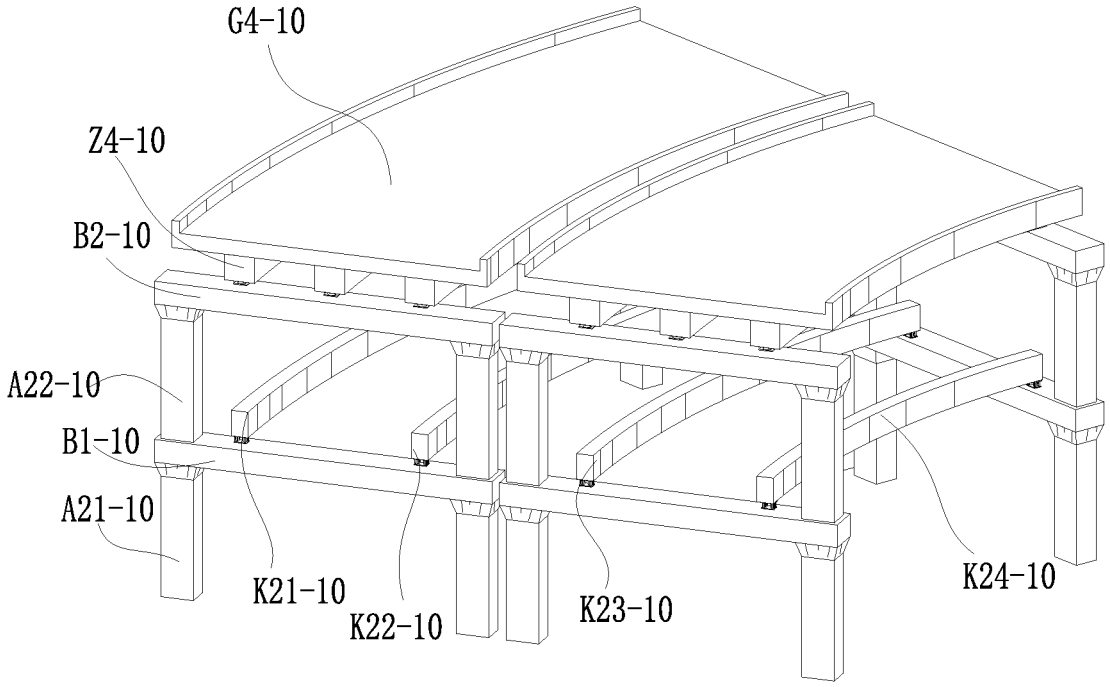

G4-10
Z4-10
B2-10
A22-10
B1-10
A21-10
K21-10
K22-10
K23-10
K24-10

FIG. **11**

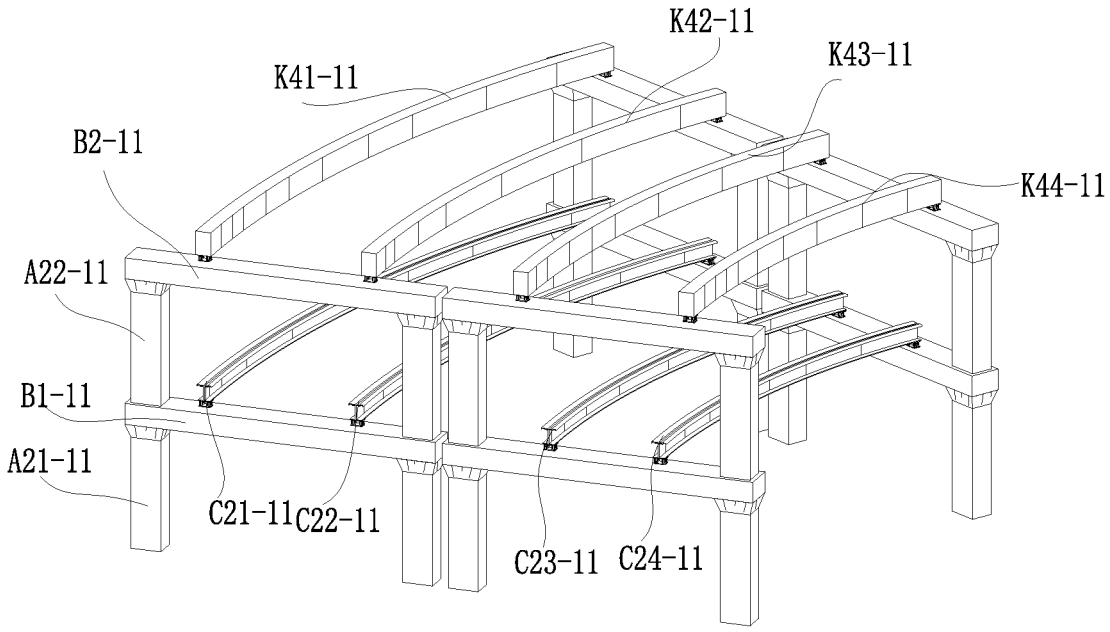

K42-11
K43-11
K41-11
B2-11
K44-11
A22-11
B1-11
A21-11
C21-11
C22-11
C23-11
C24-11

FIG. **12**

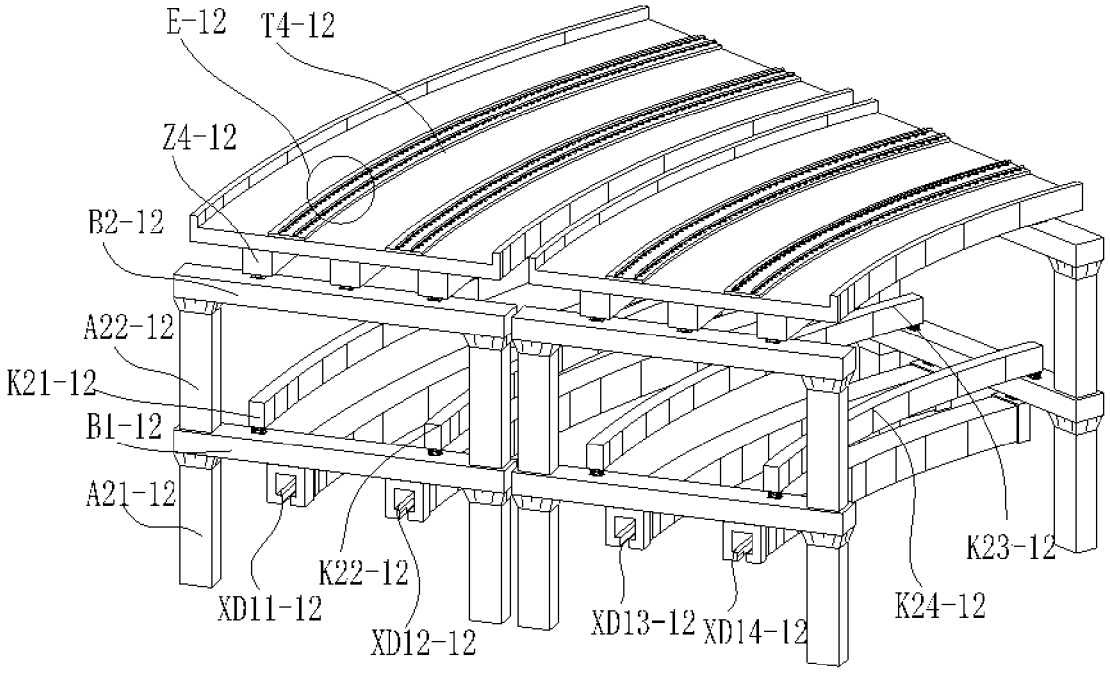

E-12
T4-12
Z4-12
B2-12
A22-12
K21-12
B1-12
A21-12
XD11-12
K22-12
XD12-12
XD13-12
XD14-12
K24-12
K23-12

FIG. **13**

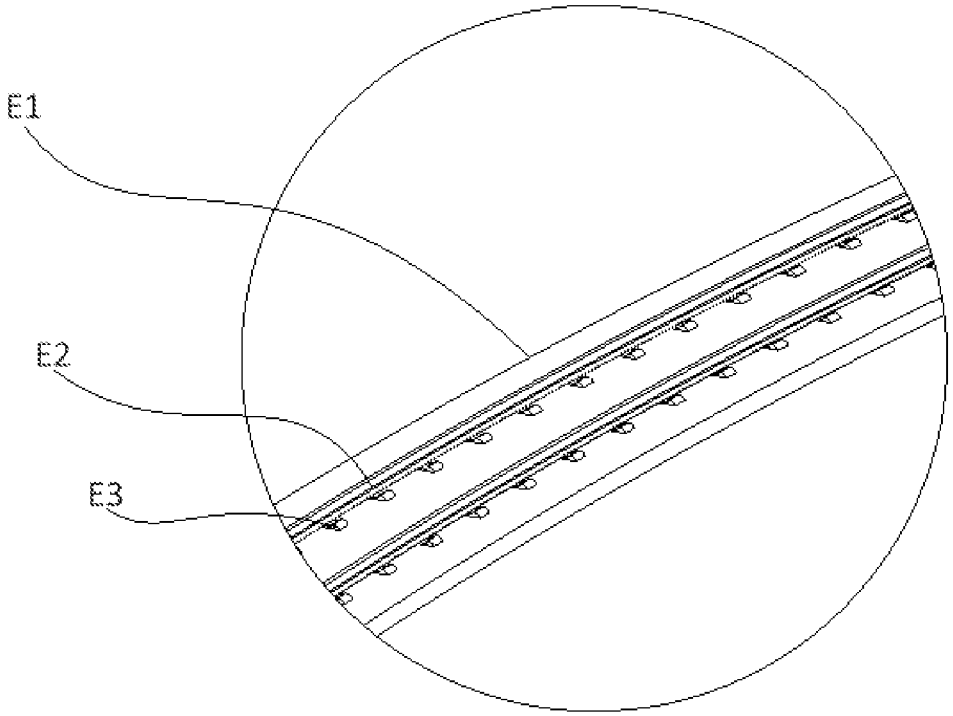

E1
E2
E3

FIG. **14**

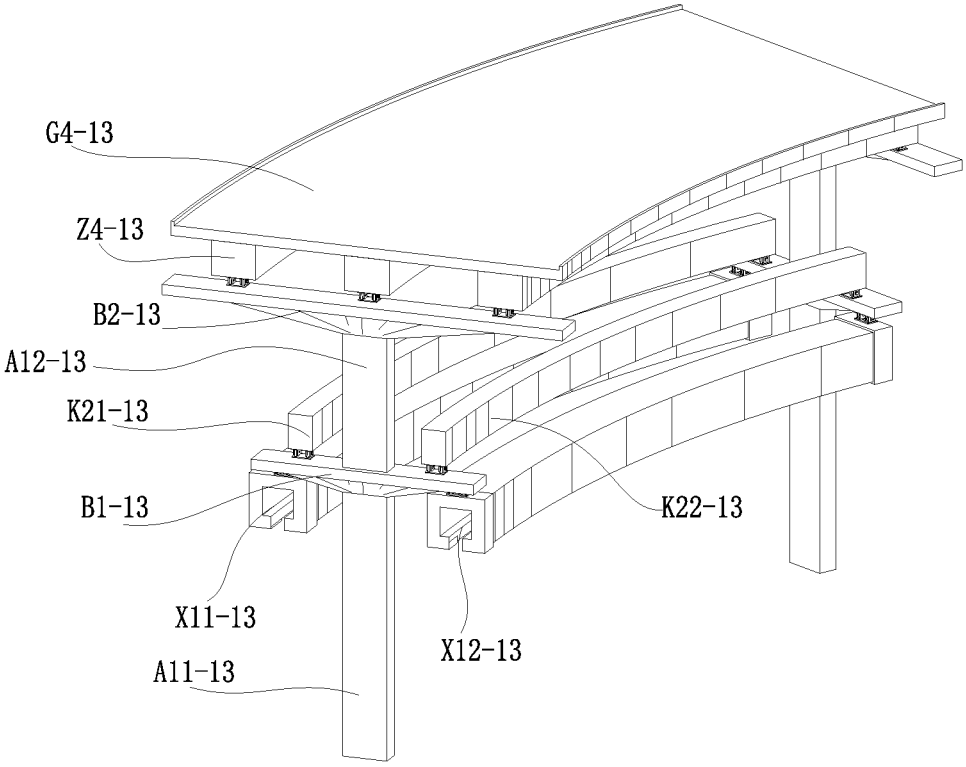

G4-13
Z4-13
B2-13
A12-13
K21-13
B1-13
K22-13
X11-13
X12-13
A11-13

FIG. **15**

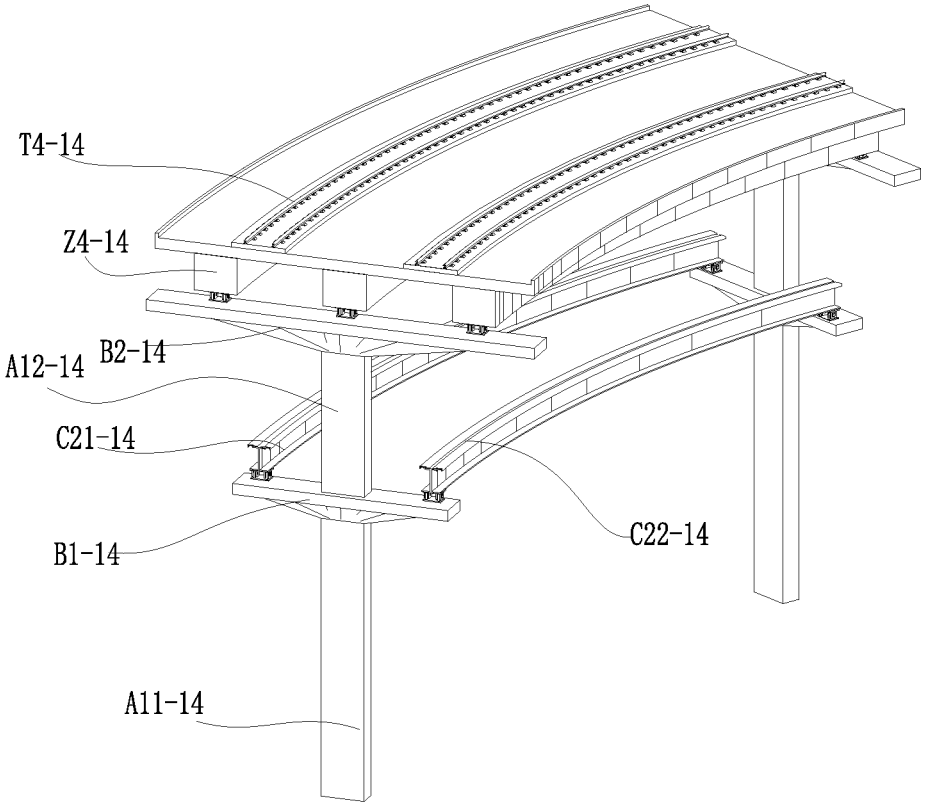

T4-14
Z4-14
A12-14
B2-14
C21-14
B1-14
C22-14
A11-14

FIG. **16**

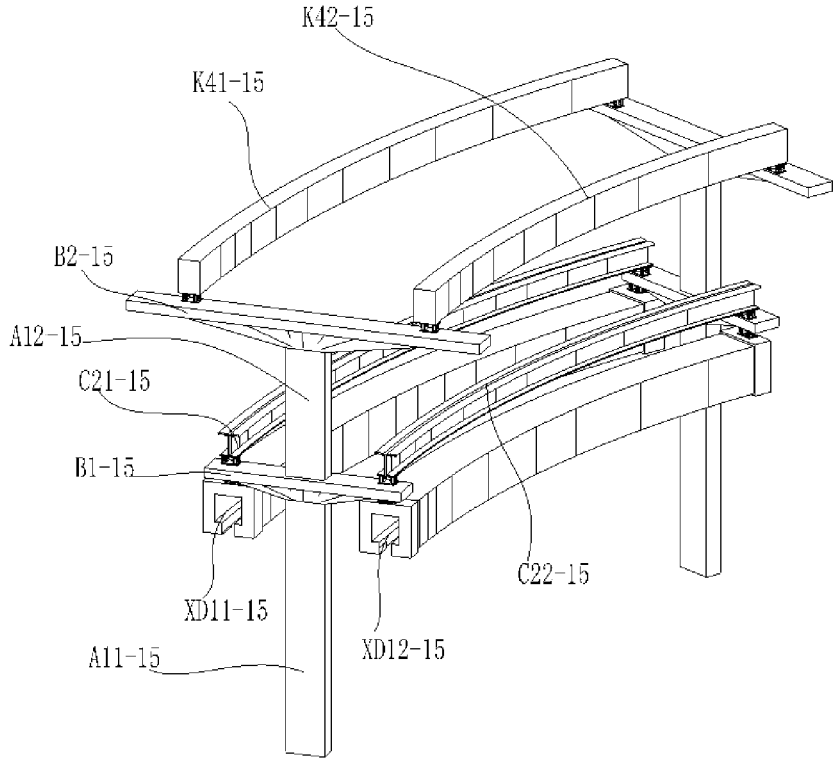

K42-15
K41-15
B2-15
A12-15
C21-15
B1-15
C22-15
XD11-15
XD12-15
A11-15

FIG. **17**

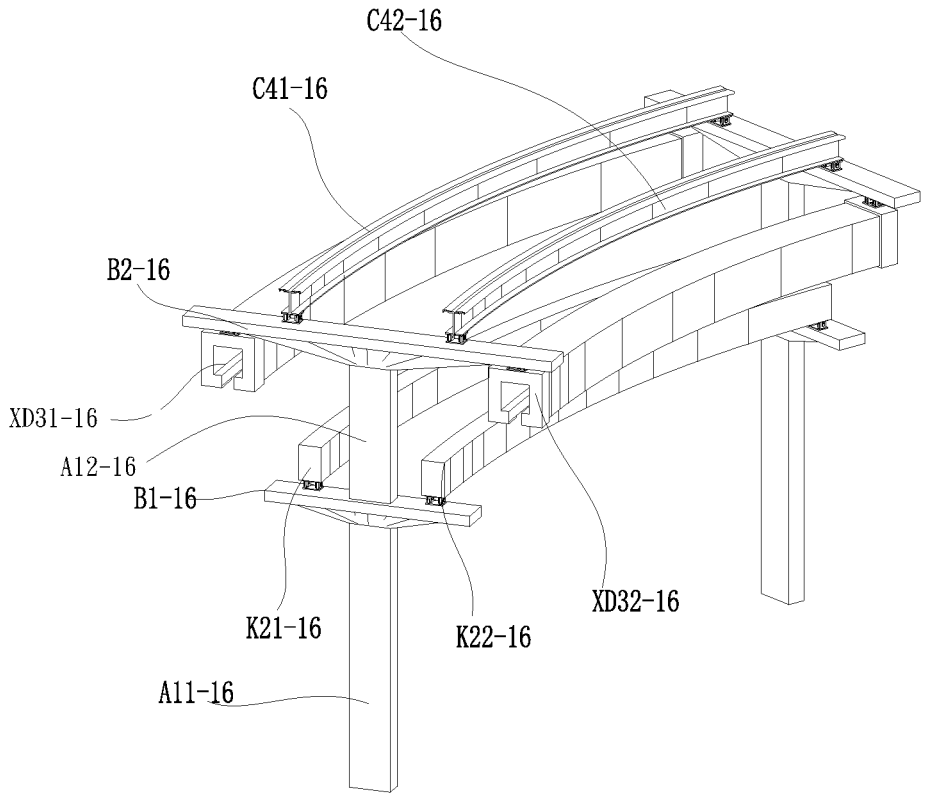

C42-16
C41-16
B2-16
XD31-16
A12-16
B1-16
XD32-16
K21-16
K22-16
A11-16

FIG. **18**

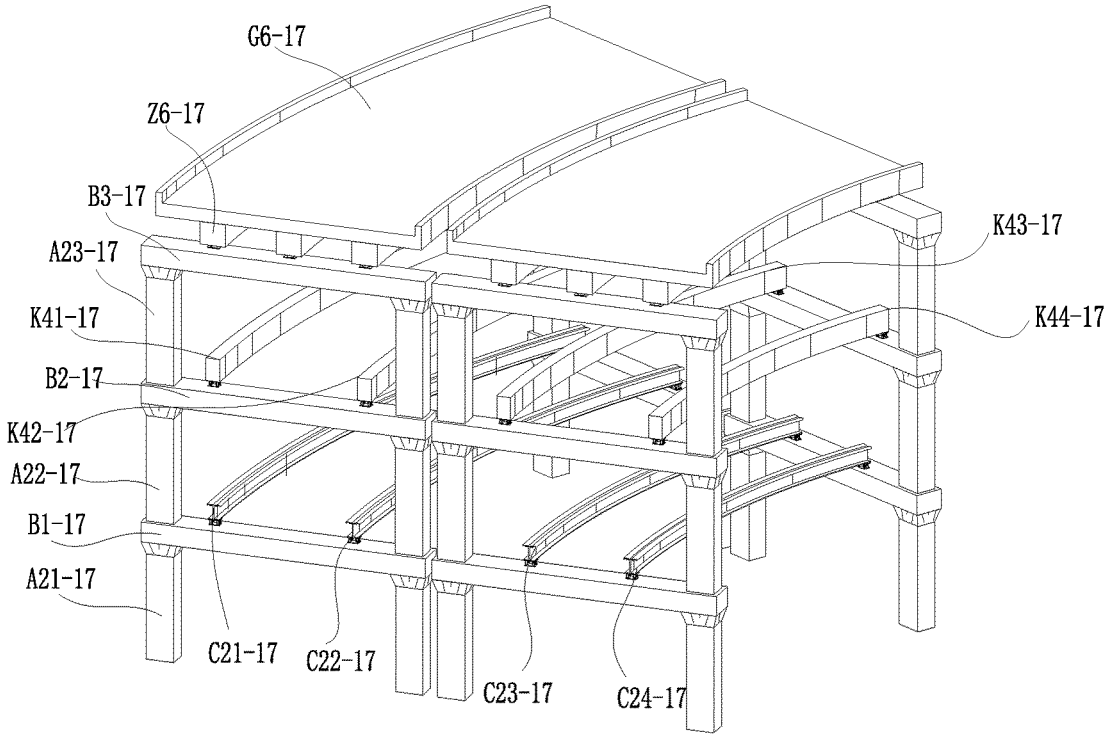

G6-17
Z6-17
B3-17
A23-17
K41-17
B2-17
K42-17
A22-17
B1-17
A21-17
C21-17
C22-17
C23-17
C24-17
K43-17
K44-17

FIG. **19**

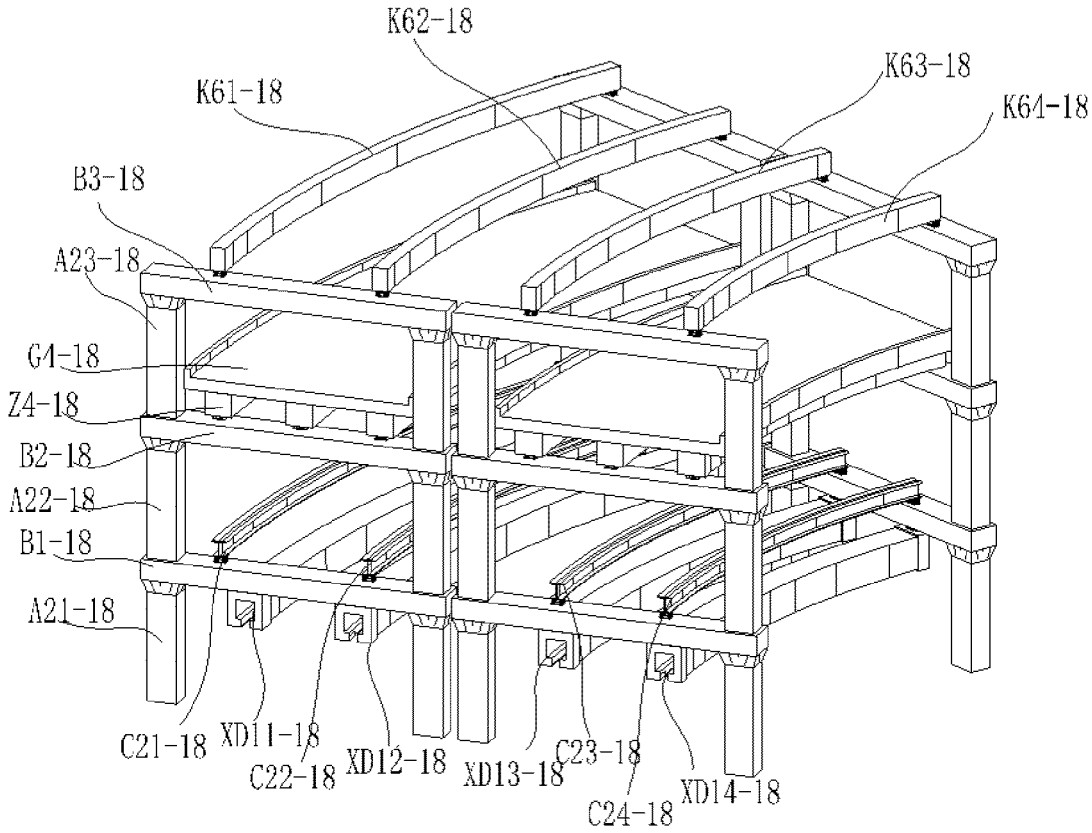

K62-18
K61-18
K63-18
K64-18
B3-18
A23-18
G4-18
Z4-18
B2-18
A22-18
B1-18
A21-18
C21-18
XD11-18
C22-18
XD12-18
XD13-18
C23-18
C24-18
XD14-18

FIG. **20**

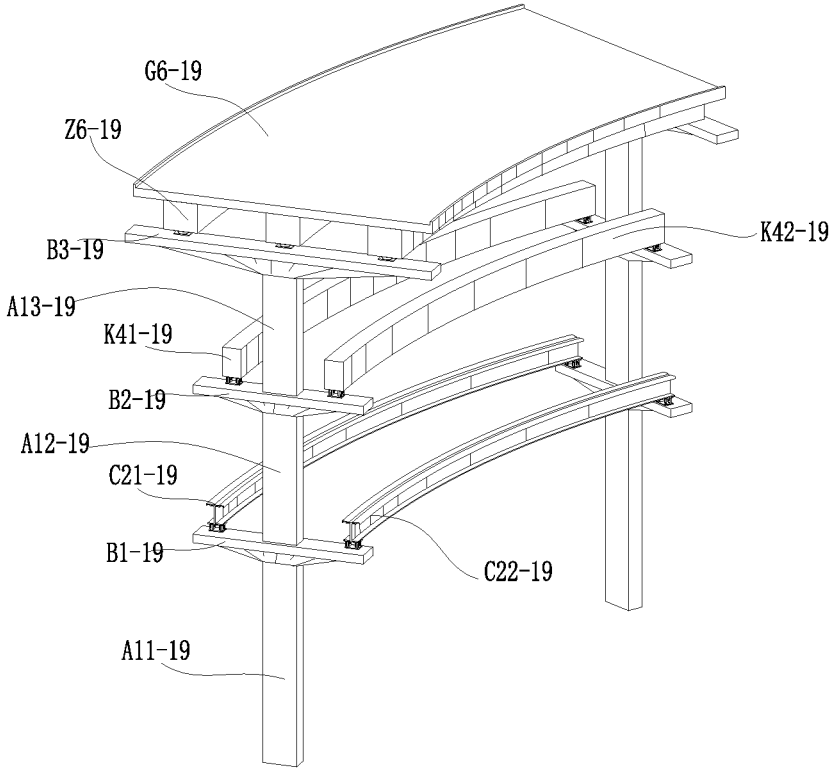

G6-19
Z6-19
K42-19
B3-19
A13-19
K41-19
B2-19
A12-19
C21-19
B1-19
C22-19
A11-19

FIG. **21**

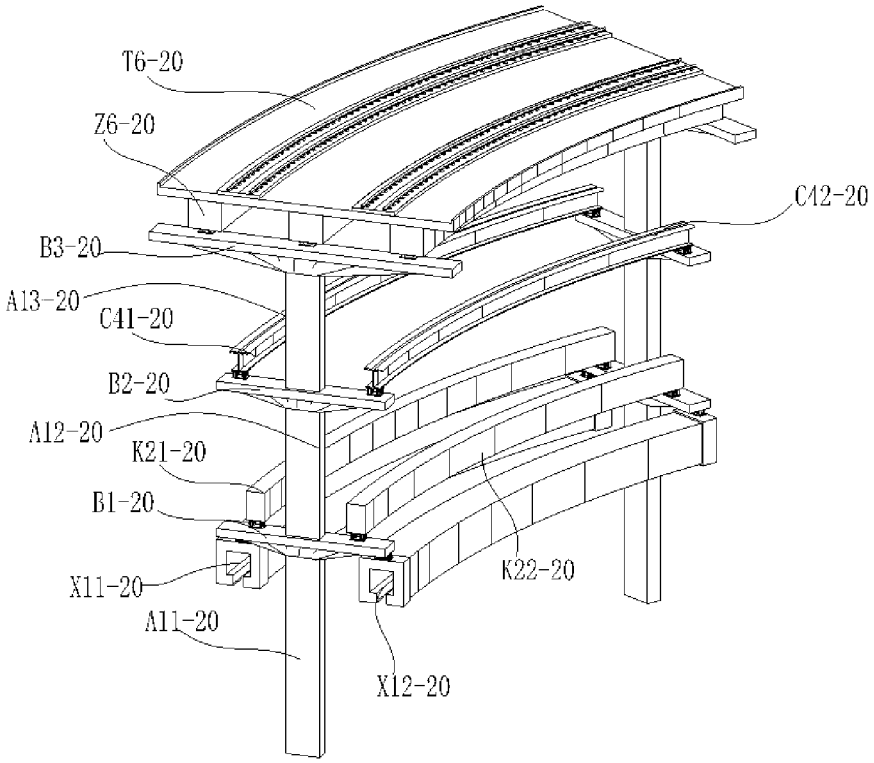

T6-20
Z6-20
C42-20
B3-20
A13-20
C41-20
B2-20
A12-20
K21-20
B1-20
K22-20
X11-20
A11-20
X12-20

FIG. **22**

MONORAIL TRANSPORTATION-BASED SPATIAL TRANSPORT SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a 371 of International Patent Application No. PCT/CN2019/104237 with a filing date of Sep. 3, 2019, designating the United States, now pending, and further claims priority to Chinese Patent Application No. 201811021460.7, filed on Sep. 3, 2018, No. 201811021471.5, filed on Sep. 3, 2018, No. 201811021472.X, filed on Sep. 3, 2018, No. 201811021615.7, filed on Sep. 3, 2018, No. 201811022979.7, filed on Sep. 3, 2018, No. 201811023547.8, filed on Sep. 3, 2018, 201811023550.X, filed on Sep. 3, 2018, the entire content of which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to a monorail transportation-based spatial transport system, which is applied to the field of monorail transportation.

BACKGROUND OF THE INVENTION

[0003] At present, the existing traffic system of monorail and viaduct system does not make full use of the ground and above-ground space, and the traffic form in the same load-bearing system is single. In the suspended monorail only the lower space of the rail beam is used, while in the viaduct system, and straddle monorail and maglev only the upper space are used. Therefore, the current traffic space layer is less. The space utilization rate is low. The passenger flow and the logistics transportation are mainly undertaken by the highway, and the efficiency is low.

[0004] In view of the above problems, combined with a large number of tests and experiments of the applicants, from the perspective of making full use of three-dimensional space and improving the efficiency of passenger logistics, a theoretical analysis is made, and finally a space transport system based on monorail transportation is proposed.

[0005] The terms involved in this patent are defined as follows:

[0006] Layer: Layer of structure obtained by layering space.

[0007] Lower-layer space: A lower-layer space mentioned in this patent refers to the transportation space within the load-bearing frame system or the load-bearing pier system.

[0008] Traffic: A traffic mentioned in this patent refers to the traffic formed by combining roadway traffic and railway traffic in the same frame or pier system based on monorail traffic.

[0009] Monorail transportation: A rail transit in which vehicles are carried and guided by only one rail beam during operation, comprising suspended monorail transportation, straddle monorail transportation, and maglev.

[0010] Other traffic: Other traffic forms mentioned in this patent refers to roadway traffic and railway traffic.

[0011] Single-mode transportation: A single-mode transportation described in this patent refers to only any one of straddle monorail transportation, suspended monorail transportation, and maglev in the same load-bearing frame or pier system.

[0012] Multi-mode transportation: A multi-mode transportation mentioned in this patent refers to monorail transportation with multiple transportation forms in the same load-bearing frame or pier system, or a combination of one or more monorail transportation types and other transportation forms.

[0013] Traffic mode: A traffic mode described in this patent comprises single-mode traffic and multi-mode traffic.

[0014] Logistics: Refer to a transportation of goods from one place to another.

[0015] Passenger flow: Refer to a transportation of passengers from one place to another.

[0016] Logistics track: Monorail transportation specially used for logistics transportation.

[0017] Passenger track: Monorail transportation specially used for passenger transportation.

[0018] Suspended guideways: Comprise bottom-open steel box suspended guideways, bottom-open concrete suspended guideways, I-shaped steel suspended guideways and steel-concrete composite suspended guideways.

[0019] Maglev guideway: Comprise steel box maglev guideways, concrete maglev guideways, I-shaped steel maglev guideways and steel-concrete combined maglev guideways.

[0020] Straddle guideways: Comprise steel box straddle guideways, concrete straddle guideways, steel-concrete composite straddle guideways.

[0021] Load-bearing frame system: Refer to a portal-type frame structure supporting the monorail transportation guideway structure and other transportation structures, comprising single-story frame piers and single-story frame bent caps, double-story frame piers and double-story frame bent caps, and three-story frame piers and three-story frame bent caps.

[0022] Load-bearing pier system: Refer to a pier system supporting a monorail transportation guideway structure and other traffic structures, comprising single-story piers and single-story bent caps, double-story piers and double-story bent caps, three-story piers and three-story bent caps.

[0023] Frame pier: A lower bearing column of the portal-type frame structure, comprising single-story frame piers, double-story frame piers, and three-story frame piers.

[0024] Bent cap: A supporting beam on the top surface of the pier system or the frame beam on the top surface of the frame pier is collectively called the bent cap, comprising the single-story frame bent cap, the double-story frame bent cap, the three-story frame bent cap, the single-story pier system bent cap, the double-story pier system bent cap, and the three-story pier system bent cap.

SUMMARY OF THE INVENTION

[0025] The problem to be solved by this patent is to provide a monorail transportation-based spatial transport system, by installing one or more monorail transportation forms in the same frame system or the same pier system, or installing one or more monorail transportations and other transportation forms to realize the full use of the three-dimensional space of the road and improve the efficiency of roadway traffic operation. Current problems such as intensive roadway traffic congestion, urban roads that are insufficient to bear the increasing traffic volume, low three-dimensional space utilization, low passenger flow and logistics operation efficiency will be solved by using this patent.

[0026] The solution adopted by this patent to solve its problem is: a monorail transportation-based spatial transport

system wherein a load-bearing frame system or a load-bearing pier system are included in the space transportation system. The spatial transport system is divided into at least two layers by bent caps by the load-bearing frame system and the load-bearing pier system. Odd-numbered layers below the bent caps and even number layers above the bent caps are included in the at least two layers. The suspended monorail transportation or no suspended monorail transportation are included in the odd-numbered layers, and the straddle monorail transportation, maglev, roadway traffic and railway traffic, or no monorail transportation and other transportation are included in the even-numbered layers. Two or more types of monorail transportation, or a combination of one or more types of monorail transportations and other transportation forms are included in the space transport system.

[0027] The above-mentioned monorail transportation-based spatial transport system is a system where a single-story frame, a double-story frame or a three-story frame is included in the load-bearing frame system.

[0028] The above-mentioned monorail transportation-based spatial transport system is a system where first piers and first-story frame bent caps are included in the single-story frame. The first piers, second piers, first-story frame bent caps, and second-story frame bent caps are included in the double-story frame. The first piers, the second piers, the third-story frame piers, the first-story frame bent caps, the second-story frame bent caps and third-story frame bent caps are included in the three-story frame. The first piers and the first-story frame bent caps of the first-story are fixed together. The lower part of the second piers and the first-story frame bent caps are fixed together. The upper part of the second piers and the second-story frame bent caps are consolidated together. The lower part of the third-story frame piers and the second-story frame bent caps are consolidated together, and the upper part of the third-story frame piers and the third-story frame bent caps are consolidated together.

[0029] The above-mentioned monorail transportation-based spatial transport system is a system where the guideways of the suspended monorail traffic in the odd-numbered layers of the load-bearing frame system are connected under the frame bent caps by bearings; the guideways of straddle monorail or maglev traffic in the even-numbered layers are supported above the frame bent caps by bearings. The bridge decks of roadway traffic or railway traffic in the even-numbered layers of the load-bearing frame system are supported by longitudinal beams above the frame bent caps.

[0030] The above-mentioned monorail transportation-based spatial transport system is a system where a single-story pier system, a double-story pier system or a three-story pier system are included in the load-bearing pier system.

[0031] The above-mentioned monorail transportation-based spatial transport system is a system where the first pier and the first-story bent caps are included in the single-story pier system. The first pier, the second piers, the first-story bent caps and the second-story bent caps are included in the double-story pier system. The first pier, the second piers, the third-story piers, the first-story bent caps, the second-story bent caps and the third-story bent caps are included in the three-story pier system. The first pier and the first-story bent caps are consolidated together. The lower part of the second piers and the first-story bent caps are consolidated together. The upper part of the second piers and the second-story bent caps are consolidated together. The lower part of the third-story piers and the second-story bent caps are consolidated together, and the upper part of the third-story piers and the third-story bent caps are consolidated together.

[0032] The above-mentioned monorail transportation-based spatial transport system is a system where the guideways of suspended monorail traffic in the odd-numbered layers of the load-bearing pier system are connected under the bent cap by bearings. The straddle monorail guideway or maglev guideway in the even-numbered layers of the load-bearing pier system are supported above the bent caps by bearings. The bridge decks of roadway traffic or railway traffic in the even-numbered layers of the load-bearing pier system are supported by longitudinal beams above the bent caps.

[0033] Compared with the prior patents, the beneficial effects of the present patent are:

[0034] 1. The layer of roadway traffic is improved and the utilization rate of the vertical three-dimensional space of the road is increased.

[0035] In the current traffic construction, the vertical space utilization rate of viaduct system and surface roads is low. Only one side of the vertical space is used by ground roads or viaducts. In the development of transportation, the space above ground roads is not fully utilized.

[0036] In this patent, a monorail transportation-based spatial transport system is proposed, and the space is divided into multiple layers through a frame system or a pier system. Compared with the traditional overhead system, the upper and lower spaces of the frame bent caps or the pier bent caps can be effectively used by the space transport system based on monorail transportation, thus improving the traffic layer. Under the same road area, monorail transportation, highways or railways are located on the same section, just like the construction of high-rise buildings in the city. Passenger flow and logistics transportation capacity are increased by several times after making full use of the lower-layer space.

[0037] 2. The efficiency of transportation is improved and the ground transportation volume is shared.

[0038] With the increase in vehicles, the current roads are not enough to bear the increasing traffic flow. Ground traffic congestion leads to inefficient passage and prolongs the passage time, and the low-layer space of the road is not fully utilized.

[0039] In this patent, a monorail transportation-based spatial transport system is proposed, using a combination of two or more monorail transportation forms, or a combination of one or more monorail transportation forms and other transportation modes, sharing the transportation volume of ground and underground transportation, and improving traffic efficiency. The problems of ground traffic congestion, low driving efficiency and low utilization of low-layer traffic will be solved by this patent.

[0040] 3. Fast logistics channels will be built to increase logistics efficiency and logistics costs and time will be saved.

[0041] At present, logistics is mainly transported by ground vehicles, and transportation efficiency is affected by roadway traffic, which in turn also affects traffic conditions. In particular, normal traffic is affected by the parking and driving of various logistics vehicles that can be seen everywhere in the city, and the logistics efficiency is also low.

[0042] In this patent, a monorail transportation-based spatial transport system is proposed, using one or more layers

of transport spaces as logistics channels. On the one hand, the impact of ground logistics vehicles on traffic is reduced. On the other hand, the logistics transportation is accelerated, saving time and cost.

[0043] 4. Cost-effectiveness and sustainable development throughout the life cycle.

[0044] Multiple types of transportation on the same load-bearing frame system are combined in the monorail transportation-based spatial transport system described in this patent. From the perspective of life cycle cost analysis, its benefit is higher than that of ordinary ground road construction and the goal of sustainable development will be achieved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0045] FIG. **1** is a schematic diagram showing the principle of layering of a three-story frame structure.

[0046] FIG. **2** is a schematic diagram showing a single-story frame monorail transportation-based spatial transport system with suspended monorail on the first layer and straddle monorail on the second layer.

[0047] FIG. **3** is a schematic diagram showing a single-story frame monorail transportation-based spatial transport system with suspended monorail on the first layer and roadway traffic on the second layer.

[0048] FIG. **4** is a schematic diagram showing a single-story frame monorail transportation-based spatial transport system with I-shaped beam suspended guideways on the first layer and railway traffic on the second layer.

[0049] FIG. **5** is a schematic diagram showing a single-story frame monorail transportation-based spatial transport system with I-shaped suspended guideways on the first layer and maglev on the second layer.

[0050] FIG. **6** is a schematic diagram showing a single-story pier monorail transportation-based spatial transport system with suspended monorail on the first layer and straddle monorail on the second layer.

[0051] FIG. **7** is a schematic diagram showing a single-story pier monorail transportation-based spatial transport system with suspended monorail on the first layer and highway traffic on the second layer.

[0052] FIG. **8** is a schematic diagram showing a single-story pier monorail transportation-based spatial transport system with I-shaped suspended guideways on the first layer and maglev on the second layer.

[0053] FIG. **9** is a schematic diagram showing a single-story pier monorail transportation-based spatial transport system with I-shaped suspended guideways on the first layer and railway traffic on the second layer.

[0054] FIG. **10** is a schematic diagram showing a double-story frame monorail transportation-based spatial transport system with suspended monorail on the first layer, straddle monorail on the second layer, no transportation on the third layer, and roadway traffic on the fourth layer.

[0055] FIG. **11** is a schematic diagram showing a double-story frame monorail transportation-based spatial transport system with no traffic on the first layer, straddle monorail on the second layer, no traffic on the third layer, and roadway traffic on the fourth layer.

[0056] FIG. **12** is a schematic diagram showing a double-story frame monorail transportation-based spatial transport system with no traffic on the first layer, maglev on the second layer, no traffic on the third layer, and straddle monorail on the fourth layer.

[0057] FIG. **13** is a schematic diagram showing a double-story frame monorail transportation-based spatial transport system with bottom opening suspended guideways on the first layer, straddle monorail on the second layer, no traffic on the third layer, and the railway traffic on the fourth layer.

[0058] FIG. **14** is a record drawing of the railway track E-**12**.

[0059] FIG. **15** is a schematic diagram showing a double-story pier monorail transportation-based spatial transport system with suspended monorail on the first layer, straddle monorail on the second layer, no traffic on the third layer, and roadway traffic on the fourth layer.

[0060] FIG. **16** is a schematic diagram showing a double-story pier monorail transportation-based spatial transport system with no traffic on the first layer, maglev on the second layer, no traffic on the third layer, and railway traffic on the fourth layer.

[0061] FIG. **17** is a schematic diagram showing a double-story pier monorail transportation-based spatial transport system with bottom-opened suspended guideways on the first layer, maglev on the second layer, no traffic on the third layer, and straddle monorail on the fourth layer.

[0062] FIG. **18** is a schematic diagram showing a double-story pier monorail transportation-based spatial transport system with no traffic on the first layer, straddle monorail on the second layer, bottom-opened suspended guideways on the third layer, and maglev on the fourth layer.

[0063] FIG. **19** is a schematic diagram showing a three-story frame monorail transportation-based spatial transport system with no traffic on the first layer, maglev on the second layer, no traffic on the third layer, straddle monorail on the fourth layer, no traffic on the fifth layer, and roadway traffic on the sixth layer.

[0064] FIG. **20** is a schematic diagram showing a three-story frame monorail transportation-based spatial transport system with suspended monorail on the first layer, maglev on the second layer, no traffic on the third layer, roadway traffic on the fourth layer, on traffic on the fifth layer, and straddle monorail on the sixth layer.

[0065] FIG. **21** is a schematic diagram showing a three-story pier monorail transportation-based spatial transport system with no traffic on the first layer, maglev on the second layer, no traffic on the third layer, straddle monorail on the fourth layer, no traffic on the fifth layer, and roadway traffic on the sixth layer.

[0066] FIG. **22** is a schematic diagram showing a three-story pier monorail transportation-based spatial transport system with suspended monorail on the first layer, straddle monorail on the second layer, no traffic on the third layer, maglev on the fourth layer, no traffic on the fifth layer, and railway traffic on the sixth layer.

[0067] The following embodiments are not difficult for a technician in this field to understand the features and numbers in the figures, so they will not be repeated.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

[0068] The principle of this patent is explained in the following text.

[0069] Firstly, with reference to FIG. **1**, the principle of the three-story frame monorail transportation-based spatial transport system of this patent is demonstrated. Space is divided by the three-story frame into six layers: K**1**, K**2**, K**3**, K**4**, K**5**, and K**6**. Below a first-story bent cap B**1** is a first

layer K1; above a first-story bent cap B1 is a second layer K2; below a second-story bent cap B2 is a third layer K3; above the second-story bent cap B2 is a fourth layer K4; below a third-story bent cap B3 is a fifth layer K5; above the third-story bent cap B3 is a sixth story K6. A three-story frame is used to divide the space into six layers to increase the passenger flow and logistics quantity of the roadway section, and the passenger flow or logistics transport capacity of the roadway section is improved.

[0070] In terms of traffic modes, the new system has changed from a single-mode system to a multi-mode system. The traffic layer is improved. In a section of a spatial transport system, there are two or more traffic systems at the same time, thus improving the utilization rate of road space. The passenger and logistics capacity of the road section is

$$S = \sum_{j=1}^{3} s_j$$

[0071] When j=1、2、3, s_1 refers to the passenger and logistics capacity of highway traffic; s_2 refers to the passenger and logistics capacity of railway traffic; s_3 refers to the passenger and logistics capacity of monorail transportation.

[0072] In terms of passenger flow, the total passenger flow transportation capacity of a certain road section in the system is calculated according to the following formula:

$$Q = \sum_{i=1}^{6} q_i$$

[0073] When 1=1、2、3、4、5、6, q_1 is the passenger transportation capacity in the K1 layer; q_2 is the passenger transportation capacity in the K2 layer; q_3 is the passenger transportation capacity in the K3 layer; q_4 is the passenger transportation capacity in the K4 layer; q_5 is the passenger transportation capacity in the K5 layer; q_6 is the passenger transportation capacity in the K6 layer.

[0074] Compared with single-mode transportation, the passenger transportation capacity and efficiency will be improved by the six-layer multi-mode transportation formed by the three-story frame space transportation system based on monorail traffic.

[0075] In terms of logistics, the total logistics transportation capacity of a certain road section in the system is calculated according to the following formula:

$$W = \sum_{i=1}^{6} w_i$$

[0076] When i=1、2、3、4、5、6, w_1 is the transportation logistics capacity in the K1 layer; w_2 is the transportation logistics capacity in the K2 layer; w_3 is the transportation logistics capacity in the K3 layer; w_4 is the transportation logistics capacity in the K4 layer; w_5 is the transportation logistics capacity in the K5 layer; w_6 is the transportation logistics capacity in the K6 layer.

[0077] Compared with the single-mode transportation, logistics transportation capacity and efficiency will be improved in the six-layer multi-mode transportation formed by the three-story frame monorail transportation-based spatial transport system.

[0078] The principles and functions of the 6-layer multi-mode three-story frame monorail transportation-based spatial transport system enhancing the traffic layer and increasing passenger flow and logistics are summarized. Single-story frame, double-story frame, single-story pier, double-story pier, and three-story pier are included in the monorail transportation-based spatial transport system. In the same way, the space is divided into layers and the multi-mode transportation is combined into a single space system, which improves the transportation efficiency of passenger flow and logistics. The above working principle will not be repeated in the following embodiments.

[0079] In the following texts, the single-story frame monorail transportation-based spatial transport system will be described.

[0080] Embodiment 1: A single-story frame monorail transportation-based spatial transport system in which the suspended monorail is installed on the first layer and the straddle monorail installed on the second layer.

[0081] It is planned to build a single-story frame monorail transportation-based spatial transport system in a certain city, and set straddle monorail and suspended monorail on the same single-story load-bearing frame system. Among them, the first layer is to set up suspended monorail under frame bent caps, using bottom-opened concrete suspended guideways. The second layer is to set up straddle monorail above frame bent caps, using concrete straddle-type guideways. The suspended monorail is used as the logistics transportation mode and straddle monorail is used as the passenger transportation mode.

[0082] With reference to FIG. **2**, the single-story frame monorail transportation-based spatial transport system in which the suspended monorail is installed on the first layer and the straddle monorail installed on the second layer in this patent is demonstrated. A first outer line suspended guideway X**11-1**, a second outer line suspended guideway X**14-1**, a first inner line suspended guideway X**12-1**, a second inner line suspended guideway X**13-1**, a first outer line straddle guideway K**21-1**, a second outer line straddle guideway K**24-1**, a first inner line straddle guideway K**22-1**, a second inner line straddle guideway K**23-1**, a first pier A**21-1** and a first-story frame bent cap B-**1** are included in the single-story frame monorail transportation-based spatial transport system in which the suspended monorail is installed on the first layer and the straddle monorail installed on the second layer.

[0083] From the perspective of traffic layer, the single-story frame monorail transportation-based spatial transport system in which the suspended monorail is installed on the first layer and the straddle monorail transportation installed on the second layer is formed by a combination of two types of monorails. A two-layer space transportation system is formed by the single-story frame. The first layer is a suspended monorail under the bent caps, and the second layer is the straddle monorail above the bent caps.

[0084] From a structural point of view, the first pier A**21-1** and the first-story frame bent cap B-**1** are concreted and consolidated together. The upper and lower layers of the first-story frame bent cap B-**1** are provided with a suspended monorail transportation guideway and a straddle monorail guideway, respectively. The first outer line suspended guide-

way X11-1, the second outer line suspended guideway X14-1, the first inner line suspended guideway X12-1, and the second inner line suspended guideway X13-1 are the main load-bearing components and guiding structure of the suspended monorail. The first outer line suspended guideway X11-1, the second outer line suspended guideway X14-1, the first inner line suspended guideway X12-1, and the second inner line suspended guideway X13-1 are installed under the first pier A21-1 under the first-story frame bent cap B-1 of the first floor by bearings and are set as the rail for logistics channel. The first outer line straddle guideway K21-1, the second outer line straddle guideway K24-1, the first inner line straddle guideway K22-1 and the second inner line straddle guideway K23-1 are the main load-bearing and guiding structure of the straddle monorail. They are installed above the first-story frame bent cap B-1 of the first pier A21-1 by bearings and are set as the rail for passenger transportation.

[0085] From the perspective of passenger flow: two types of monorail transportation forms are set up in the same single-story frame system. With the increase in traffic layers, the efficiency of passenger flow in traffic is improved; low-layer space for passenger flow transportation is efficiently used; ground road congestion will be reduced; and the passenger flow that straddle monorail transportation in the single-story frame system can bear will be increased.

[0086] In terms of logistics, in the multi-mode and multi-layer transportation system the efficiency and capacity of logistics transportation is improved and the congestion of ground logistics vehicles is avoided. The logistics transportation volume that the suspended monorail in the single-story frame system can bear is also increased.

[0087] According to the above analysis, the three-dimensional space of the road is fully used in the single-story frame monorail transportation-based spatial transport system in which the suspended monorail is installed on the first layer and the straddle monorail installed on the second layer, thereby dispersing the road ground passenger flow, reducing vehicle congestion, speeding up road logistics efficiency, reducing logistics costs, and reducing the impact of ground logistics vehicles on roadway traffic. At the same time, a multi-functional integrated transportation system of straddle-type monorail transportation and suspended monorail transportation will be realized, speeding up passenger logistics operation efficiency and reducing urban construction costs.

[0088] Embodiment 2: A single-story frame monorail transportation-based spatial transport system in which the suspended monorail is installed on the first layer and the highway traffic installed on the second layer.

[0089] It is planned to build a single-story frame monorail transportation-based spatial transport system in which the suspended monorail is installed on the first layer and the highway traffic installed on the second layer between two cities. Among them, the first layer is the suspended monorail under frame bent caps, and the steel box suspended guideway with the bottom opening is adopted. The second layer is the highway traffic above frame bent caps. It is proposed to use the outer guideway of the suspended monorail as the passenger track and the inner guideway as the logistics track.

[0090] With reference to FIG. **3**, the single-story frame monorail transportation-based spatial transport system in which the suspended monorail is installed on the first layer and the roadway traffic installed on the second layer in this patent is demonstrated. A first outer line suspended guideway X11-2, a second outer line suspended guideway X14-2, a first inner line suspended guideway X12-2, a second inner line suspended guideway X13-2, a first pier A21-2, a first-story frame bent cap B-2, a longitudinal beam Z2-2 and a highway carriageway board G2-2 are included in the single-story frame monorail transportation-based spatial transport system in which the suspended monorail is installed on the first layer and the roadway traffic installed on the second layer.

[0091] From the perspective of traffic layer, the monorail transportation-based spatial transportation system is formed by a combination of suspended monorail and highway traffic. A two-layer space transportation system is formed by the single-story frame. The first layer is the suspended monorail traffic under the frame bent caps, and the second layer is the highway traffic above the bent caps.

[0092] From the structural point of view, the first pier A21-2 and the first-story frame bent cap B-2 are concreted and consolidated together. The upper and lower layers of the first-story frame bent cap B-2 are provided with roadway traffic and suspended monorail traffic guideways, respectively. The first outer line suspended guideway X11-2, the second outer line suspended guideway X14-2, the first inner line suspended guideway X12-2, and the second inner line suspended guideway X13-2 are the main load-bearing components and guiding structures of the suspended monorail. They are installed under the first-story frame bent cap B-2 of the first pier A21-2 through bearings. The first outer line suspended guideway X11-2 and the second outer line suspended guideway X14-2 are set as passenger rails; and the first inner line suspended guideway X12-2 and the second inner line suspended guideway X13-2 are set as rails for logistics channels. The longitudinal beam Z2-2 is set above the bent cap to support the road. The carriageway board G2-2 is used for the operation of the upper roadway traffic system.

[0093] From the perspective of passenger flow: suspended monorail traffic and highway traffic are set up in the same single-story frame system. With the increase in traffic layers, the efficiency of passenger flow in traffic is improved; low-layer space for passenger flow transportation is efficiently used; ground road congestion will be reduced; and the passenger flow that straddle monorail transportation in the two-layer single-story frame system can bear will be increased.

[0094] In terms of logistics, in the multi-mode and multi-layer transportation system the efficiency and capacity of logistics transportation is improved and the congestion of ground logistics vehicles is avoided. The logistics transportation volume that the suspended monorail in the two-layer single-story frame system can bear is also increased.

[0095] According to the above analysis, the three-dimensional space of the road is fully used in the space transportation system based on monorail traffic that uses a single-story frame with suspended monorail traffic on the first layer and roadway traffic on the second layer, thereby dispersing the road ground passenger flow, reducing vehicle congestion, speeding up road logistics efficiency, reducing logistics costs, and reducing the impact of ground logistics vehicles on roadway traffic. At the same time, a multi-functional integrated transportation system of roadway traffic and sus-

pended monorail transportation will be realized, speeding up passenger logistics operation efficiency and reducing urban construction costs.

[0096] Embodiment 3: A single-story frame monorail transportation-based spatial transport system in which the I-shaped suspended guideway is installed on the first layer and the railway traffic installed on the second layer.

[0097] It is planned to build a single-story frame monorail transportation-based spatial transport system in which the I-shaped suspended guideway is installed on the first layer and the railway traffic installed on the second layer in a certain city, and set up suspended monorail and railway traffic on the same single-story load-bearing frame system. Among them, the first layer, that is, under the frame bent caps of the first layer, is provided with suspended monorail, using I-shaped steel suspended guideways. The second layer, that is, above the first layer of frame bent caps, is provided with railway traffic. It is proposed to set the outer guideway of the suspended monorail as the passenger track, and the inner guideway as the logistics track.

[0098] With reference to FIG. **4**, a single-story frame monorail transportation-based spatial transport system in which the I-shaped suspended guideway is installed on the first layer and the railway traffic installed on the second layer is described in this patent. A first outer line I-shaped suspended guideway XG**11-3**, a second outer line I-shaped suspended guideway XG**14-3**, a first inner line I-shaped suspended guideway XG**12-3**, a second inner line steel suspended type guideway XG**13-3**, a first pier A**21-3**, a first-story frame bent cap B-**3**, a longitudinal beam Z**2-3**, and a railway carriageway T**2-3** are included in the above-mentioned system.

[0099] From the perspective of traffic layer, the single-story frame monorail transportation-based spatial transport system is a combination of suspended monorail and railway traffic. A two-layer space transportation system is formed in the single-story frame. The first layer is the suspended monorail transportation under the frame bent caps of the first layer, and the railway traffic is set up on the second layer.

[0100] From the structural point of view, the first pier A**21-3** and the first-story frame bent cap B-**3** are concreted and consolidated together. The upper and lower layers of the frame bent cap B-**3** are provided with railway and suspended monorail traffic guideways, respectively. The first outer line I-shaped beam suspended guideway XG**11-3**, the second outer line I-shaped beam suspended guideway XG**14-3**, the first inner line I-shaped beam suspended guideway XG**12-3** and the second inner line I-shaped beam suspended guideway XG**13-3** are the main load-bearing and guiding structures of the suspended monorail. They are installed under the first frame bent cap B-**3** of the first pier A**21-3** by bearings. The first outer line I-shaped steel suspended guideway XG**11-3** and the second outer line I-shaped suspended guideway XG**14-3** are set as passenger rails for passenger flow channels; the first inner line I-shaped suspended guideway XG**12-3** and the second inner line I-shaped beam suspended guideway XG**13-3** are set as the rail for logistics channel. The longitudinal beam Z**2-3** is set above the bent caps to support the railway carriageway T**2-3** for the operation of the upper railway traffic.

[0101] From the perspective of passenger flow: suspended monorail transportation and railway traffic are set up in the same single-story frame system. With the increase in traffic layers, the efficiency of passenger flow in traffic is improved; low-layer space for passenger flow transportation is efficiently used; ground road congestion will be reduced; and the passenger traffic that can be undertaken by railway traffic and monorail traffic in the two-layer single-story frame system will be increased.

[0102] In terms of logistics, with the installation of logistic rails, the efficiency of road logistics and avoid the congestion of ground logistics vehicles will be improved. And the logistics transportation capacity and the logistics transportation volume that railway traffic and monorail transportation in the two-layer single-story frame structure can bear will be increased.

[0103] According to the above analysis, the three-dimensional space is fully used in the single-story frame monorail transportation-based spatial transport system in which the I-shaped suspended guideway is installed on the first layer and the railway traffic installed on the second layer, thereby dispersing ground passenger flow and reducing congestion of vehicles, speeding up logistics efficiency, reducing logistics costs, and reducing the impact of ground logistics vehicles on roadway traffic. At the same time, a multi-mode transportation system comprising railway traffic and suspended monorail will be formed to speed up passenger logistics operation efficiency and reduce urban construction costs.

[0104] Embodiment 4: A single-story frame monorail transportation-based spatial transport system in which the I-shaped suspended guideway is installed on the first layer and the maglev installed on the second layer.

[0105] It is planned to build a single-story frame monorail transportation-based spatial transport system in which the I-shaped suspended guideway is installed on the first layer and the maglev installed on the second layer in a certain city, and set up suspended monorail and maglev on the same single-story load-bearing frame system. Among them, the first layer is provided with suspended monorail under the frame bent caps, using I-shaped steel suspended guideways. The second layer is equipped with maglev above the first layer frame bent caps, using I-shaped steel maglev beam. It is planned to set the suspended monorail as the logistics rail and the maglev as the passenger rail.

[0106] With reference to FIG. **5**, A single-story frame monorail transportation-based spatial transport system in which the I-shaped suspended guideway is installed on the first layer and the maglev installed on the second layer is described in this patent. A first outer line I-shaped suspended guideway XG**11-4**, a second outer line I-shaped suspended guideway XG**14-4**, a first inner line I-shaped suspended guideway XG**12-4**, a second inner line I-shaped suspended guideway XG**13-4**, a first outer line maglev guideway C**21-4**, a second outer line maglev guideway C**24-4**, a first inner line maglev guideway C**22-4**, a second inner line maglev guideway C**23-4**, a first pier A**21-4**, and the first-story frame bent cap B-**4** are included in the single-story frame monorail transportation-based spatial transport system in which the I-shaped suspended guideway is installed on the first layer and the maglev installed on the second layer.

[0107] From the perspective of traffic layer, maglev and suspended monorail are included in the single-story frame monorail transportation-based spatial transport system with I-shaped suspended guideways on the first layer and maglev on the second layer. Traffic combination is formed. A two-layer space transportation system is formed in the single-story frame. The first layer is the suspended monorail

under the frame bent caps of the first layer, and the maglev traffic is set up on the second layer.

[0108] From the structural point of view, the first pier A**21-4** and the first-story frame bent cap B-**4** are concreted and consolidated together. The upper and lower layers of the first-story frame bent cap B-**4** are provided with a suspended monorail transportation guideway and a maglev transit rail beam, respectively. The first outer line I-shaped beam suspended guideway XG**11-4**, the second outer line I-shaped suspended guideway XG**14-4**, the first inner line I-shaped suspended guideway XG**12-4**, the second inner line I-shaped suspended guideway XG**13-4** are the main load-bearing and guiding structures of the suspended monorail. They are installed under the first-story frame bent cap B-**4** of the first pier A**21-4** by bearings, and are set as the rail for logistics channel; The first outer line maglev type guideway C**21-4**, the first inner line maglev type guideway C**22-4**, the second inner line maglev type guideway C**23-4**, and the second outer line maglev type guideway C**24-4** are the main load-bearing and guiding structure for the maglev traffic. They are installed above the first-story frame bent cap B-**4** of the first pier A**21-4** by bearings, and are set as the passenger rail for a passenger transportation channel.

[0109] From the perspective of passenger flow, two types of monorail traffic are set up in the same single-story frame system. With the increase in traffic layers, the efficiency of passenger flow in traffic is improved; low-layer space for passenger flow transportation is efficiently used; ground road congestion will be reduced; and the passenger flow that maglev in the two-layer single-layer frame system can bear will be increased.

[0110] In terms of logistics, with the installation of rails, the efficiency of road logistics is improved and the congestion of ground logistics vehicles is avoided. The logistics transportation capacity and the logistics transportation volume that the suspended monorail transportation in the two-layer space transportation in the single-story frame system can bear are increased.

[0111] According to the above analysis, the vertical three-dimensional space is fully used in a single-story frame monorail transportation-based spatial transport system in which the I-shaped suspended guideway is installed on the first layer and the maglev installed on the second layer, thereby dispersing ground passenger flow, reducing vehicle congestion, speeding up logistics efficiency, reducing logistics costs, and reducing the impact of ground logistics vehicles on roadway traffic. At the same time, a multi-mode transportation system comprising maglev and suspended monorail will be formed to speed up passenger logistics operation efficiency and reduce urban construction costs.

[0112] In the following text, the single-story pier space transportation system based on monorail transportation will be described.

[0113] Embodiment 5: A single-story pier monorail transportation-based spatial transport system in which the suspended monorail is installed on the first layer and the straddle monorail installed on the second layer.

[0114] It is planned to build a single-story pier monorail transportation-based spatial transport system in a certain city, and set up suspended monorail and straddle monorail in the same load-bearing single-story pier system. Among them, suspended monorail is set under the bent cap on the first layer, using steel-concrete composite suspended guideways. The straddle monorail traffic is set on the second layer, which is above the bent caps, using concrete straddle guideways. The suspended monorail is used as the logistics rail and straddle monorail is used as the passenger rail.

[0115] With reference to FIG. **6**, a single-story pier monorail transportation-based spatial transport system in which the suspended monorail is installed on the first layer and the straddle monorail installed on the second layer is described in this patent. A first pier A**11-5** and a first-story frame bent cap B-**5**, a first straddle guideway K**21-5**, a second straddle guideway K**22-5**, a first suspended guideway X**11-5** and a second suspended guideway X**12-5** are included in the single-story pier monorail transportation-based spatial transport system in which the suspended monorail is installed on the first layer and the straddle monorail installed on the second layer.

[0116] From the perspective of traffic layer, the single-story pier monorail transportation-based spatial transport system is composed of two types of monorail transportation systems, with suspended monorail on the first layer and straddle monorail on the second layer. A two-layer space transportation system will be formed in the single-story pier. The first layer is a suspended monorail under the bent caps, and the second layer is a straddle monorail above the bent caps.

[0117] From the structural point of view, the first pier A**11-5** and the first-story frame bent cap B-**5** are concreted and consolidated together. The upper and lower layers of the first-story frame bent cap B-**5** are respectively provided with a suspended monorail transportation rail beam and a straddle monorail guideway. The first straddle guideway K**21-5** and the second straddle guideway K**22-5** are supported above the first-story frame bent cap B-**5** by bearings as the straddle type passenger rail, and the first-story frame bent cap B-**5** is set on the first pier A**11-5**. The first suspended guideway X**11-5** and the second suspended guideway X**12-5** are installed under the first-story frame bent cap B-**5** by bearings, as the suspended logistics rail.

[0118] From the perspective of passenger flow: monorails are installed both above and below the bent caps. With the increase in traffic layers, the passenger transportation capacity in roadway traffic is improved. The low-layer space for passenger flow transportation is efficiently used, and the dense subway passenger flow and road congestion are avoided.

[0119] In terms of logistics, logistics efficiency is increased in the multi-layer and multi-mode transportation; ground traffic roads are not occupied, and congestion with ground logistics vehicles are avoided.

[0120] According to the above analysis, the vertical three-dimensional space of the road will be fully used in a single-story pier monorail transportation-based spatial transport system with suspended monorail on the first layer and straddle monorail on the second layer, thereby dispersing road ground passenger flow, reducing vehicle congestion, speeding up road logistics efficiency, reducing logistics costs, and reducing the impact of ground logistics vehicles on roadway traffic. At the same time, the multi-functional integrated construction of straddle monorail and suspended monorail will be realized; the efficiency of passenger logistics operation will be accelerated, and the cost of urban construction will be reduced.

[0121] Embodiment 6: A single-story pier monorail transportation-based spatial transport system in which the sus-

pended monorail is installed on the first layer and the roadway traffic installed on the second layer.

[0122] It is proposed to build a single-story pier monorail transportation-based spatial transport system in which the suspended monorail is installed on the first layer and the roadway traffic installed on the second layer between the two cities, and set up suspended monorail and roadway traffic in the same single-story pier load-bearing system. Among them, the first layer is the suspended monorail under the pier bent caps, and the steel box suspended guideway with the bottom opening is adopted. The second layer is the highway traffic above the pier bent caps. It is proposed to use suspended monorail as the logistics rail.

[0123] With reference to FIG. **7**, a single-story pier monorail transportation-based spatial transport system in which the suspended monorail is installed on the first layer and the roadway traffic installed on the second layer is described in this patent. A first pier A**11-6**, the first-story frame bent cap B-**6**, a first suspended guideway X**11-6**, a second suspended guideway X**12-6**, a longitudinal beam Z**2-6**, and a highway roadway slab G**2-6** are included in the single-story pier monorail transportation-based spatial transport system in which the suspended monorail is installed on the first layer and the roadway traffic installed on the second layer.

[0124] From the perspective of traffic layer, a combination of suspended monorail traffic and highway traffic is included in the single-story pier monorail transportation-based spatial transport system with suspended monorail traffic on the first layer and roadway traffic on the second layer. A two-layer space transportation system is formed in the single-story pier system. The first layer is the suspended monorail traffic under the pier bent caps, and the second layer is the highway traffic above the bent caps.

[0125] From the structural point of view, the first pier A**11-6** and the first-story frame bent cap B-**6** are concreted and consolidated together. The upper and lower layers of the first-story frame bent cap B-**6** are respectively provided with suspended monorail guideways and highway traffic. The first-story frame bent cap B-**6** is installed on the first pier A**11-6**; the longitudinal beam Z**2-6** is installed above the first-story frame bent cap B-**6** to support the highway roadway slab G**2-6**; the first-story frame bent cap B-**6**, the first suspended guideway X**11-6** and the second suspended guideway X**12-6** are installed below the B-**6** by bearings, as the suspended logistics rail.

[0126] From the perspective of passenger flow, with the increase in traffic layers, the capacity of passenger flow in roadway traffic, the low-layer space for passenger flow transportation is efficiently used, and the dense subway passenger flow and road congestion are avoided.

[0127] In terms of logistics, in the multi-mode and multi-layer transportation system, the capacity and efficiency of logistics transportation are increased and the congestion of ground logistics vehicles is avoided.

[0128] According to the above analysis, the road vertical three-dimensional space is fully used in a single-story pier monorail transportation-based spatial transport system with a suspended monorail on the first layer and roadway traffic on the second layer, thereby dispersing the road surface passenger flow, reducing vehicle congestion; speeding up road logistics efficiency, reducing logistics costs, and reducing the impact of ground logistics vehicles on roadway traffic.

[0129] Embodiment 7: A single-story pier monorail transportation-based spatial transport system in which the I-shaped suspended monorail is installed on the first layer and the maglev installed on the second layer.

[0130] It is planned to build a single-story pier monorail transportation-based spatial transport system in which the I-shaped suspended monorail is installed on the first layer and the maglev installed on the second layer in a certain city. Among them, suspended monorail is set up under the pier bent caps on the first layer, using I-shaped steel suspended guideways. The second layer is maglev traffic set up above the pier bent caps, using I-shaped steel maglev guideways. It is planned to set the suspended monorail as the logistics rail and the maglev as the passenger rail.

[0131] With reference to FIG. **8**, a single-story pier monorail transportation-based spatial transport system in which the I-shaped suspended monorail is installed on the first layer and the maglev installed on the second layer is described in this patent. A first pier A**11-7**, a first-story frame bent cap B-**7**, a first I-shaped suspended guideway XG**11-7**, a second I-shaped suspended guideway XG**12-7**, a first maglev guideway C**21-7** and a second maglev guideway C**22-7** are included in the single-story pier space transportation system based on monorail traffic in which the I-shaped suspended monorail is installed on the first layer and the maglev installed on the second layer.

[0132] From the perspective of traffic layer, the first layer is equipped with I-shaped suspended guideways, and the second layer is maglev. Two types of monorail transportation are included in the single-story pier monorail transportation-based spatial transport system. The first layer is the suspended monorail under the pier bent caps, and the second layer is the maglev system above the bent caps.

[0133] From the structural point of view, the first pier A**11-7** and the first-story frame bent cap B-**7** are concreted and consolidated together. The upper and lower layers of the bent cap are respectively provided with a suspended monorail transportation guideway and a maglev rail beam. The first-story frame bent cap B-**7** is set on the first pier A**11-7**; the first maglev guideway C**21-7** and the second maglev guideway C**22-7** are supported by the bearings above the B-**7**, which is used as the passenger rail. The first I-shaped suspended guideway XG**11-7** and the second I-shaped suspended guideway XG**12-7** are installed under the first-story frame bent cap B-**7** by bearings, which serves as a suspended logistics rail for logistics transportation.

[0134] From the perspective of passenger flow, maglev and suspended traffic systems are included in the same pier system. With the increase in traffic layers, the passenger flow transportation capacity in roadway traffic is increased, and the low-layer space for passenger flow transportation is efficiently used to avoid dense road passenger flow congestion.

[0135] In terms of logistics, logistics efficiency and capability are improved in the multi-layer and multi-mode transportation system, and the congestion of ground logistics vehicles is avoided.

[0136] According to the above analysis, the road vertical three-dimensional space is fully used in a single-story pier monorail transportation-based spatial transport system in which the I-shaped suspended monorail is installed on the first layer and the maglev installed on the second layer, thereby dispersing ground passenger flow on roads, reducing vehicle congestion, speeding up the efficiency of urban

logistics, reducing logistics costs, and reducing the impact of ground logistics vehicles on roadway traffic. At the same time, the multi-functional integrated construction of maglev and suspended monorail transportation system can be realized. Passenger logistics operation efficiency in increased and urban construction costs are reduced.

[0137] Embodiment 8: A single-story pier monorail transportation-based spatial transport system in which the I-shaped suspended monorail is installed on the first layer and the railway traffic installed on the second layer.

[0138] It is planned to build a single-story pier monorail transportation-based spatial transport system in which the I-shaped suspended monorail is installed on the first layer and the railway traffic installed on the second layer in a certain city. Among them, the first layer is to set up suspended monorail under the pier bent caps, using I-shaped steel suspended guideways. The second layer is to set up railway traffic above the pier bent caps. It is planned to use suspended monorail as the passenger rail.

[0139] With reference to FIG. **9**, a single-story pier monorail transportation-based spatial transport system in which the I-shaped suspended monorail is installed on the first layer and the railway traffic installed on the second layer is described in this patent. A first pier A**11-8**, a first-story frame bent cap B-**8**, a first I-shaped suspended guideway XG**11-8**, a second I-shaped suspended guideway XG**12-8**, a longitudinal beam Z**2-8**, and a railway carriageway T**2-8** are included in the single-story pier space transportation system based on monorail traffic in which the I-shaped suspended monorail is installed on the first layer and the railway traffic installed on the second layer.

[0140] From the perspective of traffic layer, the first layer is equipped with I-shaped suspended guideway, and the second layer is railway traffic. The suspended monorail traffic and railway traffic are included in the single-story pier monorail transportation-based spatial transport system. A two-layer space transportation system is formed in the single-story pier system. The first layer is the suspended monorail under the pier bent cap, and the second layer is the railway traffic above the bent cap.

[0141] In terms of structure, the first pier A**11-8** and the first-story frame bent cap B-**8** are concreted and consolidated together. The upper and lower layers of the first-story frame bent cap B-**8** are respectively provided with railway traffic and suspended monorail guideways. The first-story frame bent cap B-**8** is set on the first pier A**11-8**; the longitudinal beam Z**2-8** is installed above the first-story frame bent cap B-**8** to support the railway carriageway T**2-8**; the first I-shaped steel suspended guideway XG**11-8** and the second I-shaped suspended guideway XG**12-8** are connected under the first-story frame bent cap B-**8**, which can be used as a logistics rail or as a passenger rail.

[0142] From the perspective of passenger flow, railways and monorails are combined in a pier system. With the increase in traffic layers, the passenger flow transportation capacity in roadway traffic in improved; the low-layer space for passenger flow transportation is efficiently used, and dense road passenger flow and road congestion are avoided.

[0143] In terms of logistics, the layer of transportation is improved, and the capacity and efficiency of logistics and transportation are improved. Part of the logistics can be shared by the upper railway and the congestion of ground road logistics vehicles is avoided.

[0144] According to the above analysis, the vertical three-dimensional space of the road is fully used in a single-story pier monorail transportation-based spatial transport system in which the I-shaped suspended monorail is installed on the first layer and the railway traffic installed on the second layer, thereby dispersing the road ground passenger flow, reducing vehicle congestion; speeding up the efficiency of urban logistics, reducing logistics costs, and reducing the impact of ground logistics vehicles on roadway traffic. At the same time, the multi-functional integration of railway traffic and suspended monorail transportation can be realized. Passenger logistics operation efficiency will be increased and urban construction costs will be reduced.

[0145] In the following text, a double-story space frame monorail transportation-based spatial transport system is described.

[0146] Embodiment 9: A double-story space frame monorail transportation-based spatial transport system in which the suspended monorail is on the first layer, the straddle monorail on the second layer, no traffic on the third layer and the roadway traffic on the fourth layer.

[0147] It is planned to build a double-story space frame monorail transportation-based spatial transport system in which the suspended monorail is on the first layer, the straddle monorail on the second layer, no traffic on the third layer and the roadway traffic on the fourth layer in a certain city. Among them, the first layer is provided with suspended monorail under the frame bent cap, adopting the concrete suspended guideway with the bottom opening. The second layer, namely, the straddle monorail system is installed above the first layer frame bent cap, with concrete straddle guideways. The third layer, that is, under the second layer frame bent caps without traffic; and the fourth layer, that is, above the second layer frame bent caps with roadway traffic. It is planned to use suspended monorail as logistics rail and straddle monorail as passenger rail.

[0148] With reference to FIG. **10**, the double-story space frame monorail transportation-based spatial transport system in which the suspended monorail is on the first layer, the straddle monorail on the second layer, no traffic on the third layer and the roadway traffic on the fourth layer is described in this patent. A first outer line suspended guideway X**11-9**, a second outer line suspended guideway X**14-9**, a first inner line suspended guideway X**12-9**, a second inner line suspended guideway X**13-9**, a first outer line straddle type guideway K**21-9**, a second outer line straddle guideway K**24-9**, a first inner line straddle type guideway K**22-9**, a second inner line straddle type guideway K**23-9**, a first pier A**21-9**, a second pier A**22-9**, a first-story frame bent cap B**1-9**, a second-story frame bent cap B**2-9**, a roadway slab G**4-9**, and a longitudinal beam Z**4-9** are included in the double-story space frame transportation system based on monorail traffic in which the suspended monorail is on the first layer, the straddle monorail on the second layer, no traffic on the third layer and the roadway traffic on the fourth layer.

[0149] From the perspective of traffic layer, the above-mentioned one is based on a two-story frame with suspended monorail on the first layer, straddle monorail on the second layer, no traffic on the third layer, and roadway traffic on the fourth layer. The space transportation system is formed by a combination of suspended monorail, straddle monorail and highway traffic. A four-layer space transportation system is formed by the double-story frame. The first layer is the

suspended monorail under the frame bent caps on the first layer, and the second layer is the straddle monorail traffic installed above the bent caps on the first layer. The third has no traffic under the second layer of bent caps, and the fourth layer is the roadway traffic above the second story of bent caps.

[0150] From the structural point of view, the first pier A**21-9** and the first-story frame bent cap B**1-9** are consolidated together by concrete pouring; the lower part of the second pier A**22-9** and the first-story frame bent cap B**1-9** are consolidated by concrete pouring; the upper part of the second pier A**22-9** and the second-story frame bent cap B**2-9** are consolidated by concrete pouring. The first outer line suspended guideway X**11-9**, the second outer line suspended guideway X**14-9**, the first inner line suspended guideway X**12-9**, and the second inner line suspended guideway X**13-9** are the main load-bearing components and guiding structures of the suspended monorail. They are installed under the first-story frame bent cap B**1-9** of the first pier A**21-9** by bearings and are set as the rail for logistics channel; the first outer line straddle guideway K**21-9**, the second outer line straddle guideway K**24-9**, the first inner line straddle guideway K**22-9**, and the second inner line straddle guideway K**23-9** are the main bearing and guiding structures of the straddle monorail. They are installed above the first-story frame bent cap B**1-9** of the first pier A**21-9** and set as the rail for passenger flow channel. The longitudinal beam Z**4-9** is arranged above the second-story frame bent cap B**2-9** of the second story to support the roadway slab G**4-9** for the operation of the upper roadway traffic system.

[0151] From the perspective of passenger flow, there are two types of monorail and roadway traffic in the same double-story frame system. With the increase of traffic layers, the passenger flow transportation capacity in roadway traffic is increased, and the low-layer space for passenger flow transportation is efficiently used to avoid dense subway passenger flow and road congestion.

[0152] In terms of logistics, with the installation of additional rails, the efficiency of logistics transportation is improved and the congestion of ground logistics vehicles is avoided.

[0153] Based on the above analysis, the vertical three-dimensional space of the road is fully used in the double-story space frame monorail transportation-based spatial transport system in which the suspended monorail is on the first layer, the straddle monorail on the second layer, no traffic on the third layer and the roadway traffic on the fourth layer, thereby dispersing the ground passenger flow on the road, reducing the intensive vehicle congestion; speeding up the efficiency of road logistics, reducing logistics costs, and reducing the impact of ground logistics vehicles on roadway traffic. At the same time, a multi-functional integrated transportation system of monorail and highway traffic will be realized, and passenger logistics operation efficiency is increased and urban construction costs are reduced.

[0154] Embodiment 10: A double-story space frame monorail transportation-based spatial transport system in which no traffic is on the first layer, the straddle monorail on the second layer, no traffic on the third layer and the roadway traffic on the fourth layer.

[0155] It is proposed to build a double-story space frame monorail transportation-based spatial transport system in which no traffic is on the first layer, the straddle monorail on the second layer, no traffic on the third layer and the roadway traffic on the fourth layer between two cities. The straddle-type monorail traffic and highway traffic on the same double-story load-bearing frame system is set up, forming a multi-mode and multi-layer double-story frame space transportation system. Among them, the first layer with no traffic is under the first-layer frame bent caps; the second layer is the straddle monorail traffic above the first layer frame bent caps, using concrete straddle rail beams, and the third layer with no traffic is under the second layer frame bent cap; and the roadway traffic is set up on the fourth layer, that is, above the frame bent caps of the second floor. It is planned to set the inner guideway of straddle monorail as the logistics track and the outer guideway as the passenger track.

[0156] With reference to FIG. **11**, a double-story space frame monorail transportation-based spatial transport system in which no traffic on the first layer, the straddle monorail on the second layer, no traffic on the third layer and the roadway traffic in on the fourth layer is described in this patent. A first outer line straddle guideway K**21-10**, a second outer line straddle guideway K**24-10**, a first inner line straddle guideway K**22-10**, a second inner line straddle guideway K**23-10**, a first pier A**21-10**, a second pier A**22-10**, a first-story frame bent cap B**1-10**, a second-story frame bent cap B**2-10**, a roadway slab G**4-10**, and a longitudinal beam Z**4-10** are included in the double-story space frame transportation system based on monorail traffic in which no traffic is on the first layer, the straddle monorail on the second layer, no traffic on the third layer and the roadway traffic on the fourth layer.

[0157] From the perspective of traffic layer, the mentioned monorail transportation-based spatial transport system with no traffic on the first layer, straddle monorail traffic on the second layer, no traffic on the third layer, and roadway traffic on the fourth layer is formed by a combination of suspended monorail, straddle monorail and highway traffic. A four-layer space transportation system is formed in the double-story frame system. The first layer with no traffic is under the first-story frame bent caps; the second layer is the straddle monorail above the first layer bent caps; the third layer with no traffic is under the second-story layer bent caps, and the fourth layer is the roadway traffic above the second layer bent caps.

[0158] From the structural point of view, the first pier A**21-10** and the first-story frame bent cap B**1-10** are fixed together by concrete pouring, and the lower part of the second pier A**22-10** and the first-story frame bent cap B**1-10** are consolidated by concrete pouring; and the upper part of the second pier A**22-10** and the second-story frame bent cap B**2-10** are consolidated by concrete pouring. The first outer line straddle guideway K**21-10**, the second outer line straddle guideway K**24-10**, the first inner line straddle guideway K**22-10**, and the second inner line straddle guideway K**23-10** are the main load-bearing and guiding structures of the monorail and are installed on the first-story frame bent cap B**1-10** of the first pier A**21-10** by bearings. The first outer line straddle guideway K**21-10**, the second outer line straddle guideway K**24-10**, the first inner line straddle guideway K**22-10** and the second inner line straddle guideway K**23-10** are set as the logistics rail, which serves as the urban logistics channel. The longitudinal beam Z**4-10** is set above the second-story frame bent cap B**2-10** of the second story to support the roadway slab G**4-10** for the operation of the upper roadway traffic system.

[0159] From the perspective of passenger flow, monorail and highway traffic are included in the same double-story frame system. With the increase of traffic layers, the capacity of passenger flow in traffic is improved, and the low-layer space for passenger flow transportation is efficiently used, avoiding dense road passenger flow and road congestion.

[0160] In terms of logistics, the efficiency of logistics transportation is improved in the multi-layer and multi-mode transportation and the congestion of ground logistics vehicles is avoided.

[0161] According to the above analysis, it is sufficient to adopt a double-story frame monorail transportation-based spatial transport system traffic with no traffic on the first layer, straddle monorail traffic on the second layer, no traffic on the third layer, and roadway traffic on the fourth layer. The vertical three-dimensional space is used to disperse ground passenger flow and reduce vehicle congestion, speeding up logistics efficiency, reducing logistics costs, and reducing the impact of ground logistics vehicles on roadway traffic. At the same time, a multi-functional integrated transportation system of roadway traffic and straddle monorail will be realized. Passenger logistics operation efficiency will be increased and urban construction costs are reduced.

[0162] Embodiment 11: A double-story space frame monorail transportation-based spatial transport system in which no traffic is on the first layer, the maglev on the second layer, no traffic on the third layer and the straddle monorail on the fourth layer.

[0163] It is proposed to build a double-story space frame monorail transportation-based spatial transport system in which no traffic is on the first layer, the maglev on the second layer, no traffic on the third layer and the straddle monorail on the fourth layer between cities. Maglev and straddle monorail traffic are set on the same double-story load-bearing frame system to form a multi-mode and multi-story double-story frame space transportation system. Among them, the first layer with no traffic is under the first layer frame bent cap; the second layer maglev traffic above the first layer frame bent caps adopting I-shaped steel maglev guideways; and the third layer with no traffic is under the frame bent caps of the first floor, and the fourth layer straddle monorail traffic is set up above the frame bent cap of the second floor, using steel box straddle guideways. It is planned to set straddle-type monorail as the logistics rail and maglev as the passenger rail.

[0164] With reference to FIG. **12**, a first outer line straddle guideway K**41-11**, a second outer line straddle guideway K**44-11**, a first inner line straddle guideway K**42-11**, a second inner line straddle guideway K**43-11**, a first outer line straddle guideway C**21-11**, a second outer line straddle guideway C**24-11**, a first inner line straddle guideway C**22-11**, a second inner line straddle guideway C**23-11**, a first pier A**21-11**, a second pier A**22-11**, a first floor frame bent cap B**1-11** and a second floor frame bent cap B**2-11** are included in the double-story space frame transportation system based on monorail traffic in which no traffic is on the first layer, maglev on the second layer, no traffic on the third layer and the straddle monorail on the fourth layer is demonstrated in this patent. The double-story space frame transportation system based on monorail traffic in which no traffic is on the first layer, maglev on the second layer, no traffic on the third layer and the straddle monorail on the fourth layer.

[0165] From the perspective of traffic layer, there is no traffic on the first layer; the second layer is maglev; no traffic is in the third layer, and the fourth layer is straddle monorail. The double-story frame space transportation system with four layers is formed by a combination of straddle monorail and maglev. The first layer with no traffic is under the frame bent caps; the second layer maglev is set up above the first layer bent caps; the third layer with no traffic is under the second layer bent caps, and the fourth layer straddle monorail traffic is above the second layer bent cap.

[0166] From the structural point of view, the first pier A**21-11** and the first-story frame bent cap B**1-11** are consolidated together by concrete pouring, and the lower part of the second pier A**22-11** and the first-story frame bent caps B**1-11** are consolidated by concrete pouring, and the upper part of the second pier A**22-11** and the second-story frame bent cap B**2-11** are consolidated by concrete pouring. The first outer line straddle guideway K**41-11**, the second outer line straddle guideway K**44-11**, the first inner line straddle guideway K**42-11**, and the second inner line straddle guideway K**43-11** are the main load-bearing and guiding structures of the monorail. They are set above the second-story frame bent cap B**2-11** of the second pier A**22-11** through the bearings, and are set as the rail for logistics channel; the first outer line maglev guideway C**21-11**, the first inner line maglev guideway C**22-11**, the second inner line maglev guideway C**23-11**, and the second outer line maglev guideway C**24-11** are set up above the first-story frame bent cap B**1-11** by bearings, used for maglev transportation operation and used as the passenger rail.

[0167] From the perspective of passenger flow, there are two types of monorail transportation in the same double-story frame system. With the increase of traffic layers, the capacity of passenger flow in traffic is increased, and the low-layer space for passenger flow transportation is efficiently used, avoiding dense road passenger flow and road congestion.

[0168] In terms of logistics, after setting up rails in multi-mode transportation, the efficiency and capacity of logistics transportation are improved and the congestion of ground logistics vehicles is avoided.

[0169] Based on the above analysis, the vertical three-dimensional space is fully used in the a monorail-based double-story frame monorail transportation-based spatial transport system with no traffic on the first layer, maglev traffic on the second layer, no traffic on the third layer, and straddle monorail traffic on the fourth layer, thereby dispersing ground passenger flow, reducing vehicle congestion; speeding up road logistics efficiency, reducing logistics costs, and reducing the impact of ground logistics vehicles on roadway traffic. At the same time, the multi-functional integrated transportation system of straddle monorail and maglev will be realized, and the efficiency of passenger logistics operation will be accelerated and the cost of urban construction will be reduced.

[0170] Embodiment 12: A double-story space frame monorail transportation-based spatial transport system in which suspended guideway with bottom openings is on the first layer, the straddle monorail on the second layer, no traffic on the third layer and the railway traffic on the fourth layer.

[0171] It is proposed to build a double-story space frame monorail transportation-based spatial transport system in which suspended guideway with bottom openings is on the first layer, the straddle monorail on the second layer, no traffic on the third layer and the railway traffic on the fourth

layer between cities, and set up suspended monorail, straddle monorail, and railway traffic on the same load-bearing frame system to form a multi-mode and multi-layers double-story frame space transportation system. Among them, the first layer is the suspended monorail with bottom-open steel box guideways under the first-story frame bent caps; the second layer is the concrete straddle monorail above the first-story frame bent caps; the third layer no traffic is under the second-story frame bent caps; the fourth layer is the railway traffic above the second-story frame bent caps. It is planned to set the suspended monorail as the logistics rail and the straddle monorail as the passenger rail.

[0172] With reference to FIG. **13** and FIG. **14**, the double-story space frame monorail transportation-based spatial transport system in which suspended guideway with bottom openings is on the first layer, straddle monorail on the second layer, no traffic on the third layer and the railway traffic on the fourth layer is described. A first outer line bottom opening suspended guideway XD**11-12**, a second outer line bottom opening suspended guideway XD**14-12**, a first inner line bottom opening suspended guideway XD**12-12**, a second inner line bottom opening suspended guideway XD**13-12**, a first outer line straddle guideway K**21-12**, a second outer line straddle guideway K**24-12**, a first inner line straddle guideway K**22-12**, a second inner line straddle guideway K**23-12**, a first pier A**21-12**, a second pier A**22-12**, a first-story frame bent cap B**1-12**, a second-story frame bent cap B**2-12**, a railway carriageway T**4-12**, and a longitudinal beam Z**4-12** are included in the double-story space frame transport system based on monorail traffic in which suspended guideway with bottom openings is on the first layer, straddle monorail on the second layer, no traffic on the third layer and the railway traffic in on the fourth layer. Due to the size limitation of the drawings, the railway track in FIG. **13** is not very clear. FIG. **14** is the record drawing of the of the railway track E-**12**. E**1** is the railway track slab; E**2** is the steel rail and E**3** is the track bearing platform. The following embodiments comprising railways are not described in the attached drawings.

[0173] From the perspective of traffic layer, the first layer is set with bottom-opened suspended guideways; the second layer is the straddle monorail traffic; there is no traffic in the third layer, and the fourth layer is railway traffic based on monorail traffic. The double-story frame monorail transportation-based spatial transport system is formed by a combination of suspended monorail, straddle monorail and railway traffic. The double-story frame forms a four-layer space transportation system. The first layer is the suspended monorail under the first-story frame bent caps; the second layer straddle monorail traffic is above the first-story frame bent caps; the third layer with no traffic is under the second-story bent caps, and the fourth layer is the railway traffic above the second-story bent caps.

[0174] From the structural point of view, the first pier A**21-12** and the first-story frame bent cap B**1-12** are consolidated together by concrete pouring, and the lower part of the second pier A**22-12** and the first-story frame bent caps B**1-12** are consolidated by concrete pouring, and the upper part of the second pier A**22-12** and the second-story frame bent cap B**2-12** are consolidated by concrete pouring. The first outer line bottom opening suspended guideway XD**11-12**, the second outer line bottom opening suspended guideway XD**14-12**, the first inner line bottom opening suspended guideway XD**12-12**, the second inner line bottom opening suspended guideway XD**13-12** are the main load-bearing and guiding structure of the suspended monorail, which is installed under the first-story frame bent cap B**1-12** of the first pier A**21-12** by bearings, and is set as the rail for logistics. The first outer line straddle guideway K**21-12**, the second outer line straddle guideway K**24-12**, the first inner line straddle guideway K**22-12**, and second inner line straddle guideway K**23-12** are the main load-bearing and guiding structures for the straddle monorail. They are set above the first-story frame bent cap B**1-12** of the first pier A**21-12** by bearings, and are set as the passenger rail; the second-story frame bent cap B**2-12** is set above the longitudinal beam Z**4-12** to support the railway carriageway T**4-12**, and are used for the operation of the upper railway traffic system.

[0175] From the perspective of passenger flow, there are two types of monorail and railway traffic in the same double-story frame system. With the increase of traffic layers, the capacity of passenger flow in traffic is improved, and the low-layer space for passenger flow transportation is efficiently used, avoiding dense road passenger flow and road congestion.

[0176] In terms of logistics, in the multi-layer and multi-mode transportation system, the efficiency of logistics transportation in improved and the congestion of ground logistics vehicles is avoided.

[0177] Based on the above analysis, a double-story frame monorail transportation-based spatial transport system is adopted, with the first layer setting up with bottom opening suspended guideways, the second layer for straddle monorail, the third layer with no traffic, and the fourth layer for railway traffic. The vertical three-dimensional space is fully used in the transportation system, thereby dispersing ground passenger flow, reducing vehicle congestion; speeding up road logistics efficiency, reducing logistics costs, and reducing the impact of ground logistics vehicles on roadway traffic. At the same time, a multi-functional integrated transportation system of railway traffic, straddle monorail, and suspended monorail will be realized to accelerate the efficiency of passenger logistics operation and urban construction costs are reduced.

[0178] In the following text, the double-story pier monorail transportation-based spatial transport system is described.

[0179] Embodiment 13: A double-story pier monorail transportation-based spatial transport system in which suspended guideway is on the first layer; the straddle monorail on the second layer; no traffic on the third layer and the roadway traffic on the fourth layer.

[0180] It is planned to build a double-story pier monorail transportation-based spatial transport system in a certain city. Suspended monorail traffic, straddle-type monorail traffic and highway traffic are set up in the same load-bearing double-story pier system. Among them, the first layer suspended monorail with bottom opening guideway is under the first pier bent cap; the second layer is the straddle type monorail system with concrete guideways above the second pier bent caps; the third layer with no traffic is under the second pier bent caps; the fourth layer roadway traffic is above the second pier bent cap. It is planned to use suspended monorail as the logistics rail and straddle monorail as the passenger rail.

[0181] Using FIG. **15** to demonstrate the double-story space frame monorail transportation-based spatial transport

system in which suspended guideway with bottom openings is on the first layer; the straddle monorail is on the second layer; no traffic is on the third layer and the roadway traffic is on the fourth layer. The first layer is set up with suspended monorail; the second layer is set up with straddle monorail; the third layer has no traffic forms, and the fourth layer is set up with roadway traffic. A first pier A**11-13**, a second pier A**12-13**, a longitudinal beam Z**4-13**, a second-story frame bent cap B**2-13**, a first-story frame bent cap B**1-13**, a roadway slab G**4-13**, a first straddle guideway K**21-13**, a second straddle guideway K**22-13**, a first suspended guideway X**11-13** and a second suspended guideway X**12-13** are included in the system.

[0182] From the perspective of traffic layer, the first layer is equipped with suspended monorail; the second layer is equipped with straddle monorail; the third layer has no traffic, and the fourth layer is equipped with roadway traffic. The double-story pier monorail transportation-based spatial transport system is formed by a combination of suspended monorail, straddle monorail and highway traffic. A four-layer space transportation system is formed by the double-story piers and columns system. The first layer is the suspended monorail under the first-story bent caps; the second layer is the straddle monorail transportation above the first-story bent caps; the third layer with no traffic is under the second-story of bent caps, and the fourth story, that is, above the second-story of bent caps, is provided with roadway traffic.

[0183] From the structural point of view, the first pier A**11-13** and the first-story bent cap B**1-13** are consolidated together by concrete pouring, and the lower part of the second pier A**12-13** and the first-story frame bent cap B**1-13** are consolidated together by concrete pouring; the upper part of the second pier A**12-13** and the second-story frame bent cap B**2-13** are consolidated together by concrete pouring. The first pier A**11-13** is provided with the first-story of bent cap B**1-13**; the second pier A**12-13** is provided with the second-story of bent cap B**2-13**; the second-story frame bent cap B**2-13** is installed with longitudinal beam Z**4-13** through the bearings to support the roadway slab G**4-13**; the upper part of the first-story frame bent cap B**1-13** is connected to the first straddle guideway K**21-13** and the second straddle guideway K**22-13** through the bearing and are used as a straddle passenger rail for passenger flow transportation. The first-story frame bent cap B**1-13** is connected to the first suspended guideway X**11-13** and the second suspended guideway X**12-13** through bearings, as the suspended rail for logistics transportation.

[0184] From the perspective of passenger flow, two types of monorail and highway traffic are set up in the same double-story pier system. With the increase in traffic layers, the passenger flow transportation capacity in roadway traffic is improved, and the lower-layer space for passenger flow transportation is efficiently used, thus avoiding subway passenger flow congestion and road congestion.

[0185] In terms of logistics, logistics efficiency is improved in the multi-layer and multi-mode transportation system and the congestion of ground logistics vehicles is avoided.

[0186] Based on the above analysis, a double-story pier monorail transportation-based spatial transport system is adopted in which suspended monorail is installed on the first layer; straddle monorail transportation is installed on the second layer; no traffic is installed on the third layer, and highway traffic is installed on the fourth layer. The road's vertical three-dimensional space is fully used in the space transportation system, thereby dispersing ground passenger flow, reducing vehicle congestion; speeding up road logistics efficiency, reducing logistics costs, and reducing the impact of ground logistics vehicles on roadway traffic. At the same time, the multi-functional integrated construction of monorail and highway traffic is realized, and passenger logistics operation efficiency is increased and urban construction costs are reduced.

[0187] Embodiment 14: A double-story pier monorail transportation-based spatial transport system with no traffic is on the first layer, maglev traffic on the second layer, no traffic on the third layer, and railway traffic on the fourth layer.

[0188] It is proposed to build a double-story pier monorail transportation-based spatial transport system with no traffic on the first layer, maglev traffic on the second layer, no traffic on the third layer, and railway traffic on the fourth layer between cities, and to set up maglev and railway traffic in the same double-story pier load-bearing system to form a multi-mode and multi-layer space transportation system. Among them, the first layer with no traffic is below the first pier bent caps; the second layer maglev with I-shaped guideways is above the first pier bent caps; the third layer with no traffic is under the second pier bent caps, and the fourth layer railway traffic is above the second pier bent caps. It is planned to set the maglev as the passenger rail.

[0189] With reference to FIG. **16**, a double-story pier monorail transportation-based spatial transport system with no traffic on the first layer, maglev traffic on the second layer, no traffic on the third layer, and railway traffic on the fourth layer is described in this patent. A first pier A**11-14**, a second pier A**12-14**, a longitudinal beam Z**4-14**, a second-story frame bent cap B**2-14**, a first-story frame bent cap B**1-14**, a railway carriageway T**4-14**, a first maglev guideway C**21-14** and a second maglev guideway C**22-14** are included in the double-story pier monorail transportation-based spatial transport system with no traffic on the first layer, maglev traffic on the second layer, no traffic on the third layer, and railway traffic on the fourth layer.

[0190] From the perspective of traffic layer, the double-story pier monorail transportation-based spatial transport system has no traffic on the first layer, maglev traffic on the second layer, no traffic on the third layer, and railway traffic on the fourth layer. The space transportation system is formed by a combination of maglev and railway traffic. A four-layer space transportation system is formed by the double-story piers. The first layer with no traffic is under the first-story bent caps; the second layer maglev is above the first-story bent caps; the third layer with no traffic is under the second-story bent caps and the fourth layer railway traffic is above the second-story bent caps.

[0191] In terms of structure, the first pier A**11-14** and the first-story frame bent cap B**1-14** are consolidated together by concrete pouring; the lower part of the second pier A**12-14** and the first-story frame bent cap B**1-14** are consolidated together by concrete pouring; the upper part of the second pier A**12-14** and the second-story frame bent cap B**2-14** are consolidated together by concrete pouring. The first pier A**11-14** is provided with the first-story frame bent cap B**1-14**; the second pier A**12-14** is provided with the second-story frame bent cap B**2-14**; the second-story frame bent cap B**2-14** is provided with the longitudinal beam Z**4-14** to

support the railway carriageway T**4-14**; the first maglev guideway C**21-14** and the second maglev guideway C**22-14** are connected to the top of the first-story frame bent cap B**1-14** by bearings, which is used for maglev passenger rail.

[0192] From the perspective of passenger flow, maglev transportation and railway traffic are set up in the same double-story pier system. With the increase in traffic layers, passenger transportation capacity in roadway traffic is improved, and the low-layer space for passenger flow transportation is efficiently used, avoiding dense road passenger flow and road congestion.

[0193] In terms of logistics, with the multi-layer and multi-mode transportation system, the efficiency of logistics transportation is improved, and the vertical space of the road is fully used, and the congestion of ground logistics vehicles is avoided.

[0194] According to the above analysis, it is sufficient to adopt a double-story pier monorail transportation-based spatial transport system with no traffic on the first layer, maglev traffic on the second layer, no traffic on the third layer, and railway traffic on the fourth layer. The vertical three-dimensional space is utilized in the city to disperse the urban ground passenger flow and reduce vehicle congestion, speeding up the efficiency of urban logistics, reducing logistics costs, and reducing the impact of ground logistics vehicles on roadway traffic. At the same time, a multi-functional integrated transportation system of railway traffic and monorail transportation will be realized, and passenger and logistics operation efficiency are improved and urban construction costs are reduced.

[0195] Embodiment 15: A double-story pier monorail transportation-based spatial transport system with the suspended guideway with a bottom opening on the first layer, maglev on the second layer, no transportation on the third layer, and straddle monorail on the fourth layer.

[0196] It is proposed to build a double-story pier monorail transportation-based spatial transport system with a suspended guideway with a bottom opening on the first layer, maglev on the second layer, no traffic on the third layer, and straddle monorail on the fourth layer between cities. Suspended monorail traffic, straddle-type monorail traffic and maglev transportation are set up in the same double-story pier load-bearing system to form a multi-mode and multi-layer space transportation system. Among them, the first layer suspended monorail is under the first pier bent caps, using bottom-opening steel box form guideways; the second-story maglev is above the first pier bent caps, using I-shaped guideway; the third layer with no traffic is under the second pier bent caps; the fourth layer straddle monorail traffic is above the second pier bent cap, using concrete straddle guideway. It is planned to set straddle monorail and maglev as passenger rails, and suspended monorail as logistics rails.

[0197] With reference to FIG. **17**, the double-story pie column monorail transportation-based spatial transport system with a suspended guideway with a bottom opening on the first layer, maglev on the second layer, no traffic on the third layer, and straddle monorail on the fourth layer is demonstrated. The first layer is provided with a bottom-opened suspended guideway; the second layer is provided with maglev; the third layer has no traffic, and the fourth layer is provided with the straddle monorail transportation. A first pier A**11-15**, a second pier A**12-15**, a second-story frame bent cap B**2-15**, a first-story frame bent cap B**1-15**, a first straddle guideway K**41-15**, a second straddle guideway K**42-15**, a first maglev guideway C**21-15**, a second maglev guideway C**22-15**, a first bottom opening suspended guideway XD**11-15** and a second bottom opening suspended guideway XD**12-15** are included in the space transportation system.

[0198] From the perspective of traffic layer, the first layer is equipped with bottom-opened suspended guideways; the second layer is equipped with maglev; the third layer has no traffic, and the fourth layer is based on monorail transportation. The double-story pier space transportation system of transportation is formed by a combination of maglev, suspended monorail and straddle monorail. A four-layer space transportation system is formed by the double-story piers. The first layer is to set up suspended monorail transportation under the first-story of bent caps; the second layer is to set up maglev above the first-story of bent caps; the third layer with no traffic is under the second-story bent caps, and the straddle-type monorail is installed on the fourth layer above the second-story bent caps.

[0199] From the structural point of view, the first pier A**11-15** and the first-story frame bent cap B**1-15** are consolidated together by concrete pouring, and the lower part of the second pier A**12-15** and the first-story frame bent cap B**1-15** are consolidated together by concrete pouring; the upper part of the second pier A**12-15** and the second-story frame bent cap B**2-15** are consolidated together by concrete pouring. The first pier A**11-15** is provided with the first-story frame bent cap B**1-15**, and the second pier A**12-15** is provided with the second-story frame bent cap B**2-15**; the first straddle guideway K**41-15** and the second straddle guideway K**42-15** are set above the second-story frame bent cap B**2-15** by bearings, and are used as the straddle-type logistics rail or a passenger rail; under the first-story frame bent cap B**1-15**, the first bottom opening suspended guideway XD**11-15** and the second bottom opening suspended guideway XD**12-15** are installed through the bearings and are used as the suspended logistics rail. The first maglev guideway C**21-15** and the second maglev guideway C**22-15** are used as the maglev passenger rail for passenger traffic.

[0200] From the perspective of passenger flow, maglev, suspended monorail and straddle monorail are set up in the same double-story pier system. With the increase in traffic layers, the passenger flow transportation capacity in roadway traffic is improved and the low-layer space for passenger flow transportation is efficiently used to avoid road crowded passenger flow and road congestion.

[0201] In terms of logistics, in the multi-layer and multi-mode transportation system, the efficiency of logistics transportation is improved, making full use of the vertical space of the road, and the congestion of ground logistics vehicles is avoided.

[0202] Based on the above analysis, the vertical three-dimensional space of the city is fully used in the double-story pie column monorail transportation-based spatial transport system with a suspended guideway with a bottom opening on the first layer, maglev on the second layer, no traffic on the third layer, and straddle monorail on the fourth layer, thereby dispersing the urban ground passenger flow, reducing the dense vehicle congestion; speeding up the urban logistics efficiency, reducing logistics costs, and reducing the impact of ground logistics vehicles on roadway traffic. At the same time, the integration of three types of

monorail transportation is realized, and passenger logistics operation efficiency is increased and urban construction costs are reduced.

[0203] Embodiment 16: A double-story pie column monorail transportation-based spatial transport system with no traffic on the first layer, straddle monorail on the second layer, bottom-opened suspended guideway on the third layer, and maglev traffic on the fourth layer.

[0204] It is proposed to build a double-story pie column monorail transportation-based spatial transport system with no traffic on the first layer, straddle monorail on the second layer, bottom-opened suspended guideway on the third layer, and maglev traffic on the fourth layer between cities. Suspended monorail traffic, straddle monorail traffic and maglev are set up in the same double-story pier load-bearing system to form the multi-mode multi-layer space transportation system. Among them, the first layer with no traffic is below the first pier bent cap. The second layer straddle monorail traffic is above the first pier bent cap, using concrete straddle type guideways. The third layer bottom-opened concrete suspended guideway is set under the bent caps of the second piers, and the fourth story maglev is above the second pier bent cap, using I-shaped steel maglev guideway. It is planned to set the maglev as the passenger rail, and the straddle monorail and the suspended monorail as the logistics rail.

[0205] With reference to FIG. **18**, the double-story pie column monorail transportation-based spatial transport system with no traffic on the first layer, straddle monorail on the second layer, bottom-opened suspended guideway on the third layer, and maglev traffic on the fourth layer is demonstrated. The first pier A**11-16**, the second pier A**12-16**, the second-story bent cap B**2-16**, the first-story bent cap B**1-16**, the first straddle guideway K**21-16**, the second straddle guideway K**22-16**, the first maglev guideway C**41-16**, the second maglev guideway C**42-16**, the first bottom opening suspended guideway XD**31-16**, and second bottom opening suspended guideway XD**32-16** are included in the double-story pier type space transportation system based on monorail traffic with no traffic on the first layer, straddle monorail on the second layer, bottom-opened suspended guideway on the third layer, and maglev traffic on the fourth layer.

[0206] From the perspective of traffic layer, no traffic is on the first layer; the second layer is equipped with straddle-type monorail; the third layer is equipped with bottom-opening suspended guideway, and the fourth layer is equipped with maglev. The double-story pier monorail transportation-based spatial transport system is formed by a combination of maglev, suspended monorail and straddle monorail. A four-layer space transportation system is formed by the double-story piers. The first layer with no traffic is under the first-story bent caps; the second layer straddle monorail traffic is set above the first-story bent caps; the third layer suspended monorail is under the second-story bent caps and the fourth layer maglev is above the second-story bent caps.

[0207] From a structural point of view, the first pier A**11-16** and the first-story frame bent cap B**1-16** are consolidated together by concrete pouring; the lower part of the second pier A**12-16** and the first-story frame bent cap B**1-16** are consolidated together by concrete pouring; the upper part of the second pier A**12-16** and the second-story frame bent cap B**2-16** are consolidated together by concrete pouring. The first pier A**11-16** is provided with the first-story frame bent cap B**1-16**; the second pier A**12-16** is provided with the second-story frame bent cap B**2-16**; the first maglev guideway C**41-16** and the second maglev guideway C**42-16** are above the second-story frame bent cap B**2-16** by bearings and are used as the maglev passenger rail; under the second-story frame bent cap B**2-16** is set the first bottom opening suspended guideway XD**31-16** and the second bottom opening suspended guideway XD**32-16** and they are used as suspended logistics rail; the first straddle guideway K**21-16** and the second straddle guideway K**22-16** are set above the first-story frame bent cap B**1-16** for logistics transportation.

[0208] From the perspective of passenger flow, maglev, suspended monorail and straddle monorail are set up in the same double-story pier system. With the increase in traffic layers, the passenger flow transportation capacity in roadway traffic is improved and the low-layer space for passenger flow transportation is efficiently used to avoid road crowded passenger flow and road congestion.

[0209] In terms of logistics, using the multi-layer and multi-mode transportation system, the efficiency of logistics transportation is improved, making full use of the vertical space of the road, avoiding the congestion of ground logistics vehicles.

[0210] Based on the above analysis, the vertical three-dimensional space of the city is fully used in the double-story pie column monorail transportation-based spatial transport system with no traffic on the first layer, straddle monorail on the second layer, bottom-opened suspended guideway on the third layer, and maglev traffic on the fourth layer, thereby dispersing the urban ground passenger flow, reducing the dense vehicle congestion; speeding up the urban logistics efficiency, reducing logistics costs, and reducing the impact of ground logistics vehicles on roadway traffic. At the same time, the integration of three types of monorail form will be realized, and logistics operation efficiency is increased and urban construction costs are reduced.

[0211] In the following text, the three-story frame space transportation system based on monorail transportation is described.

[0212] Embodiment 17: A three-story frame monorail transportation-based spatial transport system with no traffic on the first layer, maglev on the second layer, no traffic on the third layer, straddle monorail on the fourth layer, no traffic on the fifth layer and roadway traffic on the sixth layer.

[0213] It is planned to build a three-story frame monorail transportation-based spatial transport system with no traffic on the first layer, maglev on the second layer, no traffic on the third layer, straddle monorail on the fourth layer, no traffic on the fifth layer and roadway traffic on the sixth layer between cities, and set up maglev, straddle monorail, and roadway traffic in the same load-bearing three-story frame system. Among them, the first layer with no traffic is under the first-story frame bent caps; the second layer maglev is above the first-story frame bent cap, using I-shaped steel maglev guideways; the third layer with no traffic is under the second-story frame bent caps; the straddle monorail traffic is set on the fourth layer above the second-story frame bent caps, using steel box straddle guideways; the fifth layer with on traffic is under the third-story frame bent caps, and roadway traffic is set up on the sixth layer above the third-story frame bent cap. It is planned to set straddle-type monorail as the logistics rail and maglev as the passenger rail.

[0214] With reference to FIG. **19**, the three-story frame space monorail transportation-based spatial transport system with no traffic on the first layer, maglev on the second layer, no traffic on the third layer, straddle monorail on the fourth layer, no traffic on the fifth layer and roadway traffic on the sixth layer is demonstrated in this patent. The first layer does not provide traffic; the second layer provides maglev; the third layer does not provide traffic; the fourth layer provides straddle monorail; the fifth layer does not provide traffic, and the sixth layer provides roadway traffic. A first outer line straddle guideway K**41-17**, a second outer line straddle guideway K**44-17**, a first inner line straddle guideway K**42-17**, a second inner line straddle guideway K**43-17**, a first outer line maglev guideway C**21-17**, a second outer line maglev guideway C**24-17**, a first inner line maglev guideway C**22-17**, a second inner line maglev guideway C**23-17**, a first frame pier A**21-17**, a second frame pier A**22-17**, a third frame A**23-17**, a first-story frame bent cap B**1-17**, a second-story frame bent cap B**2-17**, a third-story frame bent cap B**3-17**, a highway roadway slab G**6-17**, and a longitudinal beam Z**6-17** are included in the three-story space transportation system based on monorail.

[0215] From the perspective of traffic layers, the first layer does not provide traffic; the second layer provides maglev; the third layer does not provide traffic; the fourth layer provides straddle monorail; the fifth layer does not provide traffic, and the sixth layer provide traffic. The three-story frame monorail transportation-based spatial transport system with no traffic on the first layer, maglev on the second layer, no traffic on the third layer, straddle monorail on the fourth layer, no traffic at the fifth layer and roadway traffic at the sixth layer is formed by the combination of two types of monorail transportation forms and highway traffic. A six-layer space transportation system is formed by the three-story frame. The first layer with no traffic is under the first-story frame bent caps; the second layer maglev is set up above the first-story bent caps; the third layer with no traffic is under the second-story bent caps; the fourth layer straddle monorail is above the second-story bent caps; the fifth layer with no traffic is under the third-story bent caps and the sixth layer roadway traffic is above the third-story bent caps.

[0216] From the structural point of view, the first frame pier A**21-17** and the first-story frame bent cap B**1-17** are consolidated together by concrete pouring; the lower part of the second frame pier A**22-17** and the first-story frame bent cap B**1-17** are consolidated together by concrete pouring; the upper part of the second frame pier A**22-17** and the second-story frame bent cap B**2-17** are consolidated together by concrete pouring; the lower part of the third frame pier A**23-17** and the second-story frame bent cap B**2-17** are consolidated by concrete pouring, and the upper part of the third frame pier A**23-17** and the third-story frame bent cap B**3-17** are cast and consolidated together. The longitudinal beam Z**6-17** is set above the third-story frame bent cap B**3-17** to support the highway roadway slab G**6-17** for the operation of the upper roadway traffic system; the first outer line straddle guideway K**41-17**, the first inner line straddle guideway K**42-17**, the second inner line straddle guideway K**43-17** and the second outer line straddle guideway K**44-17** are connected to the upper part of the second-story frame bent cap B**2-17** through the bearings and are set up as the rail for logistics; the first outer line maglev guideway C**21-17**, the first inner line maglev guideway C**22-17**, the second inner line maglev guideway C**23-17** and the second outer line The maglev guideway C**24-17** are connected to the top of the first-story frame bent cap B**1-17** by bearings, and serves as the passenger rail.

[0217] From the perspective of passenger flow, three traffic modes: roadway traffic, straddle monorail traffic, and maglev traffic are set up on the same three-floor frame system. With the increase of traffic layers, the passenger transportation capacity in roadway traffic is improved, and the low-layer space for passenger flow transportation is efficiently used to avoid dense subway passenger flow and road congestion.

[0218] In terms of logistics, with the multi-mode, multi-layer transportation system, the efficiency of logistics transportation is improved and the congestion of ground logistics vehicles is avoided.

[0219] According to the above analysis, the vertical three-dimensional space of the road is fully used in the three-story frame monorail transportation-based spatial transport system with no traffic on the first layer, maglev on the second layer, no traffic on the third layer, straddle monorail on the fourth layer, no traffic on the fifth layer and roadway traffic, thereby dispersing the road ground passenger flow, reducing the dense vehicle congestion; speeding up road logistics efficiency, reducing logistics costs, and reducing the impact of ground logistics vehicles on the roadway traffic. At the same time, the multi-functional integrated construction of highway traffic and monorail is realized and passenger logistics operation efficiency is increased and urban construction costs are reduced.

[0220] Embodiment 18: A three-story frame space transportation system based on monorail traffic with suspended monorail on the first layer, maglev on the second layer, no traffic on the third layer, roadway traffic on the fourth layer, no traffic on the fifth layer and straddle monorail on the sixth layer.

[0221] It is proposed to build a three-story pie column monorail transportation-based spatial transport system with suspended monorail on the first layer, maglev on the second layer, no traffic on the third layer, roadway traffic on the fourth layer, no traffic on the fifth layer and straddle monorail on the sixth layer between cities. Maglev, straddle monorail, suspended monorail, and roadway traffic are set up in the same three-story load-bearing frame system. Among them, the first layer suspended monorail is under the first-story frame bent caps, using bottom-opened concrete suspended guideways; the second layer maglev is above the first-story frame bent caps, using I-shaped steel guideways; the third layer with no traffic is under the second-story frame bent caps; the fourth layer roadway traffic is above the second-story frame bent caps; the fifth layer with no traffic is under the third-story frame bent caps; the straddle-type monorail traffic is set up on the sixth layer above the third-story frame bent caps, using concrete straddle guideways. It is planned to set the straddle-type monorail and maglev as the passenger rail, and suspended monorail as the logistics rail.

[0222] With reference to FIG. **20**, a first outer line straddle guideway K**61-18**, a second outer line straddle guideway K**64-18**, a first inner line straddle guideway K**62-18**, a second inner line straddle guideway K**63-18**, a first outer line maglev guideway C**21-18**, a second outer line maglev guideway C**24-18**, a first inner line maglev guideway C**22-18**, a second inner line maglev guideway C**23-18**, a first external line suspended guideway XD**11-18**, a second exter-

nal line suspended guideway XD**14-18**, a first internal line suspended guideway XD**12-18**, a second internal line suspended guideway XD**13-18**, a first frame pier A**21-18**, a second frame pier A**22-18**, a third frame pier A**23-18**, a first-story frame bent cap B**1-18**, a second-story frame bent cap B**2-18**, a third-story frame bent cap B**3-18**, a highway carriageway plate G**4-18**, and a longitudinal beam Z**4-18** are included in the three-story frame space transportation system based on monorail traffic with suspended monorail on the first layer, maglev on the second layer, no traffic on the third layer, roadway traffic on the fourth layer, no traffic on the fifth layer and straddle monorail on the sixth layer.

[0223] From the perspective of traffic layer, the three-story frame monorail transportation-based spatial transport system with suspended monorail on the first layer, maglev on the second layer, no traffic on the third layer, roadway traffic on the fourth layer, no traffic on the fifth layer and straddle monorail on the sixth layer is formed by the combination of straddle monorail, suspended monorail, highway traffic, and maglev. A six-layer space transportation system is formed by the three-story frame. The first layer is the suspended monorail under the first-story frame bent caps; the second layer is the maglev traffic above the first-story bent caps; the third layer with no traffic is under the second-story bent caps; the fourth layer roadway traffic is above the second-story bent caps; the fifth layer with no traffic is under the third-story bent caps and the sixth layer straddle monorail is above the third-story bent caps.

[0224] In terms of structure, the first frame pier A**21-18** and the first-story frame bent cap B**1-18** are consolidated together by concrete pouring; the lower part of the second frame pier A**22-18** and the first-story frame bent cap B**1-18** are consolidated together by concrete pouring; the upper part of the second frame pier A**22-18** and the second-story frame bent cap B**2-18** are consolidated together by concrete pouring; the lower part of the third frame pier A**23-18** and the second-story frame bent cap B**2-18** are consolidated by concrete pouring; the upper part of the third frame pier A**23-18** and the third-story frame bent cap B**3-18** are cast and consolidated together; the first outer line straddle guideway K**61-18**, the first inner line straddle guideway K**62-18**, the second inner line straddle guideway K**63-18** and the second outer line straddle guideway K**64-18** are arranged above the third-story frame bent cap B**3-18** and are used as the passenger rail; the longitudinal beam Z**4-18** is set above the second-story frame bent cap B**2-18** of the second-story to support the highway carriageway plate G**4-18**, which is used for the operation of the highway traffic system; above the first-story frame bent cap B**1-18**, the first outer line maglev guideway C**21-18**, the first inner line maglev type guideway C**22-18**, the second inner line maglev guideway C**23-18** and the second outer line maglev guideway C**24-18** are arranged above the first-story frame bent cap B**1-18** and are used as the passenger rail; under the first-story frame bent cap B**1-18**, the first outer line suspended guideway XD**11-18**, the first inner line suspended guideway XD**12-18**; the second inner line suspended guideway XD**13-18** and the second outer line suspended guideway XD**14-18** are used as the logistics rail.

[0225] From the perspective of passenger flow, on the same three-story frame system, there are four traffic modes: straddle monorail, highway, maglev, and suspended monorail. With the increase of traffic layers, the passenger flow transportation capacity in roadway traffic is improved, and the lower-layer space for passenger transportation is efficiently used to avoid dense subway passenger flow and road congestion.

[0226] In terms of logistics, in the multi-mode, multi-layer transportation system, the efficiency of logistics transportation is improved and the congestion of ground logistics vehicles is avoided.

[0227] According to the above analysis, the vertical three-dimensional space is fully used in the three-story frame monorail transportation-based spatial transport system with suspended monorail on the first layer, maglev on the second layer, no traffic on the third layer, roadway traffic on the fourth layer, no traffic on the fifth layer and straddle monorail on the sixth layer, thereby dispersing ground passenger flow, reducing vehicle congestion; speeding up logistics efficiency, reducing logistics costs, and reducing the impact of ground logistics vehicles on roadway traffic. At the same time, the multi-functional integrated construction of highway traffic and monorail is realized, and passenger logistics operation efficiency is increased and urban construction costs are reduced.

[0228] In the following text, the three-story pier space transportation system based on monorail traffic is described.

[0229] Embodiment 19: A three-story pier monorail transportation-based spatial transport system with no traffic on the first layer, maglev on the second layer, no traffic on the third layer, straddle monorail on the fourth layer, no traffic on the fifth layer and roadway traffic on the sixth layer.

[0230] It is planned to build a three-story pie column monorail transportation-based spatial transport system with no traffic on the first layer, maglev on the second layer, no traffic on the third layer, straddle monorail on the fourth layer, no traffic at the fifth layer and roadway traffic at the sixth layer in the city, and set up maglev, straddle monorail, and highway traffic in the same load-bearing three-story pier system. Among them, the first layer with no traffic is under the first pier bent caps; the second layer maglev traffic is above the first pier bent caps, using I-shaped steel maglev guideways; the third layer with no traffic is under the second pier bent cap; the fourth layer straddle monorail is above the second pier bent cap, using steel box straddle guideways; the fifth layer with no traffic is under the third-story column bent caps, and roadway traffic is set up on the sixth layer above the third-story pier bent caps. It is planned to set straddle-type monorail as the logistics rail and maglev as the passenger rail.

[0231] With reference to FIG. **21**, the three-story pie column monorail transportation-based spatial transport system with no traffic on the first layer, maglev on the second layer, no traffic on the third layer, straddle monorail on the fourth layer, no traffic on the fifth layer and roadway traffic on the sixth layer is demonstrated in this patent. The first layer does not provide traffic; the second layer provides maglev; the third layer does not provide traffic; the fourth layer provides straddle monorail transportation; the fifth layer does not provide traffic, and the sixth layer provides roadway traffic. A first pier A**11-19**, a second pier A**12-19**, a third pier A**13-19**, a third-story frame bent cap B**3-19**, a second-story frame bent cap B**2-19**, a first-story frame bent cap B**1-19**, a longitudinal beam Z**6-19**, a roadway slab G**6-19**, a first straddle guideway K**41-19**, a second straddle guideway K**42-19**, a first maglev guideway C**21-19** and a second maglev guideway C**22-19** are included in the three-story pier space transportation system based on monorail

traffic with no traffic on the first layer, maglev on the second layer, no traffic on the third layer, straddle monorail on the fourth layer, no traffic on the fifth layer and roadway traffic on the sixth layer.

[0232] From the perspective of traffic layers, the three-story pier monorail transportation-based spatial transport system with no traffic on the first layer, maglev on the second layer, no traffic on the third layer, straddle monorail on the fourth layer, no traffic at the fifth layer and roadway traffic at the sixth layer is formed by a combination of two types of monorail transportation and highway traffic. A six-layer space transportation system is formed by the three-story pier system. The first layer with no traffic in under the first-story bent caps; the second layer maglev is above the first-story bent caps; the third layer with no traffic is under the second-story bent caps; the fourth layer straddle monorail traffic is above the second-story bent caps; the fifth layer with no traffic is under the third-story bent caps, and the sixth layer roadway traffic is above the third-story bent cap.

[0233] From the structural point of view, the first pier A**11-19** and the first-story frame bent cap B**1-19** are consolidated together by concrete pouring; the lower part of the second pier A**12-19** and the first-story frame bent cap B**1-19** are consolidated together by concrete pouring; the upper part of the second pier A**12-19** and the second-story frame bent cap B**2-19** are consolidated together by concrete pouring; the lower part of the third pier A**13-19** and the second-story frame bent cap B**2-19** are consolidated together by concrete pouring; the upper part of the third pier A**13-19** and the third-story frame bent cap B**3-19** are pouring and consolidating together. The third pier A**13-19** is provided with the third-story frame bent cap B**3-19**; the second pier A**12-19** is provided with the second-story frame bent cap B**2-19**; the first pier A**11-19** is provided with the first-story frame bent cap B**1-19**; the longitudinal beam Z**6-19** is set above the third-story frame bent cap B**3-19** to support the roadway slab G**6-19**; the first straddle guideway K**41-19** and the second straddle guideway K**42-19** are connected above the second-story frame bent cap B**2-19** by bearings and are used as the logistics rail; the first maglev guideway C**21-19** and the second maglev guideway C**22-19** are connected above the first-story frame bent cap B**1-19** by bearings and are used as a maglev passenger rail for passenger flow transportation.

[0234] From the perspective of passenger flow, the same three-story pier system is equipped with straddle monorail, maglev, and highway traffic. With the increase of traffic layers, the passenger transportation capacity in roadway traffic is improved, and the low-layer space for passenger flow transportation is efficiently used to avoid dense subway passenger flow and road congestion.

[0235] In terms of logistics, the capacity and efficiency of logistics transportation are improved in the multi-layer and multi-mode transportation system and the congestion of ground logistics vehicles is avoided.

[0236] According to the above analysis, the vertical three-dimensional space of the road is fully used in the three-story pier monorail transportation-based spatial transport system with no traffic on the first layer, maglev on the second layer, no traffic on the third layer, straddle monorail on the fourth layer, no traffic on the fifth layer and roadway traffic on the sixth layer, thereby dispersing the road ground passenger flow, reducing the dense vehicle congestion, speeding up road logistics efficiency, reducing logistics costs, and reducing ground logistics vehicles impact on roadway traffic. At the same time, the multi-functional integration of maglev, straddle monorail and highway traffic are realized, and passenger logistics operation efficiency is increased and urban construction costs are reduced.

[0237] Embodiment 20: A three-story pie column monorail transportation-based spatial transport system with suspended monorail on the first layer, straddle monorail on the second layer, no traffic on the third layer, maglev on the fourth layer, no traffic on the fifth layer and railway traffic on the sixth layer.

[0238] It is proposed to build a three-story pie column monorail transportation-based spatial transport system with suspended monorail on the first layer, straddle monorail on the second layer, no traffic on the third layer, maglev on the fourth layer, no traffic on the fifth layer and railway traffic on the sixth layer between cities, and set up maglev, straddle monorail, suspended monorail and highways in the same three-story pier load-bearing system, forming a multi-mode and multi-layer transportation system. Among them, the first layer with suspended monorail is under the first pier bent cap, adopting a concrete suspended guideways with an opening at the bottom; the second layer with straddle monorail is above the pier bent cap on the second story, using steel-concrete composite straddle guideway; the third layer with no traffic is under the second pier bent caps; the fourth layer with maglev is above the second pier bent caps, using I-shaped steel maglev guideway; the fifth layer with no traffic is below the third-story pier bent cap and the sixth layer railway traffic is above the third-story pier bent cap. It is proposed to set straddle monorail as the logistics rail, and maglev and suspended monorail as the passenger rail.

[0239] With reference to FIG. **22**, a first pier A**11-20**, a second pier A**12-20**, a third pier A**13-20**, a third-story frame bent cap B**3-20**, a second-story frame bent cap B**2-20**, a first-story frame bent cap B**1-20**, a longitudinal beam Z**6-20**, a railway carriageway T**6-20**, a first straddle guideway K**21-20**, a second straddle guideway K**22-20**, a first maglev guideway C**41-20**, a second maglev guideway C**42-20**, a first suspended guideway X**11-20** and a second suspended guideway X**12-20** are included in the three-story pie column space transportation system based on monorail traffic with suspended monorail on the first layer, straddle monorail on the second layer, no traffic on the third layer, maglev on the fourth layer, no traffic at the fifth layer and railway traffic at the sixth layer.

[0240] From the perspective of traffic layer, the first layer is equipped with suspended monorail; the second layer is equipped with straddle monorail; the third layer is not equipped with traffic; the fourth layer is equipped with maglev, and the fifth layer is not equipped with traffic and the sixth layer is equipped with railway traffic. The three-story pier monorail transportation-based spatial transport system is formed by the combination of three types of monorail transportation and railway traffic. The first layer is the suspended monorail under the first-story bent caps; the second layer is the straddle monorail above the first-story bent caps; the third layer with no traffic is set up under the second-story bent caps; the fourth story is maglev above the second-story bent caps, and there is no traffic set up on the fifth layer under the third-story bent caps, and the sixth layer railway traffic is above the third-story bent caps.

[0241] From the structural point of view, the first pier A**11-20** and the first-story frame bent cap B**1-20** are consolidated together by concrete pouring, and the lower part of

the second pier A**12-20** and the first-story frame bent cap B**1-20** are consolidated together by concrete pouring; the upper part of the second pier A**12-20** and the second-story frame bent cap B**2-20** are consolidated together by concrete pouring; the lower part of the third pier A**13-20** and the second-story frame bent cap B**2-20** are consolidated together by concrete pouring; the upper part of the third pier A**13-20** and the third-story frame bent cap B**3-20** are poured and consolidated together. The third pier A**13-20** is provided with the third-story frame bent cap B**3-20**; the second pier A**12-20** is provided with the second-story frame bent cap B**2-20**; the first pier A**11-20** is provided with the first-story frame bent cap B**1-20**; the longitudinal beam Z**6-20** is set above the third-story frame bent cap B**3-20** to support the railway carriageway T**6-20**; the first maglev guideway C**41-20** and the second maglev guideway C**42-20** are connected above the second-story frame bent cap B**2-20** as the maglev passenger rail for passenger traffic; the first straddle guideway K**21-20** and the second straddle guideway K**22-20** are connected above the first-story frame bent cap B**1-20** through the bearings and are used as the straddle rail for logistics transportation; under the first-story frame bent cap B**1-20**, the first suspended guideway X**11-20** and the second suspended guideway X**12-20** are connected through the bearings and are used as the suspended passenger rail for passenger flow transportation.

[0242] From the perspective of passenger flow, the same three-story pier system is equipped with straddle monorail, maglev, suspended monorail, and railway traffic. With the increase of traffic layers, the passenger flow transportation capacity in roadway traffic is improved, and the low-layer space for passenger flow transportation is efficiently used, avoiding dense road passenger flow and road congestion.

[0243] In terms of logistics, the capacity and efficiency of logistics transportation are improved in the multi-layer and multi-mode transportation system and the congestion of ground logistics vehicles is avoided.

[0244] According to the above analysis, the vertical three-dimensional space of the road is fully used in a three-story pier monorail transportation-based spatial transport system with suspended monorail on the first layer, straddle monorail on the second layer, no traffic on the third layer, maglev on the fourth layer, no traffic on the fifth layer and railway traffic on the sixth layer, thereby dispersing the road ground passenger flow, reducing the dense vehicle congestion; speeding up logistics efficiency, reducing logistics costs, and reducing ground logistics vehicles impact on roadway traffic. At the same time, the multi-functional integrated construction of monorail transportation and railway traffic will be realized, and passenger logistics operation efficiency will be increased and urban construction costs are reduced.

[0245] The technical solutions and beneficial effects of this patent are illustrated in the above-mentioned embodiments, and are only used to explain the rights and do not limit the rights. The above are only specific embodiments of this patent, and cannot be used to limit the scope of this patent. The space transportation system based on monorail traffic described in the above embodiments can be built on streets within cities, or on roads between cities, or in fields, and its use location is not limited. The maglev, suspended monorail, and straddle monorail described in the above embodiments can all be used as logistics rails or as passenger rails, and their use range is not limited. The form and material of the guideways or guideways in straddle monorail, suspended monorail, and maglev described in the above embodiments are not limited. Any modification, equivalent replacement, etc. made within the principles of this patent shall be included in the scope of protection of this patent.

What is claimed is:

1. A monorail transportation-based spatial transport system comprising:

a load-bearing frame system; or

a load-bearing pier system;

wherein, the spatial transport system is divided by the load-bearing frame system and the load-bearing pier system into at least two layers by bent caps;

odd-numbered layers located below bent caps and even-numbered layers located above the bent caps are included in the at least two layers;

a suspended monorail transportation or no suspended monorail are included in the odd-numbered layers;

any one of straddle monorail, maglev, roadway traffic, and railway traffic, or on monorail traffic and other transportation modes are included in the even-numbered layers;

two or more than one type of monorail modes, or a combination of one or more types of monorail transportation and other transportation modes are included in the spatial transport system;

2. The monorail transportation-based spatial transport system of claim **1**, wherein a single-story frame, a double-story frame or a three-story frame are included in the load-bearing frame system.

3. The monorail transportation-based spatial transport system of claim **2**, wherein

a first pier and a first-story frame bent cap are included in a single-story frame;

a first pier, a second pier, a first-story frame bent cap and a second-story frame bent cap are included in a double-story frame;

the first pier, the second pier, a third-story frame pier, the first-story frame bent cap, the second-story frame bent cap and a third-story frame bent cap are included in a three-story frame;

the first pier and the first-story frame bent cap are fixed together;

the lower part of the second frame pier and the first-story frame bent cap are consolidated together;

the upper part of the second pier and the second-story frame bent cap are consolidated together;

the lower part of the third-story frame pier and the second-story frame bent cap are consolidated together;

the upper part of the third-story frame pier and the third-story frame bent cap are consolidated together.

4. The monorail transportation-based spatial transport system of claim **1**, wherein

suspended monorail guideways in the odd-numbered layers of the load-bearing frame system are connected to the bottom of a frame bent cap by bearings;

straddle monorail or maglev guideways in the even-numbered layer of the load-bearing frame system are connected to the top of the frame bent cap by bearings;

bridge decks of highway or railway traffic in the even-numbered layers of the load-bearing frame system are supported above the frame bent cap by longitudinal beams.

5. The monorail transportation-based spatial transport system of claim **1**, wherein a single-story pier system, a

double-story pier system or a three-story pier system are included in a load-bearing pier system.

6. The monorail transportation-based spatial transport system of claim **5**, wherein

a first pier and a first layer bent cap are included in a single-story pier system;

the first pier, a second pier, the first layer bent cap and a second layer bent cap are included in a double-layer pier system;

the first pier, the second pier, a third pier, the first layer bent cap, the second layer bent cap and a third layer bent cap are included in a three-layer pier system;

the first pier and the first layer bent cap are consolidated together;

the lower part of the second pier and the first layer bent cap are consolidated together;

the upper part of the second pier and the second layer bent cap are consolidated together;

the lower part of the third pier and the second layer bent cap are consolidated together;

the upper part of the third pier and the third layer bent cap are consolidated together.

7. The monorail transportation-based spatial transport system of claim **1**, wherein

suspended monorail traffic guideways in odd-numbered layers of a load-bearing pier system are connected to the bottom of bent caps by bearings;

straddle monorail or maglev guideways in even-numbered layers of the load-bearing pier system are connected above bent caps by bearings;

bridge decks of the roadway or railway traffic in even-numbered layers of the load-bearing pier system are supported above bent caps by longitudinal beams.

8. The monorail transportation-based spatial transport system of claim **3**, wherein

suspended monorail guideways in the odd-numbered layers of the load-bearing frame system are connected to the bottom of a frame bent cap by bearings;

straddle monorail or maglev guideways in the even-numbered layer of the load-bearing frame system are connected to the top of the frame bent cap by bearings;

bridge decks of highway or railway traffic in the even-numbered layers of the load-bearing frame system are supported above the frame bent cap by longitudinal beams.

9. The monorail transportation-based spatial transport system of claim **6**, wherein

suspended monorail traffic guideways in odd-numbered layers of a load-bearing pier system are connected to the bottom of bent caps by bearings;

straddle monorail or maglev guideways in even-numbered layers of the load-bearing pier system are connected above bent caps by bearings;

bridge decks of the roadway or railway traffic in even-numbered layers of the load-bearing pier system are supported above bent caps by longitudinal beams.

* * * * *