(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 819 435 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
12.05.2021 Bulletin 2021/19

(21) Application number: **19814907.2**

(22) Date of filing: **04.01.2021**

(51) Int Cl.:
E02D 27/00 *(2006.01)* ***E02D 27/32*** *(2006.01)*
E02D 27/34 *(2006.01)* ***E02D 31/00*** *(2006.01)*
E02D 31/08 *(2006.01)* ***E04H 9/00*** *(2006.01)*
E04H 9/02 *(2006.01)*

(86) International application number:
PCT/KZ2019/000008

(87) International publication number:
WO 2019/235909 (12.12.2019 Gazette 2019/50)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **05.06.2018 KZ 20180375**

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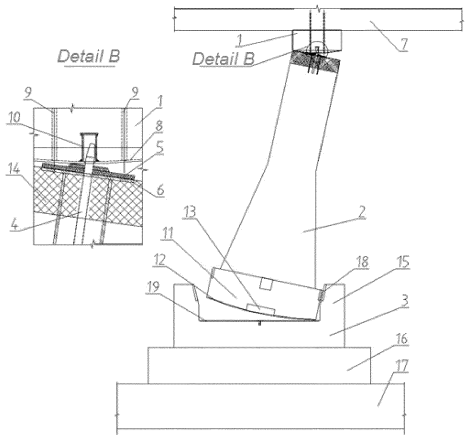
(54) EARTHQUAKE-RESISTANT FOUNDATION

(57) The invention relates to the design and construction of residential, public and industrial buildings and structures having a flexible framework and earthquake-resistant kinematic foundations. An earthquake-resistant foundation consists of a supporting structure, and an upright post with a cylindrical heel having a spherical lower surface that constitutes a portion of a sphere having a radius R freely supported on a flat supporting foundation, said supporting structure and said upright post being hingedly connected to one another and being protected against corrosion. The spherical surface of the heel has a radius R = 1,05H to R = 1,2H and is provided with an insert member. The insert member is spherically shaped with flat edges and a flat centre portion, and the lateral surface of the upright post, beginning from the middle downwards, forms a conical surface. The claimed invention achieves the technical effect of providing more effective earthquake-resistance for buildings and reducing material outlay.

Figure.2 Position during seismic load



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Description

[0001] The invention relates to the design and construction of residential, public and industrial buildings and structures with flexible framework and earthquake-resistant kinemtatic foundations.

[0002] One of the known used technologies of the previous generation is kinematic foundation of KU (Kurzanov) with ball-shaped form in the lower and upper parts of prop, used in the construction of residential buildings in Sotschi, Russia (author: Stanislav Semenov) [Pipe-concrete earthquake-resistant support, RU 2 477 353 C1]. The deficiency of this invention is the decrease of support surface of KU on supporting slab, as the radius of support on supporting slab is halved, consequently the firmness of the kinematic foundation is twice reduced. The concrete is poured through the upper orifice in the concrete pipe construction, which complicates the visual quality control of concrete pouring [Pipe-concrete seismic isolation support, RU 2 477 353 C1].

[0003] Another known kinematic foundation is pyramid-shaped socle or upright stand of rectangular section with enlarged heel of ball-shaped of lower part and hinge-joint in the upper part of kinematic foundation in line with the picture 2a, b, Guiding Construction Document of Republic of Kazakhstan 2.03-06-2002 «Instruction for design of seismic isolation of kinematic foundation».

[0004] Another known earthquake-resistant kinematic foundation (invention patent N 31353) as an upright stand of cylindrical section with enlarged heel of ball-shaped lower part and hinge in the upper part of earthquake-resistant kinematic foundation, which is a prototype.

[0005] The deficiency of these earthquake-resistant foundations are:

- insufficient firmness of earthquake-resistant kinematic foundation for buildings above 10 stores and up to 25 stores including;
- lack of limiters for horizontal seismic force of more than magnitude of 9 and resonating phenomena.
- lack of oscillation dampers and damping devices.

[0006] Technical result is a construction of earthquake-resistant foundation, shown on the figure 1, which consists of support structure 1, kinematic foundation 2 of cylindrical shape which transfers in conical shape and base foundation 3.

[0007] Between support structure 1 and kinematic foundation 2 two level gasket 5 is put on dowel pin 4 and welded to embedded part 6.

[0008] Support structure 1 is the support for interfloor slab 7, which is made of high strength concrete in cylindrical form with spherical supporting insert member 8 with anticorrosive protection, which can be made of metal or composite form, with protruding bars 9 and welded pipe 10.

[0009] In case of the precast implementation of above frame, it is the lower part of the construction "PBS 2 in 1" according to patent on invention KZ 32274.

[0010] Kinematic foundation 2 of cylindrical shape transfers into cone-shaped form, and then into enlarged cylindrical heel 11 with metallic spherical supporting insert detail with anticorrosive protection 12 with flat edges and with flat central part, with the radius of spherical surface of the foot from R=1,05 H to R= 1,2H.

[0011] Before concreting, magnetic block 13 is inserted in the central flat part of metallic spherical supporting insert member 12. This block dampens the oscillations of kinematic foundation 2 and acts as damper.

[0012] In the upper part of kinematic foundation 2 one installs cylindrical insert member 14, which is welded with the insert member 6.

[0013] Supporting foundation 3 consists of base, fenced by upstands 15, made of high-strength concrete, ledge 16 and the base 17, insert member 18, made of metallic or composite material of conical shape, which is the protection element of the upstands 15, during the seismic hit of above magnitude of 10.

[0014] For the protection from the deformation of base foundation 3 from vertical load of the nine-storied building and more, the insert member 19 with the round shape with anticorrosive protection to which magnetic block 13 gravitates and acts as damper. With each oscillation of kinematic foundation 2 magnetic block 13 touches insert member 19 and gravitates to supporting foundation 3 and prevents the oscillations of kinematic foundation 2 until it is full stop in designed position.

[0015] Thus, seismic isolation foundation effectively provides earthquake resistance of the building during the earthquake hits of above magnitude of 9; allows to design 10-25 storied buildings with underground auto parking, including the ones with flexible frame; complies with the list of norms and rules of Republic of Kazakhstan; does not require considerable capital expenditures; additionally lowers the cost of construction of 10-25-storied buildings by 30%, thanks to the exclusion of shear walls and reduction of the reinforcement of building frames; and provides comfort living without fear of earthquake, saves budget money necessary for the elimination of earthquake consequences.

[0016] Data proving feasibility of the invention are:

- Design and experimental drawings made for field loads from 30 to 800 tons, exerted on kinematic foundation 2.

- Letter from MIR (Ministry of industry and development of Kazakhstan) 04-1-30/11370 as of 23.04.2018 (last paragraph) that the technology "System of precast beamless frames with earthquake-resistant kinematic foundations", in accordance with the procedure established by legislation, was included in the unified national register of new technologies in construction; a full set of documents for the project must be submitted to the "akimat" (municipal, district or provincial government) of the re-

gion.

- Letter from Administrative Office of the Business Rights Commission of Kazakhstan № 5297/18 as of 16 .05.2018 about assistance in promoting the project and financial support from the akimats on building construction using this technology.

Details of the invention are elaborated in drawings: Fig.1 shows seismic isolation foundation in a static position with detail «A».

[0017] Fig.2 shows the earthquake-resistant foundation under earthquake load of magnitude 9 with detail «B».

[0018] Positions show:

1. Support structure made of high-strength concrete.
2. Kinematic foundation made of high-strength concrete.
3. Supporting foundation made of high-strength concrete.
4. Dowel pin made from Class A-I reinforcing steel.
5. Two-level gasket hinge joint.
6. Insert member 6 with the diameter of 2mm less than the diameter of the supporting structure 2.
7. Interfloor slab
8. Spherical supporting insert member with anticorrosive protection.
9. Reinforced protruding bars.
10. Welded pipe.
11. Enlarged cylindrical heel.
12. Metallic spherical supporting insert member with a flat central part and flat edges with anticorrosive protection.
13. Magnetic block.
14. Cylindrical insert member with anticorrosive protection.
15. Upstands made of high-strength concrete.
16. Foundation ledge made of heavy concrete.
17. Foundation base.
18. Conical-shaped insert member with anticorrosive protection.
19. Rounded insert member with anticorrosive protection.

Claims

1. An earthquake-resistant foundation consisting of a supporting structure and an upright post with a cylindrical heel having a spherical lower surface that constitutes a portion of a sphere having a radius R freely supported on a flat supporting foundation with upstands, said supporting structure and said upright post being hingedly connected to one another and being protected against corrosion, differs in a way that spherical surface of the heel has a radius of R=1.05H to R=1.2H and is provided with a spherically-shaped insert member with flat edges and a flat centre portion, and the lateral surface of the upright post, beginning from the middle downwards, forms a conical surface.

2. Earthquake-resistant foundation according to paragraph 1 differs in a way that upstands of a flat supporting foundation have a conical insert member, which forms tight abutting joint with cylindrical surface of supporting heel, and prevent the deviation of upright stand of earthquake-resistant foundation from the vertical axe by more than 15 degrees.

3. Earthquake-resistant foundation according to paragraph 1 differs in a way, that magnetic block is inserted into flat central part of cylindrical supporting heel, said magnetic block acts as damper and dampens seismic influences and fixes the upright post with cylindrical supporting heel in the original position.

Figure.1 Static position

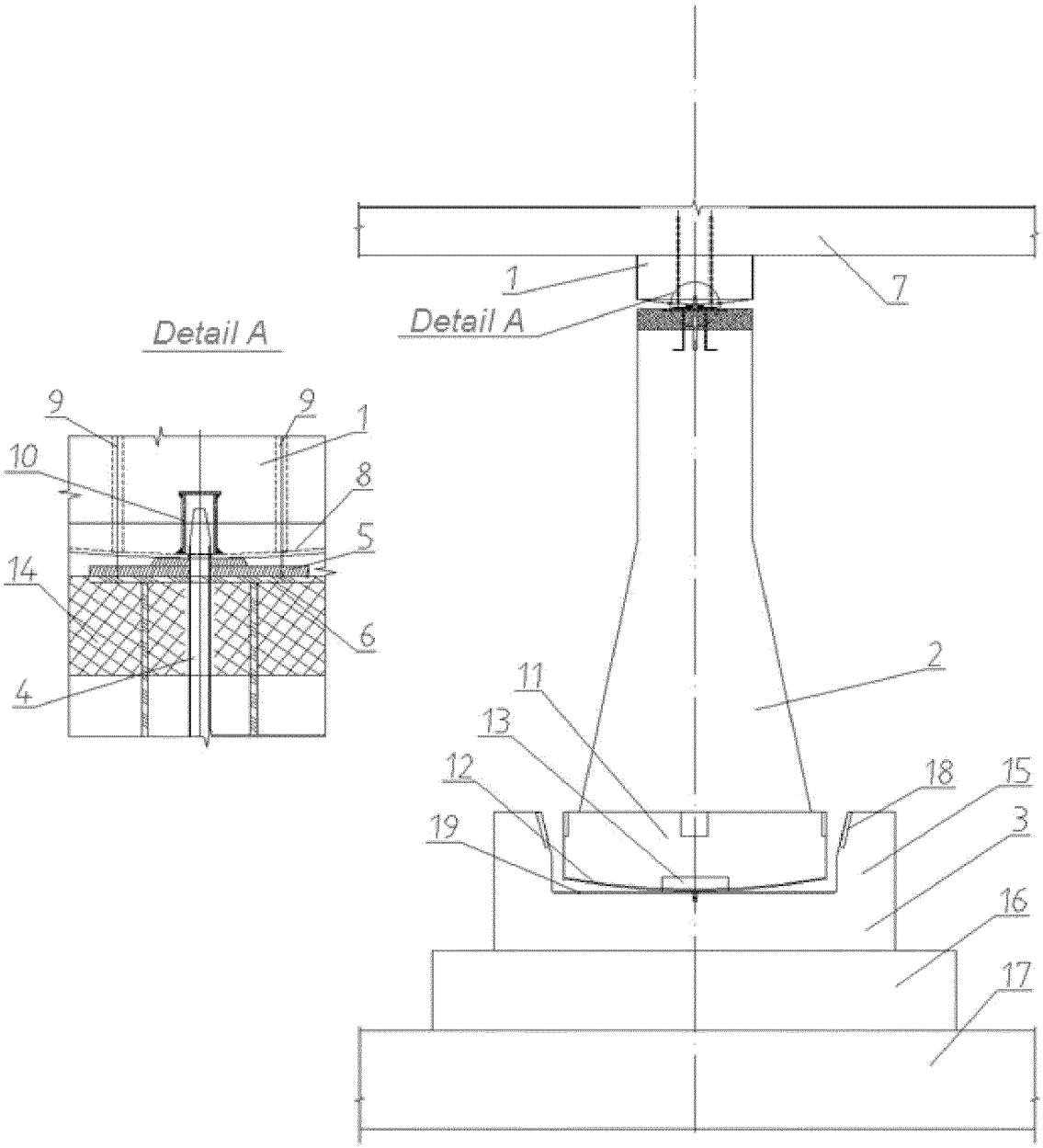
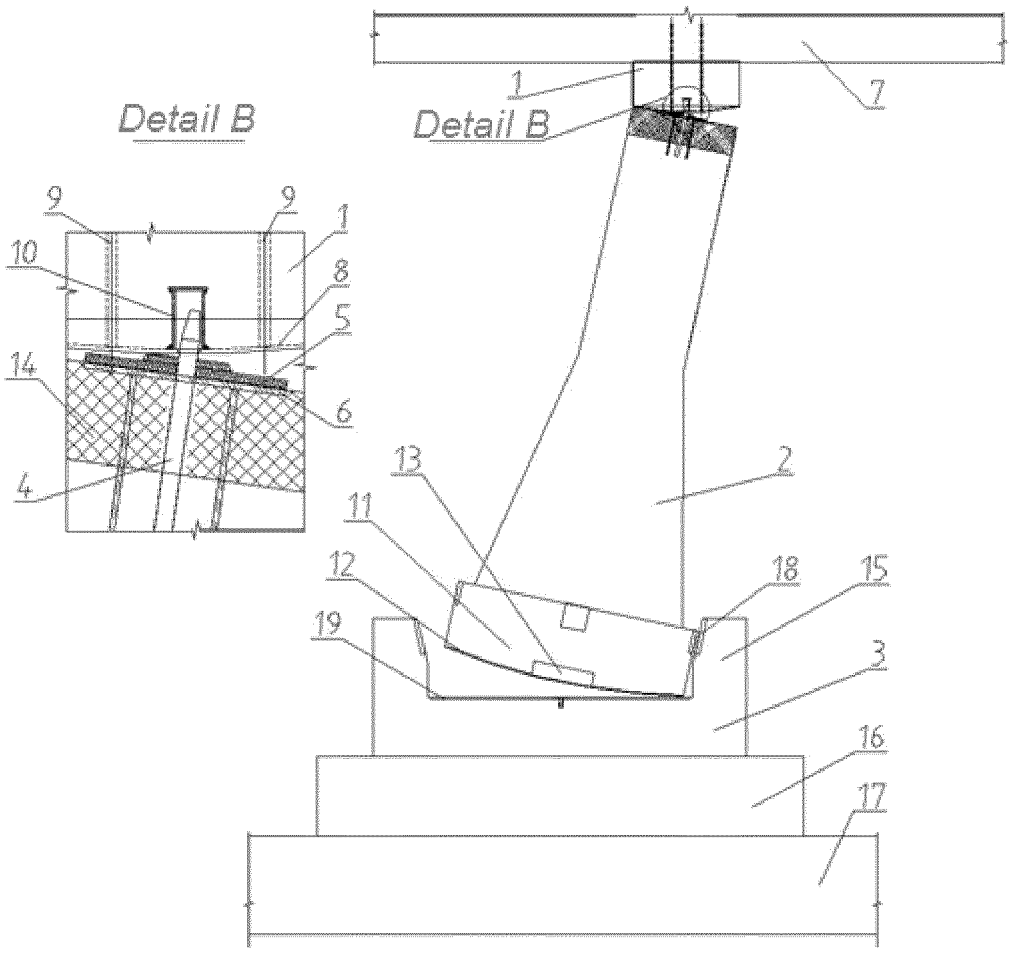


Figure.2 Position during seismic load



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KZ 2019/000008

A. CLASSIFICATION OF SUBJECT MATTER
E21D 27/34 *(2006.01)*

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E 02 D 27/00, 27/32, 27/34, 31/00, 31/08, E 04 H 9/00, 9/02

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

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

PatSearch (RUPTO internal), USPTO, PAJ, Esp@cenet, DWPI, EAPATIS, PATENTSCOPE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A,D	KZ 31353 V (TOVARISHCHESTVO S OGRANICHENNOI OTVETSTVENNOSTJU «SSK-PROEKT ») 15.07.2016	1-3
A	RU 2063503 Cl (KAMCHATSKOE OTDELENIE DALNEVOSTOCHNOGO NAUCHNO-ISSLEDOVATELSKOGO, PROEKTNO-KONSTRUKTORSKOGO I TEKHNOLOGICHESKOGO INSTITUTA PO STROITELSTVU MINSTROIA ROSSII) 10.07.1996	1-3
A	SU 1654504 A1 (BEZRUKOV JU.I. et al.) 07.06.1991	1-3
A	DE 19958537 A1 (MICHELIS, WALTER) 07.06.200119	1-3

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
19 September 2019 (19.09.2019)	11 September 2019 (11.09.2019)
Name and mailing address of the ISA/ RU	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- RU 2477353 C1 **[0002]**
- RU 31353 **[0004]**
- KZ 32274 **[0009]**

Non-patent literature cited in the description

- Instruction for design of seismic isolation of kinematic foundation. *Guiding Construction Document of Republic of Kazakhstan 2.03-06-2002* **[0003]**