

NEW SOLUTION – REFRIGERATORS FOR FRUITS AND VEGETABLES WITH ELASTIC WALL PROTECTION

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Abstract

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In this paper are reviewed several solutions for panel walls and panel connections, representing a part of the enclosing structure of the chambers of fruit storehouses, which are often subject to hits coming from various sources, including during extreme situations. The solutions represent patented inventions, representing an integral part of the dissertation of the author [1].

BG 401 (Y1) – “Connection between panels”; This solution integrates an elastic protective screen, which can be dismantled in case of premature runout; the hits produced by root fruits and vegetables, stored in bulk are absorbed by the screen, which is suspended over pins, which transfer the energy of the hits to the bearing construction of the wall panels.

BG 62742 (B1) – “Wall panel”; the hit absorption is ensured with the help of elastic screens and coverings, suspended and connected to the sides of the panel.

BG 63218 (B1) – “Multilayer panel with impact – protection and connection between panels.” The covering of the panels is made of elastic materials and it integrates star-shaped elements, which are inserted into the surface layers of the panel.

Membranes, stretched over tensegrity-structures are able to offer protection against harmful impact, e.g. acid rain, volcanic ash, overheating, etc., whereas the refrigerators for fruits and vegetables are situated under these membranes.

The membranes are made of transparent materials, e.g. polyketone, reinforced by carbon fiber, whereas the hothouse effect occurring beneath them can be used to maintain positive temperatures inside the chambers of the refrigerators for fruits and vegetables. Additional protection against premature runout of the external covering of the enclosing structure is ensured by transparent protective membranes. Positive temperature inside of the chambers of the refrigerators is a result of the use of solar energy. The protection of the refrigerators for fruits and vegetables with transparent membranes is especially important in case of extreme situations of various origin.

Key words: refrigerators; fruits; vegetables; walls; protection; patents

Introduction

The chamber walls of fruit storehouses must be protected against hits of various vehicles and objects. Here, most suitable means for ensuring the protection of their walls are elastic materials that meet the sanitary requirements. The technological parameters of the chambers of fruit storehouses require a positive temperature range from + 2 до + 12°C. In connection to this, the author has developed technical solu-

tions with inventive step (Aleksandrov, 2014; Aleksandrov, 2000a; Aleksandrov, 2000a; Aleksandrov, 2001).

The secondary use of refrigeration chambers in positive temperatures for medical purposes in extreme situations offers the possibility to multiply the effect of a protected artificially-created environment and use it in case of extreme situations as bacteriological contamination resulting from industrial averages or military conflicts. In this case, the gas-impermeable panel connections ensure that the spaces

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remain hermetic. In special cases the chambers and volumes can be situated in spaces, covered by membranes, stretched over tensegrity-structures (Rein, 2016; Schnubel, 2016; Membrane, 2016).

Materials and Methods

In order to achieve superior results, the protection of the refrigerators is made of elastic materials, integrating elastic protective screens, elastic coverings made of star-shaped elements as well as other elastic protective screens and coverings.

The methods for constructing the elastic protection of the chamber walls of the premises for storage of fruits and vegetables include the so-called layer-by-layer installation. The main benefit of this method is the possibility to dismount the elastic protection in case of need.

The external protection of the enclosing structure of these chambers is ensured by transparent membranes, which are suspended over tensegrity-structures. In the space below the membrane occurs a hothouse effect, which is then used to regulate the temperature regime of the chamber for fruits and vegetables, according to the respective technological requirements, e.g. positive temperature, humidity, gas environment (Aleksandrova, 2016).

Types of protection solutions, made of elastic materials

Use of elastic protective screens

The metric arrangement of thread openings (*known characteristics*), combined with the conical shape, intended for insertion of conical elastic parts fix a protective screen, hung on thread-like connection elements (*new characteristics which are basic for the inventive step, leading to the positive effect of the solution*). As well, there is a metric arrangement of the sides of the panel (*known characteristics*), of T-shaped elements, connected to the plugs via a thread (*new characteristics, redistributing the effects of the hits symmetrically towards the sides of the panel, thus ensuring the efficiency of the utility model*).

The metric arrangement of the openings in the sides of the panels is used as a solution for task 8 from Chapter III-4.1. (Absorption of concentrated hits, fig. 30 from the dissertation work of the author).

TASK 08 Creation of panel connection, ensuring the absorption of concentrated hits, whereas the connection should meet the sanitary requirements for fruit storehouses (Utility model № 401 Y 1. Connection between panels).

• **BG 401 (Y1) – connection between panels** (Aleksandrov, 2000a) (Figure 1)

The connection between panels shall be used in civil engineering, and in particular in building of fruit stores for

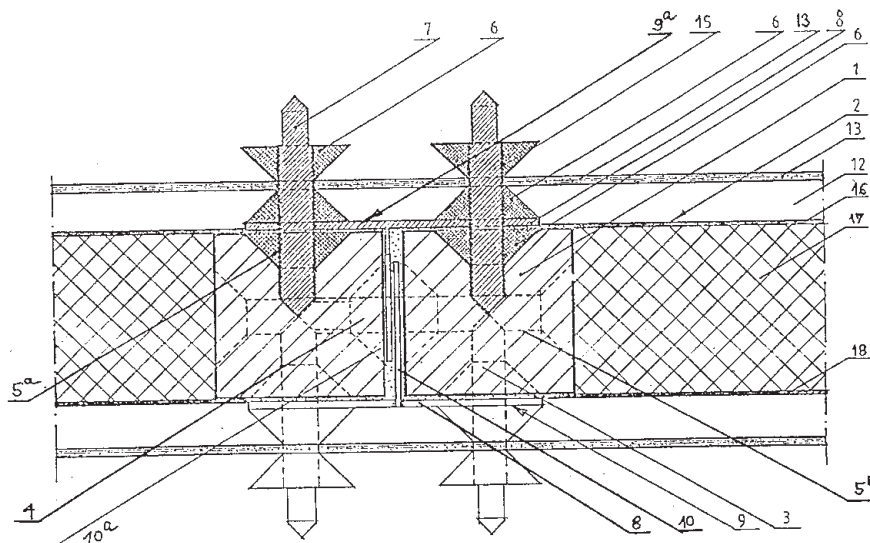


Fig. 1. Wall of a warehouse for fruits and vegetables protected by a suspended elastic screen. Patent BG 401 (Y1).

Connection between panels (Aleksandrov, 2000a)

sides (1); 2 – two panels (2); 3 – inlet (3); 4 – stud (4); 4–7 – connection threaded components (4 & 7); 5 – threaded holes (5); 6 – conical elastic parts (6); external studs (7); 8 – horizontally positioned part (8); two horizontally fitted parts (8 & 8a); two T-shaped profiles (9 & 9a); two slanted arms (10 & 10a); 11 – gasket; 12 – space; 13 – screen (13); 14 – electrical installations; 15 – thread; 16 – surface layers of the panel; 17 – heat insulation; 18 – second surface layer of the panel

bulk root crops. Its design is protected from concentrated impacts by a protection chain made of T-shaped components with threaded pins as well as against collapse of the root fruit during intensive mechanical handling operations. The panels are protected from the pressure of the filling of the fruit by means of an elastic screen suspended on the pins.

The connection is formed by panels, as the threaded holes (5) in sides (1) are displaced towards each other by heights being fitted along their three external walls. The inlet (3) of every hole is conical, and connection threaded components (4 & 7) are screwed in the threaded holes (5). The studs (4) are fitted to the front of the panel (2) and the external studs (7) are fitted sidewise to which conical type elastic parts are wound so that they would closely fit to the conical holes (3). Stud (7) of two adjacent panels (2) are also interconnected by a horizontally positioned part (8) of a T-shaped profile (9) the chamfered arm (10) of which is thread-connected to stud (4) aligning and connecting the two panels (2) to each other by means of two slanted arms (10 & 10a) and two horizontally fitted parts (8 & 8a) of two T-shaped profiles (9 & 9a) which are consecutively engaged by the threading of stud (4). A screen (13) limited on both its sides by conical elastic parts (6) is fitted to the external studs (7).

Use of elastic covering

By using elastic covering separated in one-part, three-part, U-shaped three-part and T-shaped four-part elastic elements, where there are reinforcing bars placed in their openings (*new characteristics of a known elastic material, subject to external hits, combined with known characteristics achieve inventive step, leading to the positive effect of the invention*), whereas the opening are dwelled in the zig-zagging surface sheets (*new*

characteristics which are necessary for an efficient solution), are protected against hits on these panel layers.

Elastic covering has been used in the solution of task 11 of Chapter IV- 4.2.4: Absorbing hits with the help of a covering made of elastic material. (Fig. 39 and 40 from the dissertation work of the author)

TASK 11 Creation of a multi-layer panel with anti-hit protection, allowing the absorption of hits with variable intensity (Patent BG 63218 B 1. Multi-layer panel with anti-hit protection and connection between panels).

• **BG63218 (B1) – multilayer panel with impact-protection and connection between panels** (Aleksandrov, 2000b) (Figures 2, 3)

The invention is used in civil engineering for building walls of fruit storages. It effectively takes up any impact from root crops and there is also a facility for the assembly and disassembly of the electrical installations within the anti-impact protection.

The multilayer panel includes four heat insulation inserts (2), fitted along the vertical fronts of the panel, side surrounding layers fitted to the inserts and heat insulation (14) expanded between them. Inserts (2) have T-shape and are fitted by their flanks along the four, chamfered at 45 degrees, vertical edges of the panel. The side layers are implemented of zigzagging sheets (7) and along their entire surface they are covered by star-like three-part elements (6) along their entire surface the middle parts (3) of which are included in alternating rectangular holes (5) bored through a wave in the projecting edges of the side layers (7). The T-shape inserts (2), on the fronts of the panel are interconnected by front zig-zagging sheets (4). One of the fronts of the panel is in the form of a zig-zag tooth, and the other one as a zig-zagging groove of T-shaped four-part elastic

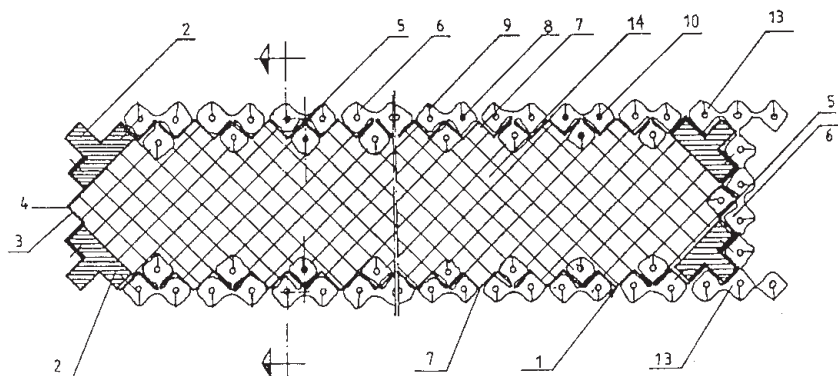


Fig. 2. Wall of warehouse for fruits and vegetables with elastic protection made of star-shaped elements. BG63218 (B1). Multilayer panel with impact- protection and connection between panels

(Transverse section of the panel – Fig. 1 on the patent) [26]

panel; 2 – four heat insulation inserts (2); 3 – middle parts (3); 4 – front zig-zagging sheets (4); 5 – alternating rectangular holes (5); 6 – star-like three-part elements (6); 7 – zigzagging sheets (7); 8 – central longitudinal hole (8); 9 – longitudinal slot (9); 10 – reinforcing rod (10); 11 – single-part elastic element (11); 12 – U-shaped three-part elastic element (12); 13 – four-part elastic elements (13); 14 – heat insulation (14)

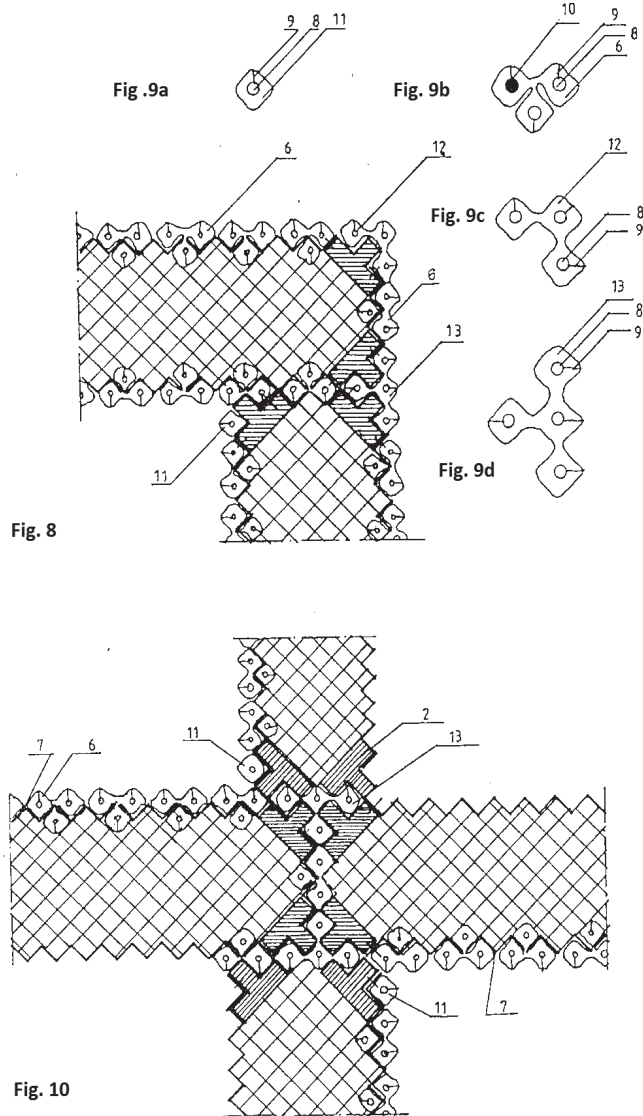


Fig. 3. Two and four walls of a warehouse for fruits and vegetables, protected by elastic star-shaped elements BG63218 (B1) - multilayer panel with impact-protection and connection between panels (Aleksandrov, 2000b) (Angular and cross connection. Various types of star-shaped elastic elements – single, double, triple and quadruple. (Figures 8, 9 and 10 of the patent) [26])

panel; 2 – four heat insulation inserts (2); 3 – middle parts (3); 4 – front zig-zagging sheets (4); 5 – alternating rectangular holes (5); 6 – star-like three-part elements (6); 7 – zigzagging sheets (7); 8 – central longitudinal hole (8); 9 – longitudinal slot (9); 10- reinforcing rod (10); 11 – single-part elastic element (11); 12 – U-shaped three-part elastic element (12); 13 – four-part elastic elements (13); 14 – heat insulation (14)

elements (13) covering the inserts (2), and star-like three-part elements (6) covering the front sheet (4), wherein the middle parts (3) of elements (6) are introduced in alternating rectangular holes (5) bored in the central projecting edge of sheet (4). Each part of the elastic elements (6 & 13) have a longitudinal slot (9) made to a central longitudinal hole (8) in which a reinforcing rod (10) and/or a tube for the electrical installation is fitted. At the external angle of an angular connection between panels, insert (2) of one of the panels is covered by an U-shaped three-part elastic element (12), and at the internal angle insert (2) of the perpendicular panel is covered by a single-part elastic element (11), the outer joint between the perpendicular panels is closed by a T-shaped four-part elastic element (13). At a cross-like connection between intersecting walls, on both sides of the front connection between two panels and centrally to the joint between them, perpendicular panels are connected, and along one of the diagonals of the cross, in the free ends of the respective inserts (2) of the perpendicular panels, single-part elastic elements (11) are fitted. In all connections between panels, the U-shaped three-part elastic element (12), the single-part elastic element (11) and the T-shaped four-part elastic element (13) have a length equal to the height of the panels, each part of elements (11, 12 & 13) have a longitudinal slot (9), fabricated next to a central longitudinal hole (8) in which a reinforcing rod (10) and/or a tube for the electrical installation is fitted.

Use of stretched elastic sheets

By using stretched elastic sheets (*new characteristics of known elastic material*), fixed to semi-cylindrical notches (*new characteristic*) formed at the ends of the surface layers, externally covered by parts of the elastic insulation (*new characteristics of a known material, combined in order to achieve inventive step, leading to the positive effect of the solution and necessary for its efficiency*) the panel layers are securely protected. Elastic sheets have been used in the solution of task 09 from Chapter IV – 4.2.2. Absorption of hits with the help of elastic screens and coverings.

TASK 09 Creation of a wall panel, whereas its structure should include an additional, replaceable protective covering against external impacts (Patent BG 62742 B1. Wall Panel).

BG62742 (B1) – wall panel (Figure 4) (Aleksandrov, 2001)

The wall panel shall find application in civil engineering for building of cold store walls. Its structure ensures extra wall protection against external effects. The wall panel consists of two external layers and elastic heat insulation expanded between them, protection elastic sheets (8) being fitted at some distance from the panel external layers (1) on its two sides. The end opposite sections of the short sides of the external layers (1) are in the form of semi-cylindrical notches (2) partially closed by straight sections (4) fitted on

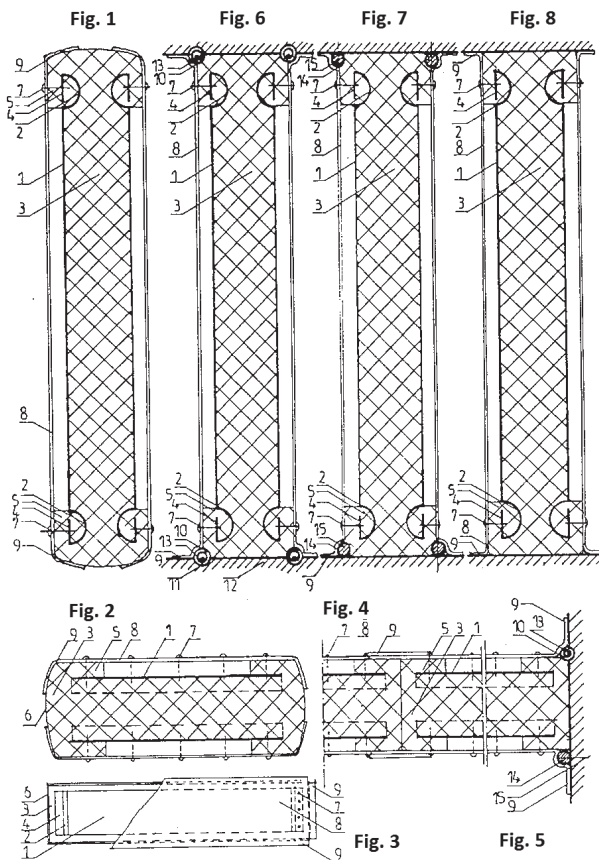


Fig. 4. Wall of a warehouse for fruits and vegetables made of panels with elastic screen and covering.

Patent BG 62742 (B1) wall panel

(Fig. 1 – longitudinal section through the panel, Fig. 2 – transverse section through the panel, Fig. 3 – view of the panel from its shorter side, Fig. 4 – panel connection, Fig. 5 – connection between wall and panel, Fig. 6 – connection among panel, floor and ceiling in a variant with elastic tube, Fig. 7 – connection among panel, floor and ceiling in a variant with elastic rope, Fig. 8 – connection among panel, floor and ceiling in a variant with stretching) 1 – panel external layers; 2 – semi-cylindrical notches; 3 – elastic heat insulation; 4 – straight sections; 5 – prismatic edges; 6 – protruding side; 7 – screws; 8 – protection elastic sheets; 9 – end section; 10 – elastic pipe; 11 – semi-cylindrical notches in floor; 12 – floor; 13 – electrical installations; 14 – elastic rope; 15 – connecting element

the plane of the surface layers (1). Prismatic edges (5) of the elastic heat insulation (3) are fabricated along the entire parameter of the panel which externally engage all end sections of the surface layers having a protruding side (6) along the contour of the panel. Sheets (8) are stretched over edges (5) and are fixed along the short sides of the panel to edges (5) and the straight sections (4) of the semi-cylindrical notches

(2) by means of screws (7). The end section (9) of the elastic sheets (8) are free and are protruding outside the overall dimensions of the panel having lengths equal to the length of the respective panel side.

Protection of chambers and volumes against harmful external impact with the help of membranes, stretched over tensegrity-structures (Figures 5, 6, 7)

The protection against acid rain, volcanic ash, overheating, etc. can be ensured with the help of resistant membranes, made of dense, transparent or semi-transparent materials.

The structure of the membranes can vary from simple to more complex solutions e.g. with integrated valves, opening upwards in order to form openings for ventilation of the inner space, closing in case of bad weather. In case of need, these valves can open or close e.g. in case of sunny weather, they can let sunrays pass for the good of internal greenery and to provide natural light.



Fig. 5. Alfred Rein Ingenieure. Tensile membranes (Rein, 2016) (www.pinterest.com)

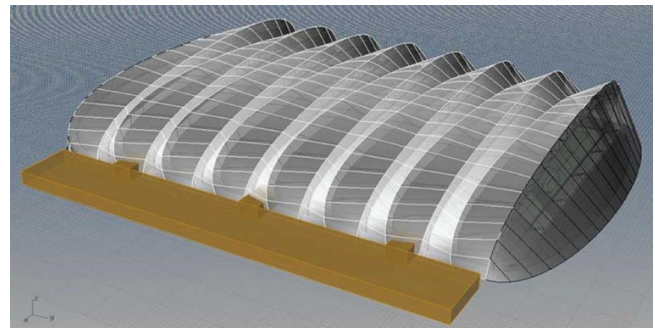


Fig. 6. Stretched membrane, forming a closed space, suitable for placing refrigerators for fruits and vegetables. Andreas Schnubel. Structural design. (www.schnubel.com) (Schnubel, 2016)

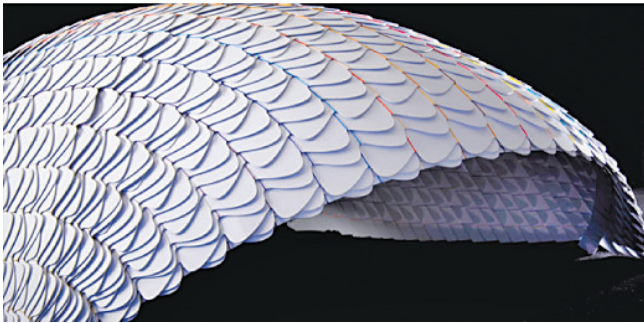


Fig. 7. Structure of the membrane (Membrane, 2016)

Some of the tiles of the membrane can be replaced in order to form openings to ventilate the underroof space. Another option is a part of the tiles to be transparent, whereas over them there will be a second mobile dense layer which will cover them in case of need.

Discussion

The internal protection of the walls of the chambers for storing fruits and vegetables has been designed by implementing innovation solutions with inventive step. All three patents of the author allow the protection with help of elastic materials. The external protection of the enclosing construction of the refrigerators for fruits and vegetables has been implemented using transparent membranes, suspended over tensegrity-structures. The refrigerators are integrated and situated under the membranes. The membranes is made of special materials, which are resistant to external influence as acid rain, volcanic ash, ultraviolet radiation, etc.

Conclusions

The application of an elastic protective screen fixed by conical elastic parts to thread-like connection elements, inserted into thread openings, situated in the sides of the panel, with T-shaped connection elements with chamfered arms, stabilizing the panel connections is new technical solution which offers the possibility to distribute the effects of all external hits symmetrically over the sides of the panel. (BG 401 (Y1). connection between panels) (Aleksandrov, 2000a)

The use of elastic coverings, separated in one-part, three-part, U-shaped three-part and T-shaped four-part elastic elements, where there are reinforcing bars placed in their openings, whereas the opening are dwelled in the zig-zagging surface sheets are protected against hits on these panel lay-

ers. The combination of all these characteristics represents a new technical solution with inventive step. (BG 62742 (B1) wall panel) (Aleksandrov, 2000b)

By using stretched elastic sheets, fixed to semi-cylindrical notches formed at the ends of the surface layers, externally covered by parts of the elastic insulation the panel layers are securely protected. The combination of all these characteristics represents a new technical solution with inventive step. (BG 63218 (B1). Multilayer panel with impact-protection and connection between panels) (Aleksandrov, 2001)

All three technologies for hit protection: the elastic protective screen, the elastic coverings, separated in various part elements, reinforced with bars as well as the elastic sheets fixed to semi-cylindrical notches formed at the ends of the surface layers are applicable in case of a secondary used of refrigeration chambers for medical purposes in extreme situations.

In case of harmful external impacts like acid rains, volcanic ash, overheating, etc. membrane constructions stretched over tensegrity-structures can be used to protect the chambers and volumes placed under them. The technical solutions for these tensegrity-structures can be developed to meet all functional and exploitation requirements.

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