

Method of controlling the distribution of internal forces and deformations along the frame structure and the frame structureField of the invention

The invention relates to frame structures and a method of controlling the distribution of internal forces and deformations along a frame structure.

State of the art

The construction of single-storey and multi-storey buildings is normally carried out as a framed structure with moment resisting connections. Typically, frame structures are made of rolled or welded sections. Developments in technology and new construction details allow for more frequent use of cold-formed sections for smaller buildings.

The great advantage of cold-formed profiles is their low weight, which allows easy handling without the use of heavy machinery. However, the cold-formed profiles are more susceptible to local loss of stability and thus lead to a different type of detailing than traditional steel structures.

The frame structure consists of vertical elements, columns, horizontal elements: frame rafters or floor beams and bracings in the vertical and horizontal planes, connected by either rigid or flexible connections to form a spatial structure. The frame structure includes moment connections and hinge connections. The hinge connections are simple and allow rotation in the joint. Moment connections are rotationally rigid or semi-rigid and are more complex in design.

Moment connections do apply typically to frame structures made of hot rolled profiles. It is not easy to achieve moment-bearing connections in cold-formed frame structures. Often only so-called semi-rigid connections can be achieved. Due to these complications, the connections of columns to the concrete foundation are most often made as hinged connections.

The most common connection to the foundation structure that achieves moment capacity uses a welded plate attached through the web of the column. This type of connection is commonly used today, and its moment capacity depends on the number and arrangement of bolts passing through the column, the thickness of the column flange and its material, the tensile capacity of the anchors used, and the flexibility of the column base end plate and the length, material and diameter of anchor. Experience with this type of connection shows that the achievable moment capacity and rotational stiffness tend to be too low and the tensile forces in the anchors tend to get higher when the anchors are placed too close together. The documents below describe the specific solutions known to date.

Document US 2023110886 A1 describes the increase of the moment capacity of a joint by welding a face plate in order to increase the ductility of the joint. The solution is oriented to structures subjected to seismic loads.

The document US 2018313053 A1 describes a solution using brackets cast in concrete. This causes limitations during the construction phase, as the horizontal and vertical positioning of the brackets may be inaccurate before concreting, or they may be displaced during concreting or omitted altogether. The erection of the structure may then be adversely affected.

EP 0864702 A1 describes a solution that uses an end plate welded to the column heel. The moment capacity of the joint and, in particular, its rotational stiffness is then dependent on the flexibility of the end plate. The disadvantage of this connection is that it is intended only for columns made of two profiles oriented back to back and the asymmetry of the connection, where the bolts in the opposite flanges always pass through the opposite profile and the mobilization of connection then occurs only by engaging the fasteners, i.e. the bolts passing through the web of column profile. The asymmetry of the connection can also result in stresses in the connection causing torsional stresses and deformation of the connection.

The disadvantage of the above solutions is that they are not structurally adapted to the connection of a thin-walled column with a concrete foundation and do not always allow the control of the rotational stiffness of the connection and its moment capacity. Another disadvantage is that they require the anchors to be fitted before the foundation structure is concreted.

Background of the invention

A method of controlling the distribution of internal forces and deformations along a frame structure comprising columns connected to rafters or beams and roof and side planes containing bracing in their planes, according to the invention, resides in the ability of continuous varying of the distribution of internal forces and deformations along the frame structure by adjusting the magnitude of the rotational stiffness and adjusting the magnitude of the moment capacity of the connection between the column and the concrete foundation, and by adjusting the magnitude of the rotation of the column relative to the concrete foundation.

The adjustment of the magnitude of the column's rotation relative to the concrete foundation is preferably carried out by adjusting the height of both the rectification nuts located on the threaded anchoring rod of the upper part of the anchoring rods below the vertical guides of the anchoring rods, connected to the lower end of the column, and at the same time the securing nuts located on the

threaded rods of the upper part of the anchoring rods above the vertical guides of the anchoring rods, with the upper part passing through the vertical guides and the lower part embedded in the concrete foundation.

In a further preferred embodiment, the adjustment of the amount of rotation of the column relative to the concrete foundation is performed by height adjustment of the rectification and securing nuts to continuously control the amount of rotation of the column relative to the concrete foundation until the required value is reached at the completion of the assembly. Preferably, the controlling of the amount of rotation of the column relative to the concrete foundation is repeatedly carried out by a scanning device placed between the bracket and the concrete foundation at least until the required value is reached at the end of the installation.

By the column rotation it is meant the angular change between the medium axis of the column and the horizontal plane of the concrete foundation caused by the adjustment of the rectification and securing nuts. This rotation may or may not be associated with the generation of forces and stresses at the joint, depending on whether the rotation is induced on the frame structure or on a separate member.

Angular or rotational deformation in the joint is associated with the transfer of forces from the load. Its magnitude is determined by the dimensions, shape and material of the parts of the connection and their deformability under load. The rotation of the connection is then the resultant of the increments of deformations of all parts of the connection.

The required rotational stiffness of the connection yields from the global analysis. It is the value of rotational stiffness at which the optimum distribution of internal forces over the frame structure occurs. The required bending moment is the magnitude of the bending moment from the load generated in the connection, which corresponds to the required rotational stiffness. The moment capacity of the joint must be greater than the required bending moment and at the same time the moment capacity of the concrete foundation must be greater than the required bending moment.

Preferably, the setting of the magnitude of the rotational stiffness and the setting of the magnitude of the moment capacity of the column-concrete base connection is carried out in a decision cycles in incremental steps, where in the first step is tested the possibility of installing the brackets on the standalone column only at a time when the other elements of the frame structure have not yet been installed, then the connection between the column and the concrete foundation transmits the internal forces and, in particular, the moments from all loads and, if the moments from all loads are greater than the moment capacity of the concrete foundation or the connection between the column and the

concrete foundation, then either the moment capacity of the concrete foundation can be increased by changing its dimensions or the dimensions of the bracket connection, consisting of a brackets with vertical guides on on it's vertical sides for anchor rods, or the second step is proceeded to, where it is proposed to install the brackets on the standalone frame, when the frame consisting of columns and frame rafters is assembled, then the connection between the column and concrete foundation carries the internal forces and especially the moments from the permanent loads from the dead weight of the purlins and the cladding and any variable loads from wind and snow and the service loads and if the internal forces and especially the bending moments from these loads are greater than the moment capacity of the concrete foundation or the column-concrete foundation connection, either the moment capacity of the concrete foundation may be increased by changing its dimensions or the dimensions of the brackets or the third step may be followed, where it is proposed to install the brackets on the finished frame with purlins and and bracing system already installed, then the column-concrete base connection shall transmit the internal forces and especially the moments from the permanent loads from the dead weight of the envelope and any variable loads from wind and snow and the service loads, and if the internal forces and especially the bending moments from these loads are greater than the moment capacity of the concrete base or the column-concrete base connection, either the moment capacity of the foundation may be increased by changing its dimensions or the dimensions of the brackets, or the fourth step may be followed, where it is proposed to mount the brackets on the finished frame with purlins, bracing systems and cladding already installed and other permanent loads, then the column-concrete foundation connection will transmit the internal forces and especially the bending moments only from the variable wind and snow loads and the service loads, and if the internal forces and especially the bending moments from these loads are greater than the moment capacity of the concrete foundation or column connection with the concrete foundation, the moment capacity of the concrete foundation can be increased by changing its dimensions and the moment capacity of the flange connection can be increased by changing its dimensions, or the first step is proceeded to, and the decision cycle with incremental steps is proceeded in this decision cycle with a change in the selection of the connection parameters until the strength condition is fulfilled, where the applied bending moment is less than the lesser of the moment capacity of the column-concrete base connection.

In a further preferred embodiment, the setting of the magnitude of the rotational stiffness and the setting of the magnitude of the moment capacity of the column-concrete base connection is performed in a decision iteration cycle where the analytical model successively selects the quantity, dimensions and materials of the top elastic washers, top steel washers, bottom steel washers and bottom elastic

washers and the material and dimensions of all parts of the flange connection up to the required magnitude of the rotational stiffness and the required magnitude of the moment capacity of the column-concrete base connection.

A frame structure for controlling the distribution of internal forces and deformations along a frame structure comprising columns connected to rafters having a roof plane stiffened with horizontal bracing and walls stiffened with vertical bracing, according to the invention, further comprising a column comprising at least one web connecting two flanges, wherein the heel of the column is provided with a simple connection with anchors for attachment to the concrete foundation and at least one bracket is connected to the flange by fasteners through holes, the bracket having vertical guides on its vertical sides for anchor rods for anchors in the concrete foundation, the anchor rods being provided with at least one rectifying nut below the vertical guides and at least one securing nut above the vertical guides.

In a preferred embodiment, the anchor rod is further provided with at least one bottom steel washer placed between the bracket guide and the rectification nut and at least one top steel washer placed between the flange guide and the securing nut.

Preferably, a top flexible washer is placed between the top steel washers and a bottom flexible washer is placed between the bottom steel washers.

The simple connection between the base of the column and the concrete foundation is preferably formed by elements selected from the group: at least one bolted angle, welded end plate, metal plate in concrete.

The bracket is preferably selected from the group: flat plate, end-bent plate.

The frame structure is preferably a steel structure.

In various preferred embodiments, the diameter of the fasteners is equal to or larger than the diameter of the holes, or the diameter of the fasteners is smaller than the diameter of the holes to allow for initial slippage and redistribution of bending moments.

The fasteners are conveniently selected from the group of bolts with nuts, self-tapping screws and self-drilling screws.

The column is preferably selected from the group of two back-to-back oriented uni-axial symmetrical profiles, two face-to-face oriented uni-axial symmetrical profiles, one open profile, one closed profile.

Preferably, the space between the column flanges is filled with concrete.

The bracket is preferably in a shape selected from the group an n -angle polygon, where n is 3 to 8, a circle, an oval and an irregular surface.

The guide is conveniently connected to the plate of the bracket in an asymmetrical design. In preferred embodiments, it is formed by elements selected from the group: circular tube, square tube, rectangular tube, oval tube.

The anchor in the connection between the base of the column and the concrete foundation is preferably made up of elements selected from the following groups: chemical anchor, mechanical anchor, screw anchor.

The frame structure for controlling the distribution of internal forces and deformations according to the technical design allows easy implementation of the moment connection of the steel column to the concrete foundation using standardized bolted brackets. The mechanical properties of the connection, rotational stiffness and moment capacity can be controlled by selecting the correct geometry and materials. The connection's deformation characteristics, when properly designed, ensure that the slender profile of the column connected to the concrete foundation does not get damaged. The connection can be made on a newly constructed structure or on an existing structure where an increase in load capacity is required.

These properties can be used to optimize frame structures and thus save material or to increase the load capacity of existing structures when snow loads increase due to climate change, in line with the latest adjustment of European standards for loads, or for buildings where solar panels will be retrofitted and the existing load capacity of the frame is insufficient. Another possible use of the connection is when designing a strategy against column damage from building traffic. The joint allows the installation of a barrier against impact by, for example, a forklift truck.

Another advantage of the proposed connection is that in a fire scenario, when the highest temperature is reached under the ceiling or the roof structure, the connection between the column and the concrete foundation is still relatively cold, thus showing moment capacity in a situation where the roof structure loses stability due to increased temperature. This can control the roof collapse which happens inward the building which tends to prevent the fire from spreading to surrounding buildings.

Another advantage of the proposed connection is that the column is rigidly connected to the foundation during the installation and there is no need for temporary stabilization. This contributes to the reduction of accidents in terms of health and safety protection on site. In addition, the column's verticality can be rectified during installation using rectification nuts.

Brief description of the drawings

The invention is shown in the accompanying drawings as follows

Fig. 1a) shows the connection between the column and the concrete foundation using the bracket with guides, Fig. 1b) is an alternative with reduced height of the bracket, utilizing of modified shape of bracket plate.

Fig. 2 shows various shapes of plate of the bracket, a) standard, b) with reduced depth.

Fig. 3 shows the detail of the assembled connection in a cross-section view.

Fig. 4 shows examples of anchors, chemical, mechanical, screw type.

Fig. 5 shows various types of column profile.

Fig. 6 shows a connection of column with concrete foundation pad using a bracket where guide is connected asymmetrically. This modification allows for use of side girts or cladding to be connected directly to the column.

Fig. 7 shows the connection of column with concrete foundation pad where plate of the bracket is folded. This modification allows for use of side girts or cladding to be connected directly to the column.

Fig. 8 shows the connection of column with concrete foundation pad, where column profiles are oriented face to face instead of back to back and where the space between flanges is filled in with concrete.

Fig. 9 shows an example of a column connection to a concrete foundation where the column is formed by a hot-rolled I-section or H-section.

Fig. 10 shows an example of a column connection to a concrete foundation, where the column is formed by a closed profile of rectangular or square cross-section.

Fig. 11 shows an example of a column connection to a concrete foundation, where the column is formed by two uniaxial symmetrical profiles oriented face to face.

Fig. 12 shows an example of a column connection to a concrete foundation where the column is connected to the concrete foundation by an end plate that is welded to the base of the column.

Fig. 13 shows an example of a column connection to a concrete foundation, where the column consists of an I-section or H-section with the space between the flanges and the column filled with concrete.

Fig. 14 shows an example of a column connection to a concrete foundation, where the simple connection between the column web and concrete foundation is through the plate encased in concrete.

Fig. 15 describes the analysis of the connection in terms of the load it carries.

Description of the preferred embodimentsExample 1

A single storey portal frame type of building was designed for difficult climatic conditions with snow and wind loads and with the requirement for increased traffic inside and outside of the building. The most suitable solution from all possible options appears to be the solution where the space between the flanges 19 of the column 6 is filled with concrete 20, since the steel-concrete column together with the brackets 1, see Figs. 2a), 2b) will be resistant to mechanical impact, see Figs. 8, 13. When designing the frame structure of the building, the designer analysed the structure and designed a connection with the appropriate rotational stiffness and magnitude of moment capacity. He performed the design in the decision iteration cycle shown in Fig. 15. Further, the analytical model successively selected the options for the dimensions of the bracket 1, materials and quantities of top steel washers 4, top flexible washers 3, bottom steel washers 13 and bottom flexible washers 14 and the diameter, material and length of the anchoring rod 15, see Figures 1a, 1b, 3, 4, inner and outer diameter, length and thickness of the guide 2 up to the required magnitude of rotational stiffness and the required magnitude of moment capacity of the connection of the column 6 to the concrete foundation 9. The result was the design of an optimized connection. The decision iteration cycle can be both manually calculated and computer programmed.

Based on this design, the brackets 1 were mounted on the standalone frame, as shown in Fig. 15 in the 'Bracket is being added to the frame that has already been assembled' branch. When the frame consisting of the columns 6 and the frame cross members is assembled, then the connection of the column 6 to the concrete foundation 9 transfers the internal forces from the permanent loads due to the dead weight of the purlins and the cladding, and any variable loads due to wind and snow and any live loads.

Example 2

Due to the change of use of an existing building, new solar panels need to be installed on the roof. The load on the roof has been increased due to the additional weight. The analysis showed that the frame structure of the existing building cannot support the increased load, but there is a reserve in the concrete foundation 9.

The brackets 1 were connected to the column 6 base on a portal frame with already erected purlins, roof bracing systems and other structural parts contributing to the permanent loading and anchored to the concrete foundation 9 with anchoring rod 15. Rectification nuts 8 on the inner side of column are

tightened strongly against bracket 1. A top elastic washer 3 has been used under the securing nut 5 on the anchor rod 15.

Once all brackets were installed on all the columns, the solar panels can be installed on the roof. After the solar panels are installed, the bracket base connection transfers the internal forces and especially the bending moments from the variable loads due to the wind and snow and the increased live load from the solar panels. In order to avoid exceeding the bearing moment of the concrete foundation 9 in the soil, the top elastic washers 3 were used under the securing nut 5 on the anchor rods 15 to offset the magnitude of the rotational stiffness of the column base connection in order to match the magnitude of the required bending moment.

The bracket connection changes the distribution of internal forces along the frame structure so that the roof can withstand the increased load, while still ensuring that when the limit load is reached, the elastic deformation of the top elastic washers 3 causes the bracket connection to rotate and therefore the limiting moment capacity of the connection does not get exceeded.

Example 3

According to the invention, a single storey portal frame type of building was designed with the requirement of a moment capacity of the connection of the column 6 to the concrete foundation 9 to achieve the stabilization of the column 6 during the fire situation where a building is expected to collapse inwards, so the fire does not get spread on neighboring buildings. The highest temperature is reached at the level of the frame rafters or floor beams, while the column footings 6 still remain in a relatively cold region, so that they are able to maintain some moment capacity required just for a fire situation. This mechanism can be used to control the roof collapse during the fire scenario, where the roof collapses inwards and the fire does not spread to surrounding buildings. The bracket connection was designed in a decision iterative cycle, where the analytical model iteratively selected the quantity, dimensions and materials of the top elastic washers 3, top steel washers 4, bottom steel washers 13 and bottom elastic washers 14 and the material and dimensions of all parts of the bracket connection up to the required magnitude of the rotational stiffness and the required magnitude of the moment capacity of the connection of column 6 to the concrete foundation 9, so that its moment capacity is higher than the moment in the column footing corresponding to the fire collapse of the rafters.

Example 4

The building where the local damage to the cladding or its connection to the frame structure occurred due to the parasitic stresses in the envelope that were not taken into account by the building design was reinforced by the application of brackets 1 at the joint of column 6 and concrete foundation 9.

The hinged or semi-rigid footing of the existing building with welded base plate 17, see Figs. 12, 14a), 14b) may be retrofitted with brackets 1 to in order to increase the rotational stiffness of the connection. The rotational stiffness will be controlled so that the moment transmitted by the bracket connection does not exceed the moment capacity of the existing concrete foundation 9. The horizontal deformation of the frame structure will be reduced, resulting in a decrease in parasitic stresses in the envelope. The adjustment of the magnitude of the rotation of the column 6 in relation to the concrete foundation 9, carried out by the height adjustment of the rectifying 8 and securing nuts 5, is continuously checked until the required value is reached at the end of the installation. Temporary propping of the frame rafter and its lifting by mechanical or hydraulic means may be necessary to reduce the resistance of the rectification nuts 8 against tightening moments increased due to the forces in connection. The checking of the magnitude of the rotation of the column 6 relative to the concrete foundation 9 is repeatedly carried out by a sensor device placed between the bracket 1 and the concrete foundation 9 at least until the desired value is reached at the end of the installation.

Example 5

Fig. 6 shows the asymmetrical connection of guides 2 and bracket 1. This modification allowed the cladding to be mounted directly on the column 6 without the use of the side girts. Composite sandwich panels can be oriented horizontally and connected directly to the columns of the main structure. This takes advantage of the high load-bearing capacity of modern thermal insulation sandwich panels, which at the same time provide energy savings for the building and reduce the number of erected pieces during the assembly. By omitting the side railing, savings are made on the material of the secondary structure.

Example 6

Fig. 7 shows the folded shape of the bracket 1. This modification has increased the strength of the bracket 1 material and at the same time increased its stability capacity. This modification allowed the cladding to be mounted directly on the column 6 without the use of the side rails in the longitudinal walls. Composite sandwich panels can be oriented horizontally and connected directly to the columns of the main structure. This takes advantage of the high load-bearing capacity of modern thermal

insulation sandwich panels, which at the same time provide energy savings for the building and reduce the number of erected pieces during the assembly. By omitting the side railing, savings are made on the material of the secondary structure.

Example 7

Another embodiment of the invention addresses the increase in moment capacity by utilizing the composite interaction of the columns with concrete infilling the space between the column 6 flanges, as shown in Figures 8 and 11. The columns 6 may have been optionally oriented either back-to-back, see Figure 5 b, e, or face-to-face Figure 5 c, f. For coupling the steel section with the concrete 20, it is advantageous to use a cross-section where the column sections 6 are oriented face to face and the space between the flanges 19 of the column 6 is filled with the concrete 20 as shown in Figure 8. This arrangement increased the moment capacity of the column by involving the interaction of the steel section and the concrete and reduced the horizontal deformation of the structure. This allowed the use of a steel profile of column 6 with a smaller thickness, thus saving material. In addition, it increased the resistance of the column to impact, e.g. by a forklift truck. This will increase safety during work.

Example 8

Another embodiment of the invention addresses the case of structures that are not symmetrical, for example, with differently spaced vertical bracing in side or gable walls, where torsional stresses typically on the gable column may occur. In these cases, the bracket connection transfers the torsional moment to the foundation.

In these cases it is advantageous to use both closed and open profiles. Example of closed profiles, square rolled tubes, are shown in Fig. 10. Other examples of profiles are shown in Fig. 5.

When an open profile is used, see Figs. 6, 7, 9, 12, the bracket connection will act as an stiffener reducing the normal stresses due to torsion causing warping of the open profile. This will help to increase the resistance of the open profile to torsion.

List of reference signs

- (1) Bracket
- (2) Vertical guide
- (3) Top elastic washer
- (4) Top steel washer
- (5) Securing nut
- (6) Column
- (7) Simple connection
- (8) Rectification nut
- (9) Concrete foundation
- (10) Bolt of a simple angle cleat connection
- (11) Anchoring bolt
- (12) Openings
- (13) Bottom steel washer
- (14) Bottom elastic washer
- (15) Anchoring rod
- (16) Connecting element
- (17) Base plate
- (18) Web
- (19) Flange
- (20) Concrete
- (21) Chemical anchor
- (22) Mechanical anchor
- (23) Screw anchor
- (24) Anchoring plate

PATENT CLAIMS

What is claimed is:

1. The method of controlling the distribution of internal forces and deformations along the frame structure comprising column (6) connected to rafter with a roof plane optionally reinforced with horizontal bracing systems and walls optionally reinforced with vertical bracing systems, **wherein** the distribution of internal forces and deformations along the frame structure can be continuously varied by adjusting the magnitude of the rotational stiffness and adjusting the magnitude of the moment capacity of the connection of the column (6) to the concrete foundation (9) and adjusting the magnitude of the rotation of the column (6) relative to the concrete foundation (9).
2. The method of controlling the distribution of internal forces and deformations along the frame structure according to the claim 1, **wherein** the adjustment of the amount of rotation of the column (6) relative to the concrete foundation (9) is performed by adjusting the height, on the one hand, of the rectification nuts (8) located on the threaded upper part of the anchoring rod (15), below the vertical guide (2) of the bracket (1) of the anchor rod (15), connected to the lower end of the column (6), and at the same time the adjustment of the securing nuts (5) located on the thread of the upper part of the anchor rod (15) above the vertical guide (2) of the bracket (1) of the anchor rod (15), with the upper part passing through the vertical guide (2) and the lower part embedded in the concrete foundation (9).
3. The method of controlling the distribution of internal forces and deformations along the frame structure according to the claims 1 to 2, **wherein** the amount of rotation of the column (6) relative to the concrete foundation (9) is continuously controlled by adjusting the height of the rectification nuts (8) and the locking nuts (5), until the required value is reached at the end of the assembly.
4. The method for controlling the distribution of internal forces and deformations along the frame structure according to the claims 1 to 3, **wherein** the control of the magnitude of the rotation of the column (6) relative to the concrete foundation (9) is repeatedly carried out by a sensor device positioned between the bracket (1) and the concrete foundation (9) at least until the required value is reached at the end of the assembly.
5. The method for controlling the distribution of internal forces and deformations along the frame structure according to the claims 1 to 4, **wherein** the adjustment of the magnitude of the rotational stiffness and the adjustment of the magnitude of the moment capacity of the connection of the column (6) to the concrete foundation (9) is carried out in a decision cycle with iterative steps, **wherein** in a

first step the possibility of mounting the bracket (1) on the standalone column (6) is proposed at a time when the other elements of the frame structure have not yet been mounted, then the connection between the column (6) and the concrete foundation (9) base transmits the internal forces and, in particular, the bending moments from all loads and, if the moments from all loads are greater than the ultimate moment capacity of the concrete foundation (9) or the the ultimate moment capacity of the connection between the column (6) and the concrete foundation (9), either the moment capacity of the concrete foundation (9) can be increased by changing its dimensions or the dimensions of the bracket connection, consisting of a bracket (1) on the vertical sides provided with the vertical guide (2) for the anchor rod (15) and the anchor rod (15) or proceed to the second step, where the possibility of mounting the bracket (1) on the standalone frame is proposed, at the moment when the frame consisting of the columns (6) and the frame rafters is assembled, then the connection between the column (6) and the concrete foundation (9) transmits the internal forces and, in particular, the bending moments from the permanent loads from the dead weight of the purlins and the cladding and any variable loads from wind and snow and the live loads, and if the internal forces and, in particular, the bending moments from these loads are greater than the moment capacity of the concrete foundation (9) or the moment capacity of the connection between the column (6) and the concrete foundation (9), either the moment capacity of the concrete foundation (9) may be increased by changing its dimensions or the dimensions of the bracket connection or the third step may be followed, where it is proposed to mount bracket (1) on the finished frame with purlins and optional bracing systems, then the connection between the column (6) and the concrete foundation (9) shall transmit the internal forces and, in particular, the bending moments from the permanent loads from the dead weight of the cladding and any variable loads from wind and snow and the live loads, and if the internal forces and, in particular, the bending moments from these loads are greater than the moment capacity of the concrete foundation (9) or the moment capacity of the connection between the column (6) and the concrete foundation (9), either the moment capacity of the foundation may be increased by changing its dimensions or the dimensions of the bracket connection or the fourth step may be followed, where it is proposed to mount the bracket (1) on the finished frame with purlins, bracing systems and cladding and the other permanent loads, then the connection of the column (6) to the concrete foundation (9) shall transmit the internal forces and in particular the bending moments only from the variable wind and snow loads and the service loads and, if the internal forces and in particular the bending moments from these loads are greater than the moment capacity of the concrete foundation (9) or the moment capacity of the connection of column (6) with the concrete foundation (9), the moment capacity of the concrete foundation (9) can be increased by changing its dimensions and the

moment capacity of the flange connection by changing its dimensions, or the first step is proceeded with and the decision cycle with iterative steps is proceeded in this decision cycle with a change in the selection of the connection parameters until the condition is fulfilled, where the applied bending moment is less than the lesser of the bending moment capacity of the connection of the column (6) to the concrete foundation (9).

6. The method of controlling the distribution of internal forces and deformations along the frame structure according to claims 1 to 5, **wherein** the setting of the magnitude of the rotational stiffness and the setting of the magnitude of the moment capacity of the connection of the column (6) to the concrete foundation (9) is performed in a decision iteration cycle, **wherein** the quantity option is selected iteratively in the analytical model, the material and dimensions of the top elastic washer (3), the top steel washer (4), the bottom steel washer (13) and the bottom elastic washer (14) and the material and dimensions of all parts of the bracket connection up to the required rotational stiffness and the required magnitude of the moment capacity of the connection of the column (6) to the concrete foundation (9) are selected.

7. A frame structure for controlling the distribution of internal forces and deformations along a frame structure comprising column (6) connected to frame rafter with a roof plane optionally reinforced with horizontal bracing system and side walls optionally reinforced with vertical bracing systems according to claims 1 to 6, **wherein** it comprises a column (6) comprising at least one web (18) connecting two flanges (19), **wherein** the base of the web (18) is provided with a simple connection (7) with anchoring bolts (11) for attachment to the concrete foundation (9) and at least one bracket (1) is attached to the flange (19) by connecting element (16) through openings (12), which is provided on its vertical sides with vertical guide (2) for anchor rod (15) for embedding in the concrete foundation (9), which are provided with at least one rectification nut (8) below the vertical guide (2) and at least one securing nut (5) above the vertical guide (2).

8. A frame structure for controlling the distribution of internal forces and deformations along a frame structure comprising column (6) connected to frame rafter with a roof plane optionally reinforced with horizontal bracing system and walls optionally reinforced with vertical bracing system according to claim 7, **wherein** the anchor rod (15) further comprising at least one bottom steel washer (13) positioned between the vertical guide (2) of the bracket (1) and the rectification nut (8) and at least one top steel washer (4) positioned between the vertical guide (2) of the bracket (1) and the securing nut (5).

9. A frame structure for controlling the distribution of internal forces and deformations along a frame structure comprising column (6) connected to frame rafter with a roof plane optionally reinforced with horizontal bracing system and walls optionally reinforced with vertical bracing system according to claims 7 to 8, **wherein** the top elastic washer (3) is placed between the top steel washers (4) and a bottom elastic washer (14) is placed between the bottom steel washers (13).

10. A frame structure for controlling the distribution of internal forces and deformations along a frame structure comprising column (6) connected to frame rafter with a roof plane optionally reinforced with horizontal bracing system and walls optionally reinforced with vertical bracing systems according to claims 7 to 9, **wherein** the simple connection (7) between the base of the column (6) and the concrete foundation (9) is formed by elements selected from the group: at least one bolted angle, a welded base plate (17), an anchoring plate (24) encased in concrete (20).

11. A frame structure for controlling the distribution of internal forces and deformations along a frame structure comprising column (6) connected to frame rafter with a roof plane optionally reinforced with horizontal bracing system and walls optionally reinforced with vertical bracing system according to claims 7 to 10, **wherein** the bracket (1) is selected from the group consisting of: a flat plate, a plate folded at the ends.

12. A frame structure for controlling the distribution of internal forces and deformations along a frame structure comprising column (6) connected to frame rafter with a roof plane optionally reinforced with horizontal bracing system and walls optionally reinforced with vertical bracing system according to claims 7 to 11, **wherein** the frame structure is a steel structure.

13. A frame structure for controlling the distribution of internal forces and deformations along a frame structure comprising column (6) connected to frame rafter with a roof plane optionally reinforced with horizontal bracing system and walls optionally reinforced with vertical bracing system according to claims 7 to 12, **wherein** the diameter of the connecting elements (16) is equal to or greater than the diameter of the openings (12).

14. A frame structure for controlling the distribution of internal forces and deformations along a frame structure comprising column (6) connected to frame rafter with a roof plane optionally reinforced with horizontal horizontal bracing system and walls optionally reinforced with vertical bracing system according to claims 7 to 12, **wherein** the diameter of the connecting elements (16) is equal to or greater than the diameter of the openings (12).

15. A frame structure for controlling the distribution of internal forces and deformations along a frame structure comprising column (6) connected to frame rafter with a roof plane optionally reinforced with horizontal bracing system and walls optionally reinforced with vertical bracing system according to claims 7 to 14, **wherein** the connecting elements (16) are selected from the group consisting of bolts with nuts, self-tapping bolts and self-drilling bolts.

16. A frame structure for controlling the distribution of internal forces and deformations along a frame structure comprising column (6) connected to frame rafter with a roof plane optionally reinforced with horizontal bracing system and walls optionally reinforced with vertical bracing system according to claims 7 to 15, **wherein** the column (6) is selected from the group consisting of two back-to-back oriented profiles symmetrical about a single axis, two face-to-face oriented profiles symmetrical about a single axis, one open profile, one closed profile.

17. A frame structure for controlling the distribution of internal forces and deformations along a frame structure comprising column (6) connected to frame rafter with a roof plane optionally reinforced with horizontal bracing system and walls optionally reinforced with vertical bracing system according to claims 7 to 16, **wherein** the space between the flanges (19) of the column (6) is filled with concrete (20).

18. A frame structure for controlling the distribution of internal forces and deformations along a frame structure comprising column (6) connected to frame rafter with a roof plane optionally reinforced with horizontal bracing system and walls optionally reinforced with vertical bracing system according to claims 7 to 17, **wherein** the bracket (1) is in a shape selected from the group consisting of an n-angle polygon, where n is 3 to 8, a circle, an oval and an irregular surface.

19. A frame structure for controlling the distribution of internal forces and deformations along a frame structure comprising column (6) connected to frame rafter with a roof plane optionally reinforced with horizontal bracing system and walls optionally reinforced with vertical bracing system according to claims 7 to 18, **wherein** the vertical guide (2) is asymmetrically connected to the bracket (1).

20. A frame structure for controlling the distribution of internal forces and deformations along a frame structure comprising column (6) connected to frame rafter with a roof plane optionally reinforced with horizontal bracing system and walls optionally reinforced with vertical bracing system according to claims 7 to 19, **wherein** the guide (2) comprises elements selected from the group consisting of: a circular tube, a square tube, a rectangular tube, an oval tube.

21. A frame structure for controlling the distribution of internal forces and deformations along a frame structure comprising columns connected to frame rafters with a roof plane optionally reinforced with horizontal bracing system and walls optionally reinforced with vertical bracing system according to claims 7 to 20, **wherein** in that the anchoring bolts (11) at the connection between the column base and the concrete foundation (9) comprises elements selected from the group: chemical anchor (21), mechanical anchor (22), screw anchor (23).