

[Title of Document] Description

[Title of Invention] Outer Wall Structure for Building, Heat-Blocking Structure, and Heat-Blocking Method

[Technical Field]

5 [0001]

The present invention relates to an exterior wall structure, a thermal insulation structure, and a thermal insulation method for a building, and more specifically, such structures and method for thermally insulating a whole exterior surface of a concrete building with a framework construction or a "Rahmen" frame construction by a combination or combined use of different types of insulation methods (an external insulation construction method and an external insulation installation method), thereby achieving a reduction of a weight of the building and so forth while maintaining a desired thermal insulation property.

15 [Background Art]

[0002]

A building with a framework construction or a Rahmen frame construction, which has a reinforced concrete (RC) structure, a steel-framed reinforced concrete (SRC) structure, or a precast reinforced concrete (PCa) structure (referred to as "a concrete building" hereinafter), is known in the art. In general, a concrete building is constituted from columns, beams, bearing walls, non-bearing walls, floor slabs, and so forth, each having an RC structure, SRC structure, or PCa structure (referred to as "a concrete structure" hereinafter). Further, as types of thermal insulation methods for buildings, an external insulation construction method ("*Soto Dannetsu Kouhou*"), an internal insulation construction method ("*Uti Dannetsu Kouhou*"), an external insulation installation method ("*Sotobari Dannetsu Kouhou*"), a thermal insulation filling-up method ("*Juten Dannetsu Kouhou*"), and so forth are known in the art (Non-Patent Literatures 1 and 2).

30 [0003]

The external insulation construction method is a thermal insulation method in which thermal insulation materials are brought into intimate contact with an exterior surface (an outdoor surface) of the structural skeleton of a concrete building so as to conceal the whole surface of the exterior wall surface by the thermal insulation materials, whereby the concrete structure skeleton taking a thermal storage effect is covered with a thermal insulation layer. For instance, according to the external insulation construction method as disclosed in Patent Literature 1, hard foamed plastic panels are provided on an exterior

surface of a concrete structure exterior wall so that the panels are brought into intimate contact therewith, and exterior finishing materials are further provided outside of the thermal insulation materials (panels), whereby the thermal insulation materials are covered with the exterior finishing materials. On the other hand, the internal insulation construction method is a thermal insulation method in which thermal insulation materials are provided on an indoor or interior side of the structural skeleton made of concrete, so that a thermal insulation layer is formed inside of the structural skeleton taking the thermal storage effect.

[0004]

The internal insulation construction method is considered to be advantageous in enhancement of flexibility in architectural design, improvement of workability of building construction works, facility of building maintenance works, and so forth. However, this method may involve generation of dew condensation water inside a wall (i.e., internal dew condensation), and a degradation in an air conditioning efficiency, owing to relatively significant influences of environmental loads acting on the skeleton with concrete structure (variations in solar radiation, outdoor temperature, and so forth). On the other hand, the external insulation construction method is considered to be disadvantageous from aspects of deterioration of exterior finishing materials, workability of building construction works, facility of building maintenance works, a fire-resistive performance of the building, and so forth. However, this method is advantageous from aspects of improvement of comfortable habitability, improvement of the air conditioning efficiency due to utilization of a thermal capacity of the concrete skeleton, and so forth, since the skeleton is unlikely to be subject to the influences of environmental loads acting on the skeleton (variations in solar radiation, outdoor temperature, and so forth). In general, it has been considered that the thermal insulation performance of the external insulation construction method would be more preferable than that of the internal insulation construction method, since the comfortable habitability, the relieved environment loads, and so forth are evaluated more highly.

[0005]

As set forth above, it is known that the exterior and internal insulation construction methods are insulation methods closely related to the thermal capacity of the structural skeleton structurally and functionally, and that these methods are insulation methods inherent to concrete buildings, exterior walls of which are concrete structure walls having relatively large thermal capacities. On the other hand, the external insulation installation method and the thermal insulation filling-up method are known as insulation methods inherent to steel

structure or wood structure buildings which do not have the exterior walls with such large thermal capacities.

[0006]

The external insulation installation method is an insulation method in which the thermal insulation materials are installed outside of the steel or wood structure frame so as to entirely cover the exterior wall surfaces of the building with the thermal insulation materials. For example, according to the external insulation installation method as disclosed in Patent Literature 2, the insulation materials and furring strips for ventilation are installed outside of steel or wooden posts or columns, and exterior finishing materials, such as ALC panels, are installed outside of the furring strips. Further, according to the external insulation installation method as disclosed in Patent Literature 3, insulation materials and supporting elements are installed outside of steel or wooden columns or posts, fastening devices for supporting the exterior finishing materials are fixed to the supporting elements, and the light-weight exterior finishing materials, such as ceramic or metal siding materials, are engaged with the fastening devices so as to be supported by the supporting elements. On the other hand, the insulation filling-up method is an insulation method in which hollow areas in the steel or wood structure frames are filled or charged with the thermal insulation materials, wherein each of the hollow areas is a space between adjacent intermediate posts (or, between the intermediate post and an end post).

[Citation List]

[Patent Literatures]

[0007]

[Patent Literature 1] Japanese Patent Laid-open Publication No. 2009-41266

[Patent Literature 2] Japanese Patent Laid-open Publication No. 2004-244968

[Patent Literature 3] Japanese Patent Laid-open Publication No. 2018-3300

[0008]

[Non-Patent Literatures]

[Non-Patent Literature 1] "Study of Building Thermal Insulation" (*Kenchiku Dannetsu No Kangaekata*), published on May 25, 2004 by Ohmsha, Ltd.), pages 46-49

[Non-Patent Literature 2] "Japanese Architectural Standard Specification, JASS 24, Thermal Insulation Work", published by the Architectural Institute of Japan, Page 2

[Summary of Invention]

5 [Technical Problem]

[0009]

An aseismic performance of a concrete building with a framework construction or Rahmen frame construction essentially depends on an aseismic strength of the frame. A seismic load acting on the building is considerably
10 large, compared to the seismic load acting on a wood structure or steel structure building. This is because a dead load of the concrete building is extremely large. In general, in a typical design of a structure of a concrete building, an appropriate number or length of bearing walls (earthquake-resisting walls) are provided at appropriate positions in the building so that the bearing walls bear
15 or carry the seismic load at least partially. However, under a normal design concept with respect to the structure of the concrete building provided with the bearing walls, an eccentricity ratio of the building in relation to the positions of the bearing walls should be restricted or limited. Therefore, it is often required to make a slit or slits in a concrete structure non-bearing wall, in order to surely
20 prevent such a non-bearing wall from increasing the eccentricity ratio due to the rigidity of the non-bearing wall.

[0010]

On the other hand, if the concrete structure skeleton is partially changed to a steel structure skeleton, the dead load of the building is relatively
25 significantly reduced, whereby the seismic load acting on the building can be reduced. Therefore, such a change is advantageous remarkably from a viewpoint of the structural strength of the building. For example, if exterior walls of a concrete building are changed to steel structure walls in an architectural design, the seismic load acting on columns and beams is relatively
30 significantly reduced. This enables to adopt a structural design of the building in which the strength of the building depends only on the aseismic strength of the Rahmen framework without depending on the aseismic strengths of bearing walls, or in which the cross-sectional dimensions of the beams and columns are reduced, or the quantity of the reinforcing steel bars and so forth are reduced. In
35 addition, the steel structure exterior wall is usually a structure constructed by a dry process. Therefore, the steel structure wall is practically advantageous in shortening of a construction period, improvement of workability, and so forth, in comparison with concrete structure exterior walls constructed by cast-in-place concrete or in-situ concrete.

[0011]

In such a case, it might not be always necessary to design all of the exterior walls of the concrete building as the steel structure exterior walls. Even if only a part of the exterior walls to be designed as non-bearing concrete walls are modified to be the steel structure walls, the weight of the building can be considerably reduced, so that excess or additional construction works and working processes for slitting the non-bearing concrete walls can be omitted. Such a reduction in the weight of the building and the omission of the construction works for slitting the concrete walls are practically and remarkably advantageous in reduction of the construction costs and in shortening of the construction period.

[0012]

However, the external insulation construction method is closely related to a heat accumulation action and effect of the skeleton with concrete structure, and therefore, this type of insulation method is based on a premise that the concrete structure skeleton exists and the thermal insulation material is in intimate contact therewith. On the other hand, the steel structure exterior wall does not directly relate to the heat accumulation action of the building skeleton, and the wall is designed to be thermally insulated by a different type of thermal insulation method which entirely differs in architectural design details (i.e., the insulation by the external insulation installation method). Under such a background, it is unknown that a concrete building is not provided only with the thermal insulation constructed by the external insulation construction method, but also with an exterior wall having a steel structure.

[0013]

Further, the concrete structure wall and the steel structure wall differ from each other in effects of wind pressures or seismic forces acting on exterior walls of middle level stories or upper stories of the building (i.e., deformations or behaviors of the exterior wall, and so forth). Further, these two types of walls differ from each other in deterioration of fire-resistive performance and sound insulation performance. In addition, the external insulation construction method and the external insulation installation method differ from each other in a structure and method for supporting and constructing thermal insulation materials and exterior finishing materials, and so forth. Taking such differences into consideration, it is difficult to assume incorporation or combination of the steel structure exterior walls into or with the concrete building which is to be thermally insulated in accordance with the external insulation construction method.

[0014]

An object of the present invention is to provide an exterior wall structure, a thermal insulation structure, and a thermal insulation method, which enable a reduction in the weight of a concrete building with a framework construction or Rahmen frame construction to be thermally insulated in accordance with an external insulation construction method, without degrading a thermal insulation performance of the building, and which is capable of overcoming various issues, such as the effects of wind pressures or seismic forces acting on the exterior walls of middle level stories and upper stories of the building, deterioration of fire-resistive performance and sound insulation performance of each of the exterior walls, differences in the structure and method for supporting or constructing insulation materials and exterior finishing materials between these different types of insulation methods, and so forth.

[Solution to Problem]

[0015]

The present invention provides an exterior wall structure of a concrete building (A) with a framework structure, wherein the framework structure is constituted from concrete beams (B) and concrete columns (C), and thermal insulation layers are provided outside of the columns and the beams disposed at an outer peripheral zone or a perimeter zone of the building, comprising:

a structural skeleton zone (β) configured by said columns and said beams, and an opening area (α) surrounded by the columns and the beams,

wherein a steel structure wall part (Wa) and an interior wall part (Wb) are built in the opening area to be an exterior wall (W) with a double-wall structure, the steel structure wall part being provided with steel structure intermediate posts (4) and the interior wall part being spaced at a distance from the steel structure wall part on its indoor side,

wherein said steel structure wall part is provided with substrate boards (6) for exterior finishing, the substrate boards being positioned outside of said post and being fixed to said posts so as to close the opening area with the substrate boards, and outside surfaces of the substrate boards, said beams, and said columns configure a single or common substrate surface (1, 10) for exterior finishing, which continuously extends over said structural skeleton zone and said opening area, and

wherein thermal insulation materials (21) are installed or laid on said substrate surface to cover the substrate surface with the thermal insulation materials, exterior finishing materials (22) are provided outside the insulation materials, and a continuous exterior thermal insulation layer (G) is formed outside the columns, the beams, and the steel structure wall part so as to

substantially uniformly or evenly extend over said opening area and said skeleton zone.

[0016]

According to the present invention, in the structural skeleton zone (β) where the columns and the beams are located, the building is externally insulated by the external insulation construction method for the concrete structure, whereas the external insulation installation method for the steel structure is applied to the opening area (α) surrounded by the columns and the beams. Therefore, the building is thermally insulated by a combined or hybrid method of the external insulation construction method and the external insulation installation method.

[0017]

The steel structure exterior wall merely has the dead load approximately ranging from about 1/5 of the dead load of the concrete structure exterior wall to about 1/10 thereof. Therefore, the dead load of the building is relatively remarkably reduced by adoption of the exterior wall structure in accordance with the present invention. As set forth above, the seismic load acting on the building is reduced in proportion to the reduction in the dead load of the building, and therefore, the aforementioned exterior wall structure is significantly advantageous in improvement of the earthquake resisting capability of the building.

[0018]

Further, since the steel structure exterior wall is built by a dry process construction method, the steel structure exterior wall is practically advantageous in shortening of the construction period, improvement of workability, and so forth, compared to the concrete structure exterior wall.

[0019]

In addition, the exterior wall structure as set forth above is a wall with a double-wall structure which comprises the steel structure wall part and the interior wall part separated from each other. The separation between these two wall parts functions to block or isolate the heat transfer or heat transmission in a heat transfer path between an outdoor environment and an indoor space. Also, the separation therebetween enables a relative displacement between these two wall parts, and prevents a phenomenon of the interior wall part that deforms or behaves due to the deformation or behavior of the steel structure wall part. The separation of these two wall parts also functions to block or isolates a solid vibration propagation and a solid propagation or transmission of noise in their paths. According to the exterior wall structure with the double-wall structure as set forth above, increase of an air conditioning load and generation of dew

condensation water, owing to generation of a thermal bridge, can be prevented from occurring, and further, a desired fire-resistive performance (one hour) for the non-bearing wall can be ensured relatively easily. The deformation or behavior of the steel structure wall part due to the excessive wind pressure or the excessive seismic force, and the solid propagation or transmission of noise or vibration from the steel structure wall part can be substantially isolated in their paths by the separation between the above two wall parts, and therefore, comfortability or habitability of indoor environment can be ensured preferably.

[0020]

Further, the substrate boards of the steel structure wall part configure, at the outer peripheral zone or the perimeter zone of the building, the substrate surface for exterior finishing which extends substantially continuously over a plurality of column-spans and a plurality of floor levels (stories), wherein the column-span is a module specified or defined by a region between centerlines of the adjacent columns. Therefore, uniform or even substrate surfaces, which is to be provided with the thermal insulation materials and the exterior finishing materials, are configured on exterior surfaces of the building. In the structural skeleton zone, the thermal insulation materials and the exterior finishing materials can be provided thereon by a conventional supporting structure and a conventional construction process in accordance with the conventional external insulation construction method. In the opening area, the thermal insulation materials and the exterior finishing materials can be provided therein by a conventional supporting structure and a conventional construction process in accordance with the conventional external insulation installation method. Thus, the continuous exterior thermal insulation layer can be substantially uniformly formed over the whole exterior wall surfaces of the building. In the present specification, the term reading "exterior thermal insulation" is used as a generic concept covering both the "thermal insulation by external insulation construction method" and the "thermal insulation by external insulation installation method".

[0021]

From another aspect of the invention, the present invention provides a thermally insulating structure of a concrete building, in which a structural skeleton of the building (A) has a framework construction constituted from concrete structure beams (B) and columns (C), and said skeleton is covered with a thermal insulation layer disposed outside the skeleton, whereby the insulation layer outside the skeleton is formed so that the insulation layer substantially continuously extends over different column-spans (γ) and/or different stories, comprising:

a first thermal insulation material (21) and a first exterior finishing material (22), which are constructed on an outside surface of a structural skeleton zone (β) in accordance with an external insulation construction method, the skeleton zone being configured by said columns and said beams disposed in an outer peripheral zone or a perimeter zone of the building, and

a second thermal insulation material (21) and a second exterior finishing material (22), which are installed on an exterior wall (W) with a double-wall structure in accordance with an external insulation installation method, the exterior wall being built in an opening area (α) surrounded by said columns and beams;

wherein said exterior wall is constituted from a steel structure wall part (Wa) and an interior wall part (Wb), the steel structure wall part is positioned in said opening area and includes steel structure intermediate posts (4), and the interior wall part is provided with steel furrings for wall (12-15) and is positioned in the opening area, spaced apart from the steel structure wall part on an indoor side thereof;

wherein said steel structure wall part has substrate boards (6) for exterior finishing which are fixed to said intermediate posts so as to close said opening area outside the intermediate posts, and outside surfaces of the boards and the outside surface of said skeleton zone configure a single or common substrate surface (1, 10) for exterior finishing, which substantially continuously extends over said opening areas and said skeleton zone; and

wherein said first and second thermal insulation materials (21) are installed or laid continuously on said substrate surface so as to cover the substrate surface with the thermal insulation materials, exterior finishing materials (22) are successively arranged outside of the insulation materials, and a continuous exterior thermal insulation layer (G) is provided outside of the columns, the beams, and the exterior wall, by the thermal insulation materials and the exterior finishing materials, so as to substantially uniformly or evenly extend over the opening areas and the skeleton zone.

[0022]

From yet another aspect of the invention, the present invention provides a method for thermally insulating a structural skeleton of a concrete building (A) having a framework structure, in which the structural skeleton constituted from concrete beams (B) and concrete columns (C) is covered with a thermal insulation layer disposed outside of the structural skeleton,

wherein an exterior wall (W) with a double-wall structure is constructed in an opening area (α) which is surrounded by the columns and the beams disposed in an outer peripheral zone or a perimeter zone of the building, the

exterior wall being constituted from a steel structure wall part (Wa) and an interior wall part (Wb), the steel structure wall part being provided with steel structure intermediate posts (4), and the interior wall part being provided with steel furrings (12-15) spaced at a distance from the steel structure wall part on its indoor side,

wherein said steel structure wall part has substrate boards (6) for exterior finishing which are fixed to said intermediate posts so as to close said opening area outside the intermediate posts, a structural skeleton zone (β) is configured by the columns and the beams, and outside surfaces (1) of the boards and the outside surface (10) of the skeleton zone (β) configure a single or common substrate surface (1, 10) for exterior finishing, which substantially continuously extends over said opening areas and the skeleton zone;

wherein a first thermal insulation material (21) and a first exterior finishing material (22) are provided on said substrate surface in said skeleton zone (β) by an exterior thermal insulation construction method, and a second thermal insulation material (21) and a second exterior finishing material (22) are installed on said substrate surface of the steel structure wall part by an external insulation installation method; and

wherein said first and second thermal insulation materials (21) are continuously installed or laid on said substrate surface to cover the substrate surface with the thermal insulation materials, said first and second exterior finishing materials (22) are substantially continuously arranged outside the first and second thermal insulation materials, and an exterior thermal insulation layer (G), which substantially uniformly or evenly extends over the opening area and the skeleton zone, is formed outside said structural skeleton and said exterior wall.

[0023]

Preferably, outside surfaces (1) of the substrate boards (6) are positioned in a vertical plane (V) specified or defined by outside surfaces (10) of the columns (C) and the beams (B), or in a situation slightly shifted on an indoor side of the vertical plane. In the present specification, the phrase reading "in a vertical plane specified or defined by outside surfaces of the columns and the beams" should be understood on a premise that construction errors to an extent of approximately 10mm be allowable. The phrase reading "a situation slightly shifted on an interior side of the vertical plane" implies the "situation shifted" "from the vertical plane" in a range of a dimension less than the thickness of the insulation material (preferably, 3/4 or less of the thickness of the insulation material, more preferably, 1/2 or less of the thickness of the thermal insulation material). More preferably, a bracket (25) penetrating the thermal insulation material (21) is fixed to the column, beam or steel structural wall part (Wa), and

a supporting mechanism for supporting the exterior finishing material is fixed to the bracket. The supporting mechanism includes a furring strip (26, 26', 26"), on which the exterior finishing material (22) can be mounted. An exterior finishing panel is mounted on the furring strip outside the insulation material, as the exterior finishing material. The exterior finishing panels configure a vertical exterior wall surface of the building, which substantially extends over the structural skeleton zone (β) and the opening area (α). A conventional panel, board, or plate for exterior finishing, which has a surface area equal to or greater than about 1m^2 , such as a ceramic or metal siding material, may be preferably employed as the exterior finishing panel as set forth above. In a preferred embodiment of the present invention, a gap of each of joint sections, each extending along boundaries between the structural skeleton zone and the opening area, is charged with a sealant for exterior finishing, whereby vertical joint sections (40) and/or horizontal joint sections (41) are provided as working joints absorbing or compensating for differences in behaviors, displacements, or deformations between the columns or beams and the steel structure wall part. In general, the "working joint" means a joint which causes a joint movement (movement of the joint) relatively significantly, due to an external disturbance factor, such as an earthquake or a variation of a weather condition.

[0024]

In a preferable embodiment of the present invention, the opening area (α) is formed in every column-span (γ) throughout an entire periphery of the building, and the steel structure wall part (W_a) and the interior wall part (W_b) are built in all of the opening areas. In another preferable embodiment of the present invention, the opening areas are formed in all the column-spans except for the column-span(s) provided with a concrete structure bearing wall(s) (KW), and the steel structure wall part and the interior wall part are built in each of these opening areas. Preferably, components of the steel structure wall part and components of the interior wall part are spaced apart from each other, so that a buffer zone is formed between these two wall parts to isolate the transmission path of heat, vibrations and solid propagation sounds. If desired, hollows or spaces inside the frames of the steel structure wall parts and/or the interior wall parts are charged with inorganic fiber-based thermal insulation materials (8, 18) (for example, an artificial mineral fiber thermal insulation material, such as a glass wool or rock wool), similar to the aforementioned thermal insulation material (21).

[0025]

According to a more preferable embodiment of the present invention, a boundary surface of the thermal insulation material (21) on its outdoor side is defined or specified by an indoor side surfaces (26a, 26a') of the furring strips,

as being a vertical surface (Va) substantially in parallel with the substrate surface. The exterior thermal insulation layer (G) includes an air layer or a ventilated air layer (23) formed between the thermal insulation material (21) and the exterior finishing material (22), and the insulation layer (G) further includes a moisture-permeable waterproofing sheet interposed between the thermal insulation material and the substrate surface, or disposed on an outside surface of the thermal insulation material on its outdoor side. The air or ventilated air layer and the sheet extend over an entire area of the exterior thermal insulation layer. Preferably, the thermal insulation material is an inorganic fiber-based thermal insulation material, and the joint section formed between the board (6) and the column (C) and/or beam (B) is a fire-resistive joint section with an inorganic sealing material which has a fire-resistive performance, and the wall (W) constituted from the aforementioned two wall parts (Wa, Wb) in each of the opening areas (α) exhibits a fire-resistive performance for one hour.

[0026]

From yet another aspect of the invention, the present invention provides a concrete building having the exterior wall structure or the thermal insulation structure as set forth above, and a method for constructing such a concrete building, which includes the thermal insulation method as set forth above.

[Advantageous Effects of Invention]

[0027]

According to the present invention, the exterior wall structure, the thermal insulation structure, and the thermal insulation method, which enable a reduction in the weight of the concrete building with the framework construction or Rahmen frame construction to be thermally insulated in accordance with the external insulation construction method, without degrading the thermal insulation performance of the building, and which is capable of overcoming the various issues, such as the effects of wind pressures or seismic forces acting on the exterior walls of middle level stories and upper stories of the building, deterioration of the fire-resistive performance and the sound insulation performance of each of the exterior walls, the differences in the structure and method for supporting or constructing the insulation materials and the exterior finishing materials between these different types of insulation methods, and so forth.

[Brief Description of the Drawings]

[0028]

[Fig. 1] Fig. 1 is a partial plan view illustrating a concrete building, which is provided with an exterior wall structure according to a preferred embodiment of the present invention.

[Fig. 2] Fig. 2 is a vertical cross-sectional view partially illustrating the concrete building as shown in Fig. 1.

[Fig. 3] Fig. 3 is a horizontal cross-sectional view of an exterior wall as shown in Figs. 1 and 2, in which a structure of the exterior wall is partially depicted.

[Fig. 4] Fig. 4 is a vertical cross-sectional view of the exterior wall as shown in Figs. 1 and 2, which shows the structure of the exterior wall.

[Fig. 5] Fig. 5 is a partially cut-away perspective view which schematically illustrates the structure of the exterior wall as shown in Figs. 1 and 2.

[Fig. 6] Fig. 6 is a partial plan view illustrating a concrete building having an exterior wall structure according to another embodiment of the present invention.

[Fig. 7] Fig. 7 is a vertical cross-sectional view partially illustrating the building as shown in Fig. 6.

[Fig. 8] Fig. 8 is a horizontal cross-sectional view of an exterior wall showing a structure of an exterior wall according to yet another embodiment of the present invention.

[Fig. 9] Fig. 9 is a partially enlarged horizontal cross-sectional view of the exterior wall as shown in Fig. 8.

[Fig. 10] Fig. 10 is a horizontal cross-sectional view of an exterior wall, which is a modification of the embodiment as shown in Figs. 8 and 9.

[Description of Embodiments]

[0029]

With reference to the attached drawings, preferred embodiments of a structure of an exterior wall according to the present invention are described in detail hereinafter.

[0030]

Figs. 1 and 2 are a plan view and a vertical cross-sectional view, each showing a concrete building partially, wherein the building has an exterior wall structure according to a preferred embodiment of the present invention.

[0031]

The building A as shown in Figs. 1 and 2 is designed to be a middle-rise or high-rise concrete building with a framework construction (a Rahmen frame construction), wherein the building A comprises beams B and columns C with RC or SRC structures, each being built by cast-in-place or in-situ concrete. The

beams B and the columns C are designed to be elements required for the structural resistance of the building A. Floor structures F at the respective floor levels and the roof floor level are concrete slabs built by cast-in-place or in-situ concrete. A foundation of the building A is a pile foundation or a spread foundation constructed by cast-in-place or in-situ concrete. Alternatively, the building A may be designed to be a middle-rise or high-rise concrete building with a framework construction (a Rahmen frame construction) which partially or generally comprises the beams B and the columns C with PCa (Precast Concrete) structures, each being elements required for the structural resistance of the building.

[0032]

Conventionally, an external insulation construction method has been employed in a case where exterior wall surfaces of such a concrete building are to be thermally insulated from its outside, and the exterior walls of the building have been designed to be concrete structure bearing walls (earthquake-resisting walls) or concrete structure non-bearing walls (non-earthquake-resisting walls). However, in the building A according to this embodiment, each of the exterior walls W is designed to be a non-bearing wall with a double-wall structure built by a dry process construction method, which comprises a steel structure wall part or portion Wa and an interior wall part or portion Wb. The wall part Wb has steel furrings for wall (JASS (Japanese Architectural Standard Specification) 26).

[0033]

The steel structure wall part Wa has a steel structure built in a rectangular or square opening area α surrounded by the columns C and the beams B. The wall part Wa has a framework comprising a lower runner 2, an upper runner 3, intermediate posts 4, and end posts 5, which are steel components with C-shaped or channel-shaped cross-sections (JIS G 3350: Light gauge steel sections for general structure), or steel components with square or rectangular cross-sections (JIS G 3466: Carbon steel square and rectangular tubes for general structure). The wall part Wa is provided with substrate boards 6 for exterior finishing, on outside face of this framework. The lower runner 2 forms a sill or functions as the sill. The upper runner 3 forms an upper horizontal furring strip or functions as such a strip. Each of the posts 4, 5 configures a vertical furring strip, or functions as such a strip.

[0034]

The interior wall part Wb is a lightweight partition wall built in the opening area α , which is a partition wall having the steel furrings (JASS 26). The wall part Wb is spaced at a width T0 of a buffer zone S inside the wall part Wa and is arranged in parallel with the wall part Wa. The framework of the wall

part Wb comprises a lower runner 12, an upper runner 13, studs 14 and end posts 15. The width T0 of the buffer zone S is a minimum distance between the wall parts Wa, Wb (in this embodiment, the minimum distance is a dimension between the runners). The width T0 is set to be at least 0.5mm, preferably, a dimension in a range from 1mm to 15mm (e.g., 5mm).

[0035]

Boards 6 of the wall part Wa are fixed to outside faces of the runners 2, 3 and the posts 4, 5 by fixing elements, such as screw nails, whereby that substrate surfaces 1 for exterior finishing are configured by the boards 6. The surface 1 can be installed or covered with a thermal insulation material 21. Substrate surfaces 10 for exterior finishing, which can be installed or covered with thermal insulation materials 21, are also configured by outside surfaces of the columns C and the beams B. In this embodiment, the surfaces 1, 10 are divided by peripheral joint sections 9. However, the surfaces 1, 10 configure a single, common, vertical, and flat substrate surface on which the thermal insulation materials can be installed or laid. This single and common substrate surface substantially continuously extends over different column-spans γ and different floor levels (different stories). The column-span γ is a module as defined or specified by a region between centerlines of the adjacent columns. If necessary, a stepped or offset configuration may be locally formed on the surface 1, 10 or at a boundary between the surfaces 1, 10. If necessary, the boards 6 may be connected with each other by a metal or resin joiner or the like, or the board 6 may be connected with the column C or the beam B by means of such a joiner or the like.

[0036]

The thermal insulation materials 21 are successively attached to or laid on the wall parts Wa, the columns C, and the beams B, in such a manner that the surfaces to be treated (the substrate surfaces 1, 10) are fully covered with the materials 21, which continuously extend on the whole exterior wall surfaces. Further, exterior finishing materials 22 are arranged outside the materials 21 in such a manner that the materials 22 are substantially continuously provided over the whole exterior wall surfaces of the building A. The materials 22 are integrally attached to the wall parts Wa, the columns C, and the beams B by means of supporting mechanisms and so forth, as described later. An air layer 23 is formed between the materials 21, 22.

[0037]

The thermal insulation materials 21, the exterior finishing materials 22, and the air layer 23 are provided continuously over the plural column-spans γ and the plural stories. Therefore, an exterior thermal insulation layer G is

provided, which continuously extends over the whole exterior wall surfaces of the building A. A thickness (width) T3 of the layer G (Figs. 3 and 4) is set to be in a range from 50mm to 200mm, preferably, from 75mm to 150mm (e.g., approximately 100mm in this embodiment). This is analogous to a thickness of an exterior thermal insulation layer provided in accordance with a conventional external insulation construction method. In the areas corresponding to the columns C and the beams B (i.e., structural skeleton zone β), the layer G functions as an externally constructed insulation layer, which covers the concrete structure skeleton with the thermal insulation materials, wherein the concrete structure skeleton has a heat storage effect. In the areas surrounded by the structural skeleton zone β (i.e., in the rectangular or square opening areas α), the layer G acts as an externally installed insulation layer, which covers the outside surface of the wall part Wa with the thermal insulation materials. Thus, the building A is provided with the layer G for thermally insulating the overall exterior wall surfaces of the building A, with use of a combined or hybrid method comprising the external insulation construction method and the external insulation installation method.

[0038]

The exterior finishing materials 22 are spaced from each other at a gap of the joint section along a boundary between the areas α , β . An exterior finishing sealant, such as a silicone sealant, an acrylic urethane sealant, or a polysulphide sealant, is charged or filled in the gap, whereby vertical and horizontal joint structures 40, 41 are provided in line with the boundary between the areas α , β . The joint structures 40, 41 function as working joints for absorbing or compensating for differences in behaviors, displacements or deformations between the structural skeleton (the columns C and the beams B) and the wall parts Wa, which may be caused due to earthquakes, strong wind conditions, and so forth.

[0039]

The building A with such an arrangement is the concrete building provided with the exterior thermal insulation layer G which thermally insulates the overall exterior wall surfaces from the outside thereof with use of a combination of the external insulation construction method and the external insulation installation method. The building A is not provided with a concrete wall. However, the building A ensures a thermally insulating performance equivalent to that obtained by the external insulation construction method which is a conventional insulation method for the concrete building. A dead load of the wall W constituted from the wall parts Wa, Wb in the building A is reduced down to approximately 1/5-1/10 of the dead load of the exterior wall with concrete structure. Therefore, the dead load of the building A is significantly

reduced. A seismic force (a temporary horizontal force) acting on the structural skeleton of the building A constituted from the beams and columns B, C is relieved relatively significantly due to such a reduction of the dead load. A structural load imposed on foundations of the building A and so forth is also reduced considerably. Thus, the combination of these two insulation methods is remarkably advantageous in the structural design of the building A. In addition, employment of the wall with the steel structure enables reduction of construction costs, shortening of construction period, and so forth, and therefore, it is also advantageous from an aspect of improvement of the construction planning of the building A.

[0040]

Further, internal spaces in the wall parts Wa, Wb can be utilized as cabling and piping spaces for building utilities. Therefore, the workability for building utility works can be improved. Nevertheless, the thickness of the wall W is merely in a range from 150mm to 250mm (the wall thickness $[T0+T1+T2]$ as shown in Figs. 3 and 4). Therefore, the wall thickness can be designed to be equivalent to the wall thickness of a conventional concrete wall. Thus, effectively usable indoor spaces of the rooms are not reduced, and disadvantages related thereto in the architectural design are avoidable. Furthermore, the double-wall structure of the exterior wall W comprising the wall parts Wa, Wb can ensure a desired fire-resistive performance (one hour), relatively easily.

[0041]

In addition, a relatively large wind load is imposed on the exterior wall surface of the building A in its upper or middle floor level. However, an out-of-plane rigidity of the steel structure wall part Wa can be so designed as to endure such a wind load, relatively easily. Further, deformations, behaviors, or vibrations of the wall Wa owing to the wind loads, or solid propagation of external noise, and so forth can be absorbed or isolated by the buffer zone S. Therefore, such deformations, behaviors, vibrations, solid propagation sounds, and so forth can be prevented from affecting the interior wall part Wb. Therefore, comfortability or habitability of indoor environment can be prevented from being degraded by the wind load and so forth. Further, a thermal transmission caused due to change of external factors, such as change of weather condition or solar radiation, can be surely isolated by the buffer zone S. Thus, there is almost no disadvantages in the design of air conditioning system that is derived from the employment of the metal framework 2-5, 12-15.

[0042]

Furthermore, the substrate surfaces 1, 10 configure the single, common, vertical, and flat substrate surface substantially continuously extending, as well

as mechanisms for supporting exterior finishing materials as described later, enable construction or installation of the thermal insulation materials 21 and the exterior finishing materials 22 over the whole exterior wall surfaces with use of substantially the same or equivalent supporting structure.

[0043]

Figs. 3 and 4 are horizontal and vertical cross-sectional views of the exterior wall W in which the construction of the wall W is depicted, and Fig. 5 is a partially cut-away perspective view of the exterior wall W, which schematically illustrates the construction of the exterior wall W.

[0044]

The framework of the steel structure wall part Wa comprises the lower runner 2 fixed on the floor structure F, the upper runner 3 fixed to the lower face of the beam B, the intermediate posts 4, and the end posts 5. The posts 4, 5 are vertically built between the runners 2, 3. The intermediate posts 4 are arranged at equal intervals in alignment with a center axis X-X of the runners 2, 3, as seen in the plan view (FIG. 3). The end posts 5 are elected vertically in close proximity to the column C. As set forth above, the runners 2, 3 and the posts 4, 5 are steel components with C-shaped or channel-shaped cross-sections (JIS G 3350: Light gauge steel sections for general structure), or steel components with square or rectangular cross-sections (JIS G 3466: Carbon steel square and rectangular tubes for general structure). In this embodiment, the runners 2, 3 and the posts 4, 5 are the steel components with C-shaped cross-sections, each having a dimension of C-100×50×20×1.6 (mm), and the posts 4 are spaced from each other at a distance ranging from approximately 300mm to approximately 600mm.

[0045]

As shown in Figs. 3 and 4, a thermal-insulating and sound-absorbing material 8 (shown by broken lines) is filled or charged in the hollow area in the frame of the steel structure wall part Wa. In this embodiment, the material 8 is a glass wool with a density of 10 to 48 kg/m³ and a thickness of 10 to 100 mm (for example, a density of 24kg/m³ and a thickness of 75 mm). In Figs. 1, 2, and 5, depictions of the material 8 are omitted for simplification of the drawings.

[0046]

As set forth above, the exterior substrate boards 6 are arranged on the outside faces of the posts 4, 5 in a form of butt-joint formation, and are fixed to the posts 4, 5 by fixing elements, such as screw nails. Various kinds of gypsum boards may be preferably used as the boards 6. In the present embodiment, the board 6 is a reinforced gypsum board with a thickness of 15mm ("Tiger Board"

(registered trademark), "Type Z-WR" manufactured by Yoshino Gypsum Co., Ltd.). The lower end, upper end, and side edges of the boards 6 terminate in the vicinity of the beams B (or the floor structure F) and the columns C. The peripheral joint sections 9 are formed along the periphery of the boards 6. Each of the joint sections 9 has a joint structure, wherein a backing-layer sealing material 9a and a surface-layer sealing material 9b are continuously filled or charged in each of the joint sections (a channel-shaped gap formed between the ends or edges of the boards and the column C or the beam B) along the upper, lower, and side edges of the boards 6, as a filler for the joint section. For instance, in this embodiment, an inorganic sealing material, such as a rockwool felt (e.g., "Tiger Rock Felt" (trademark), a product of Yoshino Gypsum Co., Ltd.), is used as the sealing material 9a, and a urethane resin sealant or the like (e.g., "Tiger U Tight" (trademark), a product of Yoshino Gypsum Co., Ltd.) is used as the sealing material 9b.

[0047]

The width of each of the runners 2, 3 is set to be the same as the width of each of the posts 4, 5. The center axis X-X of the runners 2, 3 (Fig. 3) and the center axis Y-Y of the posts 4, 5 (Fig. 4) are positioned in the same vertical plane. The lower and upper ends of the posts 4, 5 are fixed to the runners 2, 3 by welding. In this embodiment, C-shaped steels, each being C-100×50×20×1.6 (mm), are used as the runners 2, 3 and the posts 4, 5. In this embodiment, the thickness T1 of the wall Wa including the thickness of the board 6 is set to be T1=115mm, on the architectural design.

[0048]

The outside surfaces of the boards 6 (that is, the substrate surface 1) are positioned in a vertical structural plane V of the skeleton (Figs. 2 to 4). The plane V is specified or defined by the outside surfaces of the beam B and the column C (i.e., the substrate surfaces 10). If desired, the surface 1 may be shifted at a position slightly retracted on an indoor side with respect to the plane V. The thermal insulation materials 21 constituting the exterior thermal insulation layer G are positioned on the outside surfaces of the beams B, the columns C, and the boards 6. The materials 21 are fastened to the beams B, the columns C and the wall parts Wa by the fixing elements (not shown), in a condition that the materials 21 are kept in plane contact or in intimate contact with the surfaces 1, 10.

[0049]

For example, the thermal insulation materials 21 are fastened to the posts 4, 5 by screws with washers, which penetrate the boards 6. If desired, a moisture-permeable waterproofing sheet (not shown) is adhered to the exterior substrate 1, 10 so as to be interposed between the materials 21 and the surfaces

1, 10. Alternatively, this sheet may be provided on the outside (outdoor side) surface of the materials 21. If desired, the materials 21 may be adhered to the surfaces 1, 10.

[0050]

5 In this embodiment, the thermal insulation materials 21 are glass wool panels, plates, or boards, each having a density of 16 to 48 kg/m³ and a thickness of 20 to 50mm (for example, a density of 24 kg/m³ and a thickness of 25 mm). The exterior finishing materials 22 are provided outside the boards 6, the beams B and the columns C, by means of the components 24 to 29 (FIG. 3) constituting the supporting mechanism as described hereinafter. As the exterior finishing material 22, a ceramic or metal siding panel having a height of 300 to 600 mm (for example, 450 mm), a width of 1200 to 2000 mm (for example, 1500 mm), and a thickness of 15 to 25 mm (for example, 18 mm) may be preferably employed. An air layer 23 is formed between the materials 21, 22.

15 [0051]

As shown in the partially enlarged view included in FIG. 3, the exterior finishing materials 22 are supported by the posts 4, 5 and the structural skeleton (the columns C and the beams B), with use of the supporting mechanism which comprises brackets 25, vertical furring strips 26, and metal fastening fittings 27. The brackets 25 are fixed to the posts 4, 5 by fixing elements 24, such as screws or bolts, which extend through the boards 6. Also, the brackets 25 are fixed to the structural skeleton (the columns C and the beams B) by anchor bolts 29 for RC structure, such as hole-in anchors. Each of the brackets 25 penetrates the thermal insulation material 21. Each of the vertical furring strips 26 is fixed to the bracket 25 by fixing elements 28, such as screws or bolts. Each of the brackets 25 is constituted from a plurality of L-shaped metal elements vertically aligned and spaced from each other at intervals. Each of the vertical furring strips 26 is an elongated L-shaped metal element, which vertically extends continuously. The supporting mechanisms, each constituted from the bracket 25 and the furring strip 26, are uniformly or evenly dispersed over the entire exterior walls across the opening area α and the structural skeleton zone β , whereby substrate furrings for installation of the exterior finishing materials are provided by the supporting mechanisms. The inner side surface 26a of the vertical furring strip 26 facing the heat insulating material 21 abuts against the material 21 to confine the material 21 from its outside, thereby defining or regulating an outside boundary of the material 21.

[0052]

Each of the metal fastening fittings 27 is provided with a device for supporting the exterior finishing material. The fittings 27 are mounted on the vertical furring strips 26 in positions, vertically spaced at intervals. The exterior

finishing materials 22 are fixed to the strip 26 by means of the fittings 27, whereby the materials 22 are integrally supported by the posts 4, 5, or the structural skeleton (the columns C and the beams B), via the brackets 25. For example, in a case where a ceramic siding panel is adopted as the material 22, a fastening fitting manufactured especially for the installation of the ceramic siding panel is employed. The vertical joint section 40 as shown in Fig. 3 has a joint structure in which a backup member 40a and a sealing material 40b are filled or charged in a gap of the joint section formed between the materials 22. The horizontal joint section 41 as shown in Figs. 2 and 4 has substantially the same joint structure as the joint section 40 has. The joint sections 40, 41 function to compensate for or absorb the differences in behaviors, displacements, or deformations of the materials 22 that may occur at the boundary between the opening area α and the structural skeleton zone β , during earthquakes, strong wind conditions, or the like.

[0053]

On the other hand, the framework of the interior wall part Wb arranged on the indoor side of the steel structure wall part Wa comprises the lower runners 12 disposed on the beams B (or the floor structure F), the upper runners 13 fixed to the lower faces of the beams B, and the steel studs 14 and the end posts 15 vertically built between the upper and lower runners 12, 13. The studs 14 are arranged in alignment with the central axes of the runners 2, 3, spaced at equal intervals from each other. The end post 15 is positioned in close proximity to the column C. Each of the runners 12, 13 and the studs 14 is a steel members with a plate thickness of 0.4 mm or more. Steel runners and steel studs as specified in JIS A 6517 ("Steel furrings for wall and ceiling in buildings"), or its equivalent, compliant or compatible products may be preferably used as the runners 12, 13 and the studs 14. That is, the runners 12, 13 and the studs 14 constitute steel furrings for wall as defined in JIS A 6517 or steel furrings equivalent thereto. In this embodiment, the end posts 15 may also be the steel studs as specified in JIS A 6517, or its equivalent, compliant or compatible products.

[0054]

In this embodiment, each of the studs 14 and the end posts 15 is a steel furring for wall, which has a channel-shaped cross-section of 50mm×45mm and 0.8 mm thickness. The studs 14 are spaced from each other at a distance of approximately 450 mm. The width of each of the runners 12, 13 is slightly larger than the width of each of the studs 14 and the end posts 15. The upper and lower ends of each of the studs 14 and the end posts 15 are inserted into grooves of the runners 12, 13. In practice, the width of each of the runners 12, 13 may be regarded as being substantially the same as the width of each of the

studs 14 and the end posts 15. Therefore, the designed wall thickness T2 of the wall part Wb including the boards 16, 17 is regarded as being $T2=72$ mm or 75 mm in this embodiment, wherein each of the studs 14 and the end posts 15 is the steel furring for wall with the channel-shaped cross-section of $50\text{mm}\times 45\text{mm}$ and 0.8 mm thickness. Alternatively, steel studs or the like, each having a rectangular or square cross-section of $50\text{mm}\times 45\text{mm}$ and 0.45mm thickness or $40\text{mm}\times 40\text{mm}$ and 0.45mm thickness, may be used as the stud 14 and the end post 15.

[0055]

As shown in Figs. 3 and 4, the thermal-insulating and sound-absorbing materials 18 are filled in the hollow areas inside the frame of the interior wall part Wb. The material 18 is a glass wool with a density of 10 to 48 kg/m^3 and a thickness of 30 to 50mm (e.g., a density of 24kg/m^3 and a thickness of 40mm). In Figs. 1, 2, and 5, depictions of the materials 18 are omitted for simplification of the drawings.

[0056]

The substrate layer boards 16 are fixed to the interior side faces of the studs 14 and the end posts 15 by screws (tapping screws, not shown). The surface layer boards 17 are fixed to the interior side faces of the boards 16 by staples and adhesives. Various kinds of gypsum boards with a thickness ranging from 9mm to 25 mm, e.g., reinforced gypsum board ("Tiger Board-Type Z" (registered trademark) manufactured by Yoshino Gypsum Co., Ltd.), are preferably used as the boards 16, 17. In this embodiment, a reinforced gypsum board with a thickness of 12.5mm is used as the board 16, and a regular-hard type gypsum board with a thickness of 9.5mm is used as the board 17; or otherwise, the reinforced gypsum board with a thickness of 12.5mm is used as each of the boards 16, 17.

[0057]

As an adhesive for installation of the gypsum boards, vinyl acetate resin type emulsion adhesive is preferably used, which is generally or usually used as an adhesive for such a usage. If desired, the boards 17 may be fixed to the boards 16 by not only the adhesive, but also screws and staples; or otherwise, the boards 17 may be fixed to the boards 16 only by the screws.

[0058]

The lower end, upper end, and side edges of the boards 16, 17 are positioned in the vicinity of the floor structure F, the beam B, and the columns C, so that the peripheral joint sections 19 for the boards 16, 17 are provided. Each of the joint sections 19 has a joint structure in which a backing-layer sealing material 19a and a surface-layer sealing material 19b are continuously

filled or charged, as a filler for the joint section, in each of the joint sections (a channel-shaped gap along the column C or the beam B) in line with the upper and lower ends, and side edges of the boards 16, 17. For instance, in this embodiment, a rockwool felt (e.g., "Tiger Rock Felt" (trademark), a product of Yoshino Gypsum Co., Ltd.) is used as the backing-layer sealing material 19a, and a urethane resin sealant (e.g., "Tiger U Tight" (trademark), a product of Yoshino Gypsum Co., Ltd.) is used as the surface-layer sealing material 19b.

[0059]

In interior finishing works, surfaces of the boards 17, lower or side surfaces of the beam B, vertical surfaces of the column C, and so forth, which are exposed to the indoor spaces, are coated or covered by interior finishing materials 30 (such as paint coating, or cloth). Floor finishing materials 31 are laid on an upper surface of the floor structure F. If desired, an OA floor system, a free access floor system, a system floor assembly, and so forth, may be constructed on the floor structure F, or a system ceiling assembly, a steel ceiling furrings as specified in JIS A 6517, and so forth, may be constructed in the ceiling region. In FIG. 5, depictions of the interior finishing materials 30 and the floor finishing materials 31 are omitted.

[0060]

As the advantageous effects to be obtained from the exterior wall W with the arrangements as set forth above, the following merits are exemplified:

(1)The dead load of the exterior wall can be reduced to about 1/5 to 1/10 of the dead load of the exterior wall with the reinforced concrete structure;

(2)The construction work for the exterior wall W is advantageous in the shortening of the construction term of time and the reduction of the construction costs, compared to the construction work for the exterior wall with the reinforced concrete structure;

(3)The workability of the installation work of building utilities is improved, due to the utilization of the internal spaces of the wall parts Wa, Wb as wiring and piping spaces for building utilities;

(4) The wall thickness ($T_0+T_1+T_2$) of the exterior wall W can be designed to be equivalent to the wall thickness of the conventional concrete wall.

(5)The exterior wall W can relatively easily ensure the desired fire resistive performance (fire resistance time equal to or longer than 1 hour);

(6)The wall Wa can be designed to effect the out-of-plane rigidity against the wind load, relatively easily;

(7)The deformations, behaviors, or vibrations of the steel structure wall

part Wa owing to the wind loads, or the solid propagation of external noise and so forth can be absorbed or isolated by the buffer zone S;

(8)The heat transfer or heat load resulting from variation in the weather condition, solar radiation, and so forth can be isolated in the thermal transmission path by the buffer zone S; and

(9)The surfaces 1, 10 and the supporting mechanisms 24-29 allows the thermal insulation materials 21 and the exterior finishing materials 22 to be provided on the overall exterior wall surface by substantially equal or equivalent supporting structure, wherein the surfaces 1, 10 constitute a single, common, vertical, and flat substrate surface extending substantially continuously, and wherein the supporting mechanisms are substantially commonly disposed over the entire exterior surfaces to be finished.

[0061]

Figs. 6 and 7 are a partial plan view and a partial vertical cross-sectional view illustrating a concrete building having the exterior wall structure, which is another embodiment according to the present invention.

[0062]

In the embodiment as set forth above, the building A is not provided with a bearing wall (earthquake resisting wall), and all of the exterior walls W are designed to be the wall with double-wall structure built by dry process construction works, which comprises the steel structure wall part Wa and the interior wall part Wb built by the steel furrings for wall (steel furrings as defined in JASS26 or equivalent thereto). Therefore, the seismic load acting on the building can be relatively remarkably reduced, due to the reduction in the dead load of the building. On the other hand, the total seismic load has to be carried by the framework constituted from the columns C and the beams B. If the structural loads imposed on the columns C and the beams B are excessive, a concrete bearing wall (earthquake resisting wall) KW may be provided at a desired position of the exterior walls, as exemplified in the building A' shown in Figs. 6 and 7. According to such an exterior wall structure, the substrate surface 10 is continuously formed not only on the columns C and the beams B, but also on the bearing wall KW. The thermal insulation materials 21 constituting the exterior thermal insulation layer G are disposed not only on the outside surfaces of the beams B, the columns C and the boards 6, but also on the outside surface of the bearing wall KW.

[0063]

In accordance with a construction method similar to that of the aforementioned embodiment, the thermal insulation materials 21 are fastened to the beams B, the columns C, the steel structure wall parts Wa, and the bearing

walls KW by fastening means (not shown), in a condition that the materials 21 are in surface contact or intimate contact with the substrate surfaces 1, 10. If desired, moisture-permeable waterproofing sheets (not shown) are adhered to the substrate surfaces 1, 10, so that the sheets are interposed between the materials 21 and the substrate surfaces 1, 10. Alternatively, the sheets may be laid on the outdoor side surface of the materials 21. If desired, the thermal insulation materials 21 may be adhered to the substrate surfaces 1, 10.

[0064]

Similarly to the aforementioned embodiment (Fig. 3), the exterior finishing materials 22 are supported by the intermediate and end posts 4, 5, with use of the fixing elements 24, 28, the brackets 25, the vertical furring strips 26, and the metal fastening fittings 27, and are fixed to the columns C and the beams B, with use of the anchor bolts 29 for RC structure, the elements 28, the brackets 25, the strips 26, and the fittings 27. Equivalently to the structure for supporting the materials 22 by the columns C and the beams B, the materials 22 are fixed to the bearing walls KW, with use of the anchor bolts 29, the elements 28, the brackets 25, the strips 26, and the fittings 27. Analogously to the aforementioned embodiment, the supporting mechanisms 24-29 constitute the substrate structure for installation of the exterior finishing materials, which is uniformly or evenly dispersed over the entire exterior walls across the opening area α and the structural skeleton zone β , and the joint structures 40, 41 are provided at the boundary of the areas α and β . The joint structures 40, 41 absorb or compensate for differences in behaviors, displacements, or deformations of the materials 22 which may occur during earthquakes or strong wind conditions.

[0065]

According to the building A' thus having both of the bearing walls KW with the reinforced concrete structure and the non-bearing exterior walls W with the steel structure, the effects to be obtained from the weight reduction of the building A' may be slightly degraded. However, the arrangement of the building A' still enables to achieve reduction in the structural loads acting on the beams B and the columns C, improvement of an aseismic performance of the building A', reduction in the construction costs due to reduction in the quantity of reinforcement steel bars, and so forth.

[0066]

Figs. 8 and 9 are a horizontal cross-sectional view and a partially enlarged horizontal cross-sectional of the exterior wall, which is yet another embodiment according to the present invention, and Fig. 10 is a horizontal cross-sectional view of the exterior wall, which shows a modification of the embodiment as shown in Fig. 8.

[0067]

In the embodiment as shown in Figs. 8 and 9, the vertical furring strips 26, each being made of the elongated metal material with the L-shaped cross-section (Fig. 3), are replaced with vertical furring strips 26', each being made of an elongated steel member with a square or rectangular cross-section. For instance, a square steel pipe with dimensions of 40mm×40mm and 1.6 mm thickness may be preferably adopted as the strip 26'. Similarly to the aforementioned embodiments, the brackets 25 and the strips 26' constitute the supporting mechanisms for installation of the exterior finishing materials 22 outside of the thermal insulation materials 21. These mechanisms provide a substrate structure for installation of the exterior finishing materials, which are uniformly or evenly dispersed over the entire exterior walls across the opening areas α and the structural skeleton zones β . The inside surfaces 26a' of the strips 26' abut against the outside surfaces of the materials 21 so as to confine the materials 21 from their outside. An outside surface of each of the materials 21 is specified or defined by the many inside surfaces 26a', as a vertical plane Va (Fig. 9), which is substantially in parallel with the substrate surface 1. The other structures of the exterior walls of the present embodiment are substantially the same as those of the aforementioned embodiments, and therefore, duplicated descriptions are omitted.

[0068]

An exterior wall structure, which is a modification of the exterior wall structure shown in Fig. 8, is illustrated in Fig. 10, wherein a profile or configuration of the column C appears outside the building A as a shape of the column. The exterior wall structure of the present invention can be similarly applied to an architectural design in which the profile or configuration of the column (and/or, a profile or configuration of a beam) is revealed outside of the exterior wall. For example, in the architectural design as shown in FIG. 10, the column C projects outward with respect to the exterior wall W as seen in the plan view. In such a design, the thermal insulation materials 21 are provided along the outer surface of the column C, and also, the anchor bolts 29 for RC structure, the brackets 25, the vertical furring strips 26', and the fastening fittings 27 are fixed to the column C, and further, the exterior finishing materials 22 are mounted on the fastening fittings 27. Further, at the corners of the column C, vertical furring strips 26" (for example, C-shaped steel of C-75mm×45mm×15 mm and 1.6mm thickness) are fixed to the brackets 25, and the exterior finishing materials 22', each having an L-shaped cross-section, are fixed to the strips 26". Such an exterior wall structure can be similarly adopted in an exterior wall structure for making a profile or configuration of the beam B appear on the exterior wall surface.

[0069]

In Fig. 8, there is shown a partition wall 50 having a wall end portion abutted against the interior side surface of the interior wall part Wb, wherein a direction of the wall 50 is orthogonal to a direction of the exterior wall W. The wall 50 is a lightweight partition wall arranged in a single-runner staggered-stud pattern. Architectural spaces, such as living rooms, are defined or partitioned on both sides of the wall 50. The studs 51 constituting intermediate posts are disposed in a staggered arrangement, wherein the studs are decentered alternately on either one side with respect to the wall centerline by installation of spacers 54, and are vertically erected or stood between a lower runner 52 and an upper runner (not shown). The end post 55 is formed by a pair of steel studs 55a, 55b disposed in a staggered arrangement by spacers 54. At the end of the partition wall 50, joint sections 59 similar to the joint section 19 comprising the backing-layer and surface-layer sealing materials 19a, 19b are provided. By constructing both of the wall part Wb and the wall 50 as lightweight partition walls (partition walls with the steel furrings defined in JASS26 or equivalent thereto), the workability or efficiency of construction work can be improved.

[0070]

Although the present invention has been described as to preferred embodiments, the present invention is not limited thereto, but may be carried out in any of various changes or variations without departing from the scope of the invention as defined in the accompanying claims.

[0071]

For example, although reinforced gypsum boards and regular-hard type gypsum boards are used as the boards constituting the exterior wall W in the above embodiments, the boards of the wall W may be the other conventional gypsum board products, such as structural gypsum boards, gypsum sheathing boards, or decorated gypsum boards, in accordance with design conditions. Alternatively, gypsum boards with glass fiber nonwoven fabric ("Tiger Glass Rock" (registered trademark) manufactured by Yoshino Gypsum Co., Ltd.); slag gypsum boards ("Asnon"(registered trademark) and so forth); cement boards ("Duracrete" (registered trademark) and so forth); fiber reinforced gypsum boards ("FG board" (trademark) and so forth); extruded cement panels ("Clion Stud-less Panel", "SLP Panel" (trademarks)); ALC panels; calcium silicate boards; wooden plywood panels; ceramic sidings; and so forth, may be used as the boards of the wall W, according to the design conditions.

[0072]

Further, in the present invention, the column of the concrete building may include a wing wall having a horizontal projection dimension equal to or

smaller than the cross-sectional dimension of the column (the horizontal dimension measured in the wall core direction), and the beam of the concrete building may include a hanging wall or a spandrel wall having a vertical dimension equal to or smaller than the cross-sectional dimension of the beam (the vertical dimension of the beam). As regards an architectural design in which an additional placement of concrete is provided on an upper part of the beam or an edge of a concrete floor slab extends on the upper part of the beam, such an additional concrete portion or the extension of the floor slab on the beam is regarded as a part of the beam, in the present invention.

[0073]

Furthermore, the exterior wall structure of each of the aforementioned embodiments has an arrangement in that a glass wool-based thermal insulation material, which is a kind of inorganic fiber-based thermal insulation material, is disposed as the exterior thermal insulation layer and is filled in the hollow area inside the frame of the wall, especially in consideration of fire-resistive performance or non-combustibility. If desired, a rock wool-based thermal insulation material, which is a kind of inorganic fiber-based thermal insulation material different from the glass wool-based thermal insulation material; a wood fiber-based insulation material; a foamed plastic-based heat insulation material (such as a hard urethane foam, a phenol foam, a polystyrene foam, or the like); or the other type thermal insulation materials made from the other raw materials, may be employed as the aforementioned thermal insulation material.

[0074]

In addition, in each of the aforementioned embodiments, the frame of the steel structure wall part has a structure in which the upper and lower ends of the intermediate posts and the end posts are welded to the upper and lower runners, but the frame of the steel structure wall part may be designed to have the other constructions, such as the following constructions:

(1) Steel pieces (pieces of steel) of an angle steel bar, each having L-shaped cross-section, are fixed to the upper and/or lower end surface(s) of the beam(s) by means of anchor bolts or the like, and the upper and/or lower ends of the posts are fixed to the pieces by means of bolts or welding;

(2) The runner(s) is fixed to the upper and/or lower end surface(s) of the beam(s), and the lower and/or upper ends of the posts are fixed to the runner by welding;

(3) The runner(s) is fixed to the upper and/or lower end surface(s) of the beam(s), and the above steel pieces are welded to the upper and/or lower end surface(s) of the runner(s), the upper and/or lower ends of the posts are fixed to the pieces by means of bolts or welding;

(4)In the construction of the above item (3), the lower end and/or upper end of the posts are further welded to the upper or lower surface of the runner(s).

[Industrial Applicability]

5 [0075]

The present invention can be applied to the exterior wall structure, the thermal insulation structure, and the thermal insulation method of the concrete building having concrete columns and concrete beams. Especially, the present invention can be applied to the architectural structure, the insulation structure,
10 and the thermal insulation method of the exterior wall constructed or built in the opening area surrounded by the columns and beams, in the concrete building with the thermal insulation materials and the exterior finishing materials provided outside the columns and beams at the outer peripheral zone or the perimeter zone of the building. According to the present invention, the concrete
15 building having the framework construction or the Rahmen frame construction can be thermally insulated by a combination or combined use of the external insulation construction method and the external insulation installation method, and a reduction in the weight of the building can be achieved, and further, the various difficulties owing to adoption of the combination or combined use of
20 the different types of insulation methods can be overcome, and therefore, the present invention is practically advantageous remarkably.

[List of Reference Signs]

[0076]

A, A' building
25 B beam
C column
G exterior thermal insulation layer
V vertical structural plane of skeleton
Va vertical plane (outside boundary of thermal insulation materials)
30 W exterior wall
KW bearing wall (earthquake-resisting wall)
Wa steel structure wall part
Wb interior wall part
S buffer zone
35 α rectangular or square opening area

	β	structural skeleton zone
	γ	column-span
	1,10	substrate surface for exterior finishing
	2, 3, 12, 13	runner
5	4, 14	intermediate post, stud
	5, 15	end post
	9, 19	peripheral joint section
	16	substrate-layer board
	17	surface-layer board
10	21	thermal insulation material
	22, 22'	exterior finishing material
	23	air layer
	25	bracket
	26, 26', 26"	vertical furring strips
15	27	metal fastening fitting
	30	interior finishing material
	31	floor finishing material
	40	vertical joint section
20	41	horizontal joint section

[Title of Document] Claims

[Claim 1]

An exterior wall structure of a concrete building with a framework structure, wherein the framework structure is constituted from concrete beams and concrete columns, and thermal insulation layers are provided outside of the columns and the beams disposed at an outer peripheral zone or a perimeter zone of the building, comprising:

a structural skeleton zone configured by said columns and said beams, and an opening area surrounded by the columns and the beams,

wherein a steel structure wall part and an interior wall part are built in the opening area to be an exterior wall with a double-wall structure, the steel structure wall part being provided with steel structure intermediate posts and the interior wall part being spaced at a distance from the steel structure wall part on its indoor side,

wherein said steel structure wall part is provided with substrate boards for exterior finishing, the substrate boards being positioned outside of said post and being fixed to said posts so as to close the opening area with the substrate boards, and outside surfaces of the substrate boards, said beams, and said columns configure a single or common substrate surface for exterior finishing, which continuously extends over said structural skeleton zone and said opening area, and

wherein thermal insulation materials are installed or laid on said substrate surface to cover the substrate surface with the thermal insulation materials, exterior finishing materials are provided outside the insulation materials, and a continuous exterior thermal insulation layer is formed outside the columns, the beams, and the steel structure wall part so as to substantially uniformly or evenly extend over said opening area and said skeleton zone.

[Claim 2]

The exterior wall structure as defined in claim 1, wherein outside surfaces of said substrate boards are positioned in a vertical plane (V) specified or defined by outside surfaces of said columns and said beams, or in a situation slightly shifted on an interior side of the vertical plane;

wherein brackets are fixed to said columns, said beams, or said structural wall parts to extend through said thermal insulation materials, supporting mechanisms for supporting said exterior finishing materials are fixed to said brackets, and the supporting mechanisms include furring strips on which said exterior finishing materials can be mounted; and

wherein exterior finishing panels are mounted on said strips outside of

said thermal insulation materials, as said exterior finishing materials, and the panels configure a vertical exterior wall surface of the building, which substantially extends over said structural skeleton zone and said opening area.

[Claim 3]

5 The exterior wall structure as defined in claim 1 or 2, wherein a gap of each of joint sections, each extending along a boundary between said structural skeleton zone and said opening area, is charged with a sealant for exterior finishing, so that vertical and/or horizontal joint sections are provided as working joints for absorbing or compensating for differences in behaviors,
10 displacements or deformations between said columns and beams and said steel structure wall part.

[Claim 4]

15 The exterior wall structure as defined in one of claims 1 through 3, wherein said opening area is formed in every column-span throughout an entire periphery of the building, and said steel structure wall part and said interior wall part are built in all of the opening areas; or said opening areas are formed in all the column-spans except for the column-span or column-spans which is or are provided with a concrete structure bearing wall or walls, and said steel structure wall part and said interior wall part are built in each of the opening areas.

20 [Claim 5]

25 The exterior wall structure as defined in one of claims 1 through 4, wherein components of said steel structure wall part and components of said interior wall part are spaced apart from each other, a buffer zone is formed between these wall parts to isolate a transmission path of heat, vibrations and solid propagation sounds.

[Claim 6]

30 The exterior wall structure as defined in claim 2, wherein a boundary surface of the thermal insulation material on its outdoor side is specified or defined by indoor side surfaces of said furring strips, as being a vertical surface (Va) substantially in parallel with said substrate surface, and said exterior thermal insulation layer includes an air layer or a ventilated air layer formed between the thermal insulation material and said exterior finishing material, and a moisture-permeable waterproofing sheet interposed between the thermal insulation material and the substrate surface, or disposed on a surface of the
35 thermal insulation material on its outdoor side.

[Claim 7]

 The exterior wall structure as defined in one of claims 1 through 6, wherein said thermal insulation material is an inorganic fiber-based thermal

insulation material, each of joint sections formed between said boards and said columns and/or beams is a fire-resistive joint with an inorganic sealing material, and a wall structure constituted from said wall parts in each of the opening areas effects a fire-resistive performance for one hour.

5 [Claim 8]

A thermally insulating structure of a concrete building, in which a structural skeleton of the building has a framework construction constituted from concrete structure beams and columns, and said skeleton is covered with a thermal insulation layer disposed outside the skeleton, whereby the insulation
10 layer outside the skeleton is formed so that the insulation layer substantially continuously extends over different column-spans and/or different stories, comprising:

a first thermal insulation material and a first exterior finishing material, which are constructed on an outside surface of a structural skeleton zone in
15 accordance with an external insulation construction method, the skeleton zone being configured by said columns and said beams disposed in an outer peripheral zone or a perimeter zone of the building, and

a second thermal insulation material and a second exterior finishing material, which are installed on an exterior wall with a double-wall structure in
20 accordance with an external insulation installation method, the exterior wall being built in an opening area surrounded by said columns and beams;

wherein said exterior wall is constituted from a steel structure wall part and an interior wall part, the steel structure wall part is positioned in said opening area and includes steel structure intermediate posts, and the interior
25 wall part is provided with steel furrings for wall and is positioned in the opening area, spaced apart from the steel structure wall part on an indoor side thereof;

wherein said steel structure wall part has substrate boards for exterior finishing which are fixed to said intermediate posts so as to close said opening area outside the intermediate posts, and outside surfaces of the boards and the
30 outside surface of said skeleton zone configure a single or common substrate surface for exterior finishing, which substantially continuously extends over said opening areas and said skeleton zone; and

wherein said first and second thermal insulation materials are installed or laid continuously on said substrate surface so as to cover the substrate surface
35 with the thermal insulation materials, exterior finishing materials are successively arranged outside of the insulation materials, and a continuous exterior thermal insulation layer is provided outside of the columns, the beams, and the exterior wall, by the thermal insulation materials and the exterior

finishing materials, so as to substantially uniformly or evenly extend over the opening areas and the skeleton zone.

[Claim 9]

The thermally insulating structure as defined in claim 8, wherein outside
5 surfaces of said substrate boards are positioned in a vertical plane (V) specified or defined by outside surfaces of the columns and the beams, or in a situation slightly shifted on an indoor side of the vertical plane;

wherein brackets are fixed to said columns, said beams, or said exterior
10 wall to extend through said insulation materials, and supporting mechanisms for supporting said exterior finishing materials are fixed to said brackets, and the supporting mechanisms include furring strips on which said exterior finishing materials can be mounted; and

wherein exterior finishing panels are installed to the furring strips outside
15 of the insulation materials, as said exterior finishing materials, and the panels configure a vertical exterior wall surface of the building, which substantially extends over said structural skeleton zone and said opening area.

[Claim 10]

The thermally insulating structure as defined in claim 8 or 9, wherein a
20 gap of each of joint sections, each extending along a boundary between said structural skeleton zone and said opening area, is charged with a sealant for exterior finishing, so that the vertical and/or horizontal joint sections are provided as working joints for absorbing or compensating for differences in behaviors, displacements or deformations between said column and beam and said steel structure wall part.

[Claim 11]

The thermally insulating structure as defined in one of claims 8 through
10, wherein said insulation material is an inorganic fiber-based thermal insulation material, and a hollow or space in a frame of each of said steel structure wall parts and/or said interior wall parts is charged with the inorganic
30 fiber-based thermal insulation material.

[Claim 12]

The thermally insulating structure as defined in claim 9, wherein a
boundary surface of the thermal insulation material is defined or specified by indoor side surfaces of said furring strips, as being a vertical surface (Va)
35 substantially in parallel with said substrate surface, and said insulation layer includes an air layer or a ventilated air layer formed between the thermal insulation material and said exterior finishing material, and a moisture-permeable waterproofing sheet interposed between the thermal insulation

material and the substrate surface, or disposed on an outside surface of the thermal insulation material on its outdoor side.

[Claim 13]

A method for thermally insulating a structural skeleton of a concrete building having a framework structure, in which the structural skeleton constituted from concrete beams and concrete columns is covered with a thermal insulation layer disposed outside of the structural skeleton,

wherein an exterior wall with a double-wall structure is constructed in an opening area which is surrounded by the columns and the beams disposed in an outer peripheral zone or a perimeter zone of the building, the exterior wall being constituted from a steel structure wall part and an interior wall part, the steel structure wall part being provided with steel structure intermediate posts, and the interior wall part being provided with steel furrings spaced at a distance from the steel structure wall part on its indoor side,

wherein said steel structure wall part has substrate boards for exterior finishing which are fixed to said intermediate posts so as to close said opening area outside the intermediate posts, a structural skeleton zone is configured by the columns and the beams, and outside surfaces of the boards and the outside surface of the skeleton zone configure a single or common substrate surface for exterior finishing, which substantially continuously extends over said opening areas and the skeleton zone;

wherein a first thermal insulation material and a first exterior finishing material are provided on said substrate surface in said skeleton zone by an exterior thermal insulation construction method, and a second thermal insulation material and a second exterior finishing material are installed on said substrate surface of the steel structure wall part by an external insulation installation method; and

wherein said first and second thermal insulation materials are continuously installed or laid on said substrate surface to cover the substrate surface with the thermal insulation materials, said first and second exterior finishing materials are substantially continuously arranged outside the first and second thermal insulation materials, and an exterior thermal insulation layer, which substantially uniformly or evenly extends over the opening area and the skeleton zone, is formed outside said structural skeleton and said exterior wall.

[Claim 14]

The method as defined in claim 13, wherein outside surfaces of said substrate boards are positioned in a vertical plane (V) specified or defined by outside surfaces of the columns and the beams, or in a situation slightly shifted on an indoor side of the vertical plane;

brackets are fixed to said columns, said beams, or said steel structure wall part to extend through said insulation materials, and supporting mechanisms for supporting said exterior finishing materials are fixed to said brackets, and the supporting mechanisms include furring strips, on which said exterior finishing materials can be mounted; and

exterior finishing panels are mounted on the strips outside the insulation materials, as said exterior finishing materials, and the panels configure a vertical exterior wall surface of the building, which substantially extends over said structural skeleton zone and said opening area.

[Claim 15]

The method as defined in claim 13 or 14, wherein a gap of each of joint sections, each extending along a boundary between said structural skeleton zone and said opening area, is charged with a sealant for exterior finishing, so that vertical and/or horizontal joint sections are provided as working joints for absorbing or compensating for differences in behaviors, displacements or deformations between said column and beam and said steel structure wall part.

[Claim 16]

The method as defined in one of claims 13 to 15, wherein said opening area is formed in every column-span throughout an entire periphery of the building, and said steel structure wall parts and said interior wall parts are located in all the opening areas; or said opening areas are formed in the column-spans except for the column-span or column-spans which is or are provided with a concrete structure bearing wall or walls, and said steel structure wall part and said interior wall part are located in each of opening areas; and

wherein said insulation layer includes an air layer or a ventilated air layer formed between said thermal insulation material and said exterior finishing material, and a moisture-permeable waterproofing sheet is interposed between the thermal insulation material and the substrate surface, or disposed on an outdoor side surface of the thermal insulation material, whereby said air layer or ventilated air layer and said sheet extend over an entire area of said insulation layer.

[Claim 17]

The method as defined in one of claims 13 to 16, wherein components of said steel structure wall part and components of said interior wall part are spaced apart from each other, and a buffer zone is formed between the wall parts to isolate a path of transmission of heat, vibrations, and solid propagation sounds.

[Claim 18]

The method as defined in one of claims 13 to 17, wherein said insulation material is an inorganic fiber-based thermal insulation material, and a hollow or space in a frame of each of said steel structure wall parts and/or said interior wall parts is charged with the inorganic fiber-based thermal insulation material.

5 [Claim 19]

The method as defined in claim 14, wherein an outside boundary surface of the insulation material is specified or defined by an inside surface of said furring strips, as being a vertical surface (Va) substantially in parallel with said substrate surface.

10 [Claim 20]

A concrete building having the exterior wall structure as defined in one of claims 1 through 7, or the thermally insulating structure as defined in one of claims 8 through 12.

 [Claim 21]

15 A method for constructing a concrete building, which includes the method as defined in one of claims 13 to 19.