

FABRICATED STONE PANEL UNIT AND  
MOUNTING STRUCTURE THEREOF

BACKGROUND OF THE INVENTION

1. Field of the Invention

5           This invention relates to a stone panel unit for use  
as an external wall member of architecture such as a  
building or the like, and a mounting structure thereof;  
and more particularly to a fabricated stone panel unit  
10 which can effect a reduction in the weight of an  
external wall, a saving in building costs and a  
shortening of manufacturing time; and also more  
particularly to a fabricated stone panel mounting  
structure whereby the creation of clearance between  
15 structural members can be prevented by mounting the  
stone panel units in such a manner that they may be  
displaced in the transverse direction which is parallel  
with the panel surface, and also in the direction at  
right angles to the panel surface, hence construction  
efficiency can be improved.

20 2. Description of Prior Art

External wall members in the form of stone panel  
units comprising stone panels mounted on rectangular  
frames have recently become widely used, where adapted  
to be mounted on the structural members of buildings  
25 which consist of slabs, columns and beams.

When using stone panel units of the known kind  
specified above,

the frames tend to deform under the heavy weight of the stone panels (referred to simply as stone panels hereinbelow). Thick steel frames having a sufficient strength to resist deformation, and also the placing of mortar on the rear surface of the frames have been used as methods of preventing deformation of the frames due to the weight of their respective stone panels.

Such stone panel units have very large overall thickness and are heavy in weight thus increasing the thicknesses of the external walls of buildings more than the actual requirements, thereby reducing the living spaces inside the buildings. Further, when stone panel units are mounted on the structural members of buildings, not only do large cranes need to be used, thus impairing the construction efficiency, but also since high stresses are exerted, it is necessary to increase the thicknesses of slabs and the dimensions of beams and columns used so that they can carry the heavy weight of the stone panel units. As a result of these requirements, building costs are increased.

Further, because of the need for curing mortar, the stone panel unit manufacturing time is prolonged.

Further, in respect of the structure for mounting stone panel units on the skeleton of buildings and the connecting structure between adjoining stone

panel units, there are a variety of restrictions due to the heavy weight of stone panel units themselves, and therefore simple and reasonably flexible mounting structures and connecting constructions cannot be used.

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#### SUMMARY OF THE INVENTION

The present invention has been made in view of the above-mentioned circumstances, and has a first object to provide a stone panel unit which is light in weight and comparatively thin in thickness and which can be manufactured in a short time and can reduce the building cost.

Another object of the present invention is to provide a stone panel unit mounting structure wherein the creation of clearance between structural members can be prevented by mounting the stone panel units as set forth in the above-mentioned first object on the skeleton of a building so that, at the time of mounting, they may be adjusted in their position in the transverse direction which is parallel with the panel surface and also in the direction at right angles to the panel surface, and whereby the construction efficiency can be improved.

To achieve the above-mentioned first object, according to the first aspect of the present invention, there is provided a stone panel unit comprising:

a frame member  
formed by connecting, in a rectangular shape, an upper  
transverse frame member, a lower transverse frame member  
having an outwardly and horizontally projecting stone  
5 panel resting piece formed integrally at the lower end  
thereof, and one set of left and right vertical frame  
members spaced away at intervals of a predetermined  
distance; at least one stone plate adhesively bonded onto  
the outer surface of the frame so that it may be supported  
10 on the frame by allowing the lower end thereof to rest  
on the stone plate resting piece; and at least one  
reinforcing face plate mounted substantially on the  
entire rear surface of said frame.

To achieve the above-mentioned second object,  
15 according to the second aspect of the present invention,  
there is provided a stone panel unit mounting structure  
comprising: a stone panel unit including a frame formed  
by connecting, in a rectangular shape, an upper trans-  
verse frame member, a lower transverse frame member having  
20 an outwardly and horizontally projecting stone plate  
resting piece formed integrally at the lower end thereof  
and one set of left and right vertical frame members  
spaced away at intervals of a predetermined distance;  
at least one stone plate adhesively bonded onto the  
25 outer surface of the frame so that it may be supported on

the frame by allowing the lower end thereof to rest on the stone plate resting piece; and at least one reinforcing face plate mounted substantially on the entire rear face of the frame; a plurality of mullion members located vertically on a building at intervals of a predetermined horizontal spacing and fixedly secured onto the building wall;

a plurality of upper brackets each having a projection which projects towards the indoor side and in parallel with each of the mullions, the projection having at least one downward recess formed in the approximately central, lower portion thereof, the upper brackets being fixedly secured to the upper parts of the vertical frame members of the stone panel unit by means of a plurality of bolts;

a plurality of supporting rods each engaging with a downward recess of at least one of the upper brackets in such a manner that, at the time of mounting, the stone panel unit mounted on one set of adjoining mullion members, which are located at intervals of a spacing somewhat wider than the transverse length of the stone panel units and wherein each one of said plurality of supporting rods projects horizontally and inwardly from each of the mullion members, may be moved in the transverse direction in parallel with the panel surface and in the direction at right angles to the panel

surface; and

5 a plurality of L-shaped connecting brackets each having a first side piece and a second side piece, the first side piece being fixedly secured to the side wall of at least one of the mullion members by means of a plurality of bolts, the second side piece being fixedly secured to the lower transverse frame member and upper transverse frame member of one set of vertically adjoining stone panel units by means of a plurality of bolts.

10 Further, according to the present invention, there is provided a stone panel unit and a mounting structure thereof, characterized in that the stone panel unit as set forth in the first and second aspect comprises further at least one intermediate transverse frame member  
15 which is disposed substantially horizontally by butting both ends thereof to the set of left and right vertical frame members, respectively, between the upper transverse frame member and the lower transverse frame member, and which has an outwardly and horizontally  
20 projecting stone member resting piece formed integrally therewith at the approximately intermediate portion of the outer vertical plate, thereby forming a rectangular frame portion comprising the intermediate transverse frame member, the upper or lower transverse frame member and the one  
25 set of left and right vertical frame members so that a

piece of stone plate may be mounted on the frame portion.

According to the stone panel unit and the mounting structure thereof as set forth in the above-mentioned aspects, the strength of the frame for mounting a stone plate can be increased by reinforcing it with the reinforcing face plate, and it is thereby possible to prevent deformation of the frame due to the weight of the stone plate without having to increase the thickness of the frame members forming the frame.

Therefore, since there is no need for increasing the thickness of the frame, the thickness of the stone panel unit can be reduced, and so the thickness of the external wall of the building concerned can be reduced thereby making it possible to increase the living space in it. Further, because the weight of the stone panel units can be reduced, they can be lifted easily by means of a small crane and mounted on the structural members of the building thus improving construction efficiency.

Still further, the structural members of the building need not carry a heavy load, thus eliminating the need for increasing the dimensions of the structural members of the building more than actual requirements and also the need for increasing the strength thereof so that the construction cost can be reduced.

Further, because there is no need for placing

mortar, the time required for curing mortar can be eliminated so that the construction work can be completed in a short time.

5 Furthermore, since the lower part of the stone plate is supported on the stone plate resting piece of the lower transverse frame member or the intermediate transverse frame member, a heavy load is not applied on the adhesively bonded portion between the stone plate and each of the frame members so that there is no possibility  
10 of the stone plate being disengaged from the frame thereof.

The above-mentioned and other objects, aspects and advantages of the present invention will become apparent to those skilled in the art by referring to the following  
15 description and the accompanying drawings in which a preferred embodiment incorporating the principles of the present invention is shown by way of example only.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a fragmentary, schematic front view of  
20 the external wall of a building on which stone panel units of the present invention are mounted;

Figs. 2 and 3 are fragmentary, sectional views taken along lines II-II and III-III, respectively, in Fig. 1;

25 Fig. 4 is a schematic, perspective view showing an

open-air inlet portion in the transverse and vertical space of the stone panel unit of the present invention;

Fig. 5 is a schematic, perspective view showing a drainage portion between the side end of each of one set of adjoining left and right stone panel units and a mullion member crossing it;

Fig. 6 is a schematic, perspective view showing a connecting portion between one set of vertically adjacent mullion members.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

An example of the present invention will now be described in detail below by way of an embodiment thereof with reference to the accompanying drawings.

As shown in Fig. 1, a building, not shown, has, at least on one side surface thereof, a plurality of stone panel units 1 mounted transversely and vertically on the building body, not shown, so as to form openings 2 at a plurality of places, each of the individual openings 2 having a window unit 3 mounted thereon thereby forming the external wall of the building.

Each of the stone panel units 1 has an upper transverse frame member 4, a lower transverse frame member 5, and a pair of left and right vertical frame members 6 and 6, a frame 7 formed by connecting the frame members 4, 5, 6 and 6 in a rectangular shape has at least

one stone plate 8 mounted thereon.

In the embodiment shown in the drawings, provided between the upper and lower transverse frame members 4 and 5 are two intermediate transverse frame members 9 and 9 which are connected to the left and right vertical frame members 6 and 6. A piece of frame 7 is formed by three pieces of the rectangular frame portions 7'. Each of the rectangular frame portions 7' has a stone plate 8 mounted thereon.

10 The upper transverse frame member 4 has an indoor side vertical plate 10 and an outdoor side vertical plate 11, as shown in Fig. 2. The upper ends of both the vertical plates 10 and 11 are integrally connected by a stepped upper plate 12, whilst a lower plate 13 extending horizontally from the approximately intermediate portion of the outdoor side vertical plate 11 to the lower end of the indoor side vertical plate 10 is integrally connected. Thus, the upper transverse frame member 4 is formed as a long hollow member having an approximately key shape in section. Further, the upper plate 12 has an inner upward projection 14 having an upward groove 15 formed in the upper part thereof on the indoor side. Whilst, the lower plate 13 has a downward piece 16 and a hanging-down piece 17 formed integrally therewith at the inner and outer ends thereof, respectively. The outside surface of the

hanging-down piece 17 is flush with that of the outdoor side vertical plate 11. The upward groove 15 has an upper transverse air tight member or AT member 18 mounted thereon, and an upper transverse sealing piece 19 is mounted on the outer surface of the inner upward projection 14 so as to project towards the outdoor side.

The lower transverse frame member 5 has an indoor side vertical plate 20 and an outdoor side vertical plate 21, as shown in Fig. 2. The upper and lower ends of both the vertical plates 20 and 21 are integrally connected by an upper plate 22 and a lower plate 23, respectively. Thus, the lower transverse frame member 5 is formed as a long hollow member having an approximately rectangular shape. The upper plate 22 has an upward projection piece 24 and a rising piece 25 formed integrally therewith at the inner and outer ends thereof, respectively. Whilst, the lower plate 23 has a hanging-down piece 26 formed integrally therewith at the outer end thereof. The hanging-down piece 26 has a stone plate resting piece 27 which is formed integrally therewith at the lower end thereof and which extends horizontally towards the outdoor side. And, the outside surfaces of the above-mentioned rising piece 25 and hanging-down piece 26 are flush with the outer surface of the outer vertical plate 21.

As shown in Fig. 3, each vertical plate member 6 is formed, as a long hollow member having an approximately rectangular sectional shape, by an indoor side vertical plate 30, an outdoor side vertical plate 31, an inner plate 32 and an outer plate 33. The inner plate 32 has an inward projection 34 formed integrally therewith at the inner end thereof and which extends in parallel with the surface of the panel. The outer plate 33 has a groove 35 which is formed in the outer surface thereof and which has a vertical fin-shaped piece 36 fitted therein so as to project outwardly.

The upper part of each vertical frame member 6 is formed in a stepped shape which is the same as that of the upper plate 12 of the upper transverse frame member 4, and the upper and lower transverse frame members 4 and 5 are butt-jointed to the inner plates 32, 32 of a pair of left and right vertical frame members 6, 6.

Thus, on the inside of the frame 7, the downward piece 16 of the upper transverse frame member 4, the upward projection piece 24 of the lower transverse frame member 5 and the inward pieces 34, 34 of one set of left and right vertical frame members 6, 6 are peripherally connected so that the inner surfaces thereof can be located flush with one another, and at least one sheet of reinforcing face plate 50 is mounted on the peripheral

inner surfaces by means of a plurality of screws 51.

A stone plate 8 is bonded by means of an adhesive 37 to the outer surfaces of the outdoor side vertical members 11, 21 of the upper and lower transverse frame members, and one set of left and right outdoor side vertical plates 31, 31. The lower end surface of the stone plate 8 rests on the upper surface of the stone plate resting piece 27, and is fixedly secured to the hanging-down piece 17 of the upper transverse frame member 4 and the rising piece 25 of the lower transverse frame member 25 by means of a plurality of stud bolts 38 fixedly secured to the stone plate 18 and a plurality of nuts 39 threadably engaged therewith.

According to the stone panel unit 1 of the present invention, as described in detail hereinabove, the strength of the frame 7 is increased by the provision of the reinforcing face plate 50, such that even if the sizes of the upper and lower transverse frame members 4, 5 and the pair of left and right vertical frame members 6, 6 are reduced, the frame 7 is not deformed by the weight of the stone plate 8. Further, since the stone plate 8 rests on the stone resting piece 27 of the lower transverse frame member 5, no high stress is applied on the adhesively bonded portions, and therefore it is possible to prevent

the stone plate 8 from detaching from the frame 7.

Further, as shown in Fig. 2, the intermediate transverse frame members 9 in the embodiment shown is formed in an approximately rectangular hollow shape by an indoor side vertical plate 40, an outdoor side vertical plate 41, an upper plate 42, and a lower plate 43. The upper and lower plates 42 and 43 have an upward piece 44a and a downward piece 44b formed integrally therewith at their respective inner ends. Further, the upper and lower plates 42 and 43 have a rising piece 45 and a hanging-down piece 46 formed integrally therewith at their respective outer ends so that they may be located flush with the outside surface of the outdoor side longitudinal plate 41. Further, the outdoor side vertical plate 41 has a stone plate resting piece 47 formed integrally therewith so as to project horizontally towards the outdoor side. The thus formed intermediate transverse frame members 9 are butt-jointed to the inner plates 32, 32 of the left and right vertical frame members 6, 6 thereby forming a plurality of rectangular frame portion 7'. Each of the rectangular frame portions 7' has the stone plate 8 and the reinforcing face plate 50 mounted thereon in the same manner as mentioned above. A sealing member 48 is mounted at a position between the adjoining stone plates 8, 8 so that it may fulfil sealing function.

Next, the structure for mounting the stone panel unit 1 on a building body will be described.

As shown in Figs. 2 and 3, a plurality of mullion members 60 are orientated vertically on a building, not shown, at intervals of a horizontal spacing which is somewhat wider than the transverse length of the stone panel unit 1, and are fixedly secured to the building body. Mounted on the upper parts of the inner plates 32, 32 of the left and right vertical frame members 6, 6 of the stone panel unit 1 by means of a plurality of bolts 63 are upper brackets 62, 62 each having a projection which projects towards the indoor side and in parallel with the side walls 60a, 60a of each of the adjoining mullion members 60, 60. The projection of each of the upper brackets 62 has at least one downward recess 61 formed in the approximately central, lower part thereof and which is located on an indoor side of the indoor side vertical plate 30 of the vertical frame member 6. Supporting rods 64, 64, whose number is at least one on one side, project, respectively, horizontally inwards from the inward side walls 60a, 60a of each of the two adjacent mullion members 60, 60. The supporting rods 64, 64 are fitted in the downward recesses 61, 61 of the left and right upper brackets 62, 62 with some play therebetween so that, at the time of mounting, the upper

part of the stone panel unit 1 can be mounted on the adjoining two mullion members 60, 60 in such a manner that it may be swung in the transverse direction which is parallel with the panel surface of the stone panel unit 1, and also it may be adjusted in position in the direction at right angles to the panel surface.

Further, the reinforcing face plate 50 and the inward piece 34 of the vertical frame member 6 have notches 50a and 34a, respectively, formed therein for positioning the upper bracket 62. Further, in case the intermediate transverse frame members 9 are provided, it is needless to say that the reinforcing face plate 50 and the inward piece 34 are formed additionally with recesses for mounting the frame members 9.

The lower part of the stone panel unit 1 is mounted together with the upper end of the adjoining lower stone panel unit 1 on one set of adjoining left and right mullion members 60, 60, as described below.

Stating in brief, referring to one mullion member 60, at least one L-shaped vertically connecting bracket 66 has one side piece 66a and the other side piece 66b, the one side piece 66a being mounted on the lower transverse frame member 5 and the upper transverse frame member 4 of one set of adjoining upper and lower stone panel units 1, 1, respectively, by means of a plurality of bolts 67,

and the other side piece 66b being mounted on the inward side wall 60a of the mullion member 60 by means of a plurality of bolts 65. One of the bolts 67 passes through an elongated hole 68 formed in the upper part of one side piece 66a of the vertically connecting bracket 66 and is threadably engaged with the indoor side vertical plate 40 of the lower transverse frame member 5, whilst the other bolt 67 passes through a through-hole 69 formed in the lower part of the one side piece 66a of the vertically connecting bracket 66 and is threadably engaged with the indoor side vertical plate 10 of the upper transverse frame member 4.

The stone panel units 1 are mounted on a building body, not shown, one by one, starting at a lower part of said building body and working towards an upper part of said building body.

In the next place, weathering of the portions on which the stone panel units are mounted will be described.

A pair of left and right vertical AT members 72, 72 are mounted vertically and outwardly on both the left and right sides of the outdoor side front wall 60b of the mullion member 60. The vertical AT members 72 are pressed against the indoor side vertical plates 30 of the vertical frame members 6, and also the upper transverse AT member 18 mounted on the upper transverse frame member 4 is pressed against the lower plate 23 of the lower

transverse frame member 5 thereby sealing the clearance between the stone panel unit 1 and the mullion member 60 and the clearance between the vertically adjoining stone panel units 1, 1.

5                   Whilst the upper transverse sealing piece 19 mounted on the upper transverse frame member 4 is pressed against the hanging-down piece 26 of the lower transverse frame member 5, as shown in Fig. 2, thereby forming a transverse space 73 between the sealing piece 19 and the  
10                   above-mentioned upper transverse AT member 18. This transverse space 73 communicates with the outside air via an outside air inlet hole 74 formed in the upper transverse sealing piece 19. Further, vertical sealing pieces 36 mounted, respectively, on the vertical frame members 6  
15                   are allowed to lie one on another, as shown in Fig. 3, thereby forming a vertical space 75 together with the above-mentioned vertical AT member 72. This vertical space 75 communicates with hollow portions 6', 6' of the vertical frame 6, 6 via outside air inlet ports 76,  
20                   76 formed in the outer plates 33, 33 of the vertical frame members 6, 6.

                  Stating in brief, as shown in Fig. 4, the upper transverse AT member 18 is pressed against the lower end surface of the indoor side vertical plate 30 of the  
25                   vertical frame member 6 and the indoor side lower end

surfaces of the inner plate 32 and the outer plate 33,  
and also the end portion of the upper transverse  
sealing piece 19 is pressed against the outdoor side  
inner surface of the outer plate 33 thereby blocking the  
5 end portion of the above-mentioned transverse space 73,  
and further the upper transverse AT member 18 blocks  
the indoor side of the hollow portion 6' of the vertical  
frame member 6 thereby allowing the transverse space 73  
to communicate with the hollow portion 6' of the vertical  
10 frame member 6.

Thus, the upper transverse AT members 18 and the  
vertical AT member 72 are mounted, on the upper transverse  
frame member 4 and the mullion member 60, respectively,  
and the upper transverse AT member 18 and the lower  
15 transverse frame member are pressed against each  
other by the weight of the stone panel unit 1 located  
above. Also, the vertical AT member 72 is pressed against  
the vertical frame member 6 when the stone panel unit 1  
is fixedly secured to the mullion member 60 by means of  
20 bolts. Therefore, when mounting the stone panel units 1  
on the external wall of a building, such AT members do not  
interfere with the mounting work thus improving the  
construction efficiency and reducing the possibility  
of creating clearances between the AT members and the  
25 frames due to inter-layer displacements and working errors.

Further, since the transverse space 73 and the vertical space 75 are kept at the same pressure as the outside air, the clearance between the above-mentioned upper transverse AT member 18 and the lower transverse frame member 5 and that between the vertical AT member 72 and the vertical frame member 6 can be sealed more satisfactorily.

Further, the hollow portions 6' of the above-mentioned vertical frame members 6 are allowed to open through openings, not shown, formed in the inner plates 32 into the space between the stone plates 8 and the reinforcing face plates 50 so that the space can be kept at the same pressure as the outside air, thus preventing the stone plates 8 from being deformed by the pressure of the outside air exerted thereon.

Further, as shown in Fig. 5, a catch pan 80 is mounted in the intersecting portion of the upper, lower left and right stone panel units 1.

The catch pan 80 comprises an upwardly open box-shaped body 81 mounted on the upper plates 12, 12 of the left and right upper transverse frame members 4, 4, and a transverse plate 82 kept into contact with the outdoor side wall 60b of the mullion member 60. The arrangement is made such that the rain water which has flowed into the vertical space 75 flows along the transverse plate 82 and

then through a primary drainage port 83 into a hollow portion 81a of the box-shaped body 81, whilst the rain water which has flowed into the hollow portions 6' of the vertical frame members 6 flows into the box-shaped portions 81b formed on both side of the box-shaped member 81 and then into the hollow portion 81a, and is drained through a secondary drainage port 84 formed in the outer bottom wall of the hollow portion 81a.

Further, the above-mentioned mullion members 60 are connected at the intermediate portions of the upper and lower stone panel units 1, and as shown in Fig. 6, the adjoining upper and lower longitudinal AT members 72 are connected by a joint packing 85.

It is to be understood that the foregoing description is merely illustrative a preferred embodiment of the present invention, and that the scope of the invention is not to be limited thereto, but is to be determined by the scope of the appended claims.



CLAIMS

1. A stone panel unit comprising:

a frame member formed by connecting, in a rectangular shape, an upper transverse frame member, a lower transverse frame member having an outwardly and horizontally projecting stone panel resting piece formed integrally at the lower end thereof, and one set of left and right vertical frame members spaced away at intervals of a predetermined distance;

at least one stone plate adhesively bonded onto the outer surface of said frame so that it may be supported on the frame by allowing the lower end thereof to rest on said stone plate resting piece; and

at least one reinforcing face plate mounted substantially on the entire rear surface of said frame.



2. A stone panel unit as claimed in claim 1, characterized in that it further comprises at least one intermediate transverse frame member which is disposed substantially horizontally by butt-jointing both ends thereof to said one set of left and right vertical frame members, respectively, between said upper transverse frame member and said lower transverse frame member, and which has an outwardly and horizontally projecting stone plate resting piece formed integrally therewith at the approximately intermediate portion of an outdoor side vertical plate, thereby forming a rectangular frame portion comprising the intermediate transverse frame member, said upper or lower transverse frame member and said one set of the left and right vertical frame members so that a piece of stone plate may be mounted on the frame portion.



3. A stone panel unit mounting structure comprising a stone panel unit according to claim 1 or 2 and further comprising:-

a plurality of mullion members located vertically on a building at intervals of a predetermined horizontal spacing and fixedly secured onto the building wall;

20 a plurality of upper brackets each having a projection which projects towards the indoor side and in parallel with each of the mullions, the projection having at least one downward recess formed in the approximately central, lower portion thereof, said upper brackets being fixedly secured to the upper parts of the vertical frame members of said stone panel unit by means of a  
25 plurality of bolts;

a plurality of supporting rods each engaging with a downward recess of at least one of said upper brackets in such a manner that, at the time of mounting, said stone panel unit mounted on one set of adjoining mullion members, which are located at intervals of a spacing somewhat  
30 wider than said transverse length of the stone panel units and wherein one of each said plurality of supporting rods projects horizontally and inwardly from each of the mullion members, may be moved in the transverse direction in parallel with the panel surface  
35 and in the direction at right angles to the panel surface;



and

a plurality of L-shaped vertically connecting brackets each having a first side piece and a second side piece, said first side piece being fixedly secured to the side wall of at least one of the mullion members by means of a plurality of bolts, said second side piece being fixedly secured to the lower transverse frame member and upper transverse frame member of one set of vertically adjoining stone panel units by means of a plurality of bolts.

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