US 20070240375A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2007/0240375 A1**

(43) **Pub. Date: Oct. 18, 2007**

Bennett et al.

(54) **CONTAINED LOAD TRANSFER DEVICE FOR WOOD SHEATHING PRODUCTS AND ROOF CONSTRUCTION METHOD THEREWITH**

(76) Inventors: **John Landus Bennett**, Nicholson, GA (US); **Vincent B. Thomas**, Athens, GA (US); **Richard D. Jordan**, Lawrenceville, GA (US)

Correspondence Address:
J M HUBER CORPORATION
333 THORNALL STREET
PATENT DEPARTMENT
EDISON, NJ 08837-2220 (US)

(21) Appl. No.: **11/403,631**

(22) Filed: **Apr. 13, 2006**

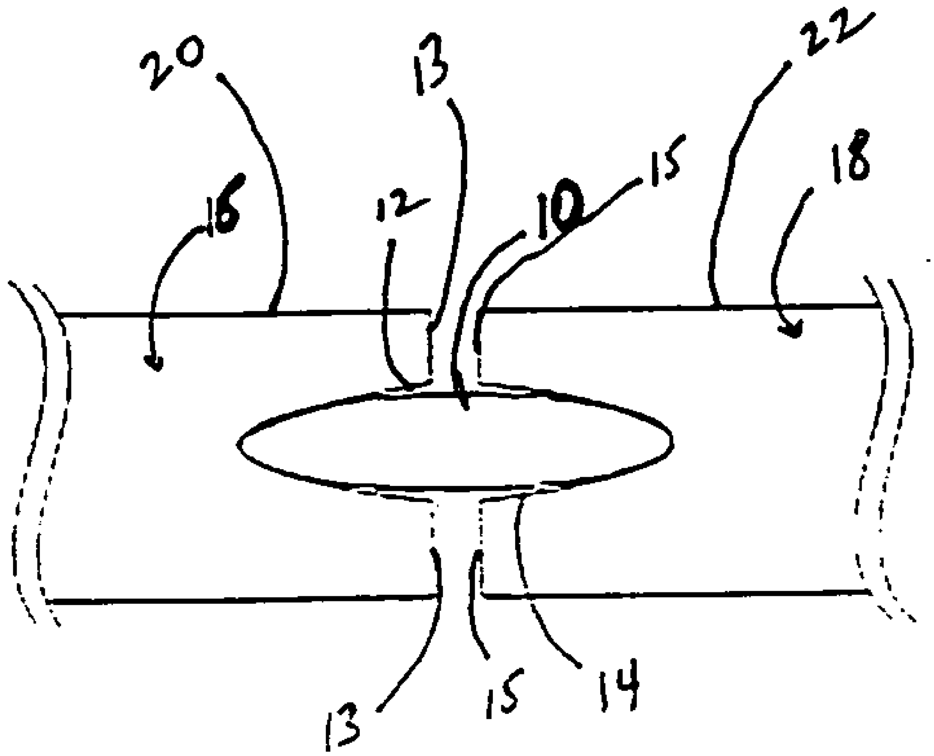
Publication Classification

(51) **Int. Cl.**
E04B 2/00 (2006.01)

(52) **U.S. Cl.** **52/586.1**

(57) **ABSTRACT**

The utilization of a specific load transfer device for the purpose of allowing for reliable connection and adhesion of composite wood boards during edifice manufacture therewith is provided. Such a device is configured for containment within slots cut into the peripheral edges of such wood boards and cut into a shape therein that is complementary to that of the device itself. In such a manner, the device, when introduced within the properly shaped slot, permits separation of adjacent wood boards that are sequentially applied to the frame of the target edifice, as well as, ultimately, sufficient load bearing strength for the overall construction (such as a roof) within which such connected wood boards are utilized. The separation of wood boards thus permits proper sealing therebetween (with tape, sealant, or other like material) as well as proper distance for shrinking or swelling (due to moisture/temperature variations) to be taken into account during the lifetime of the edification (thereby permitting expansion as needed). The ability to impart increased load bearing strength thus allows for an increase in construction materials (in number and in weight) to be carried and kept on such a structure during construction as well. The method of manufacture of an edifice utilizing such load transfer devices between wood boards is also encompassed within this invention.



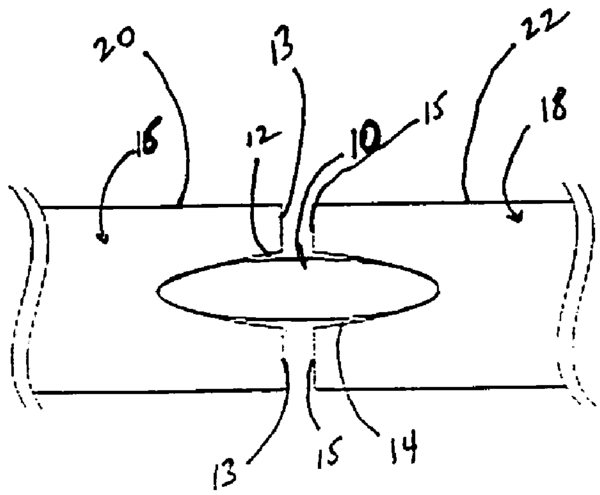


FIG. 1

FIG. 2

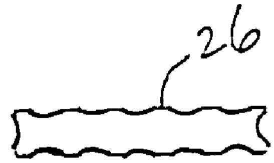


FIG. 3

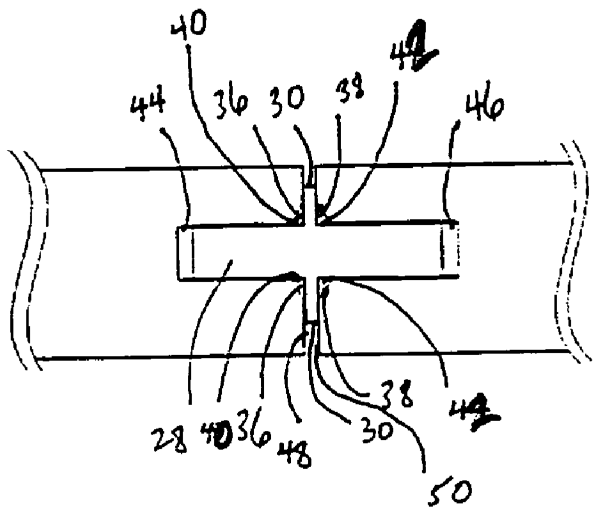


FIG. 4

CONTAINED LOAD TRANSFER DEVICE FOR WOOD SHEATHING PRODUCTS AND ROOF CONSTRUCTION METHOD THEREWITH

FIELD OF THE INVENTION

[0001] The subject invention relates to the utilization of a specific load transfer device for the purpose of allowing for reliable connection and adhesion of composite wood boards during edifice manufacture therewith. Such a device is configured for containment within slots cut into the peripheral edges of such wood boards and cut into a shape therein that is complementary to that of the device itself. In such a manner, the device, when introduced within the properly shaped slot, permits separation of adjacent wood boards that are sequentially applied to the frame of the target edifice, as well as, ultimately, sufficient load bearing strength for the overall construction (such as a roof) within which such connected wood boards are utilized. The separation of wood boards thus permits proper sealing therebetween (with tape, sealant, or other like material) as well as proper distance for shrinking or swelling (due to moisture variations) to be taken into account during the lifetime of the edification (thereby permitting expansion as needed). The ability to impart increased load bearing strength thus allows for an increase in construction materials (in number and in weight) to be carried and kept on such a structure during construction as well. The method of manufacture of an edifice utilizing such load transfer devices between wood boards is also encompassed within this invention.

BACKGROUND OF THE INVENTION

[0002] Composite wood boards, such as plywood boards or oriented strand boards, are well-known in the construction industry. In fact, such boards are used in the manufacture of inclined roofs. To facilitate making the roofs, board manufacturers sell rectangular boards which are about four feet wide, eight feet long and about ⅜ to ¾ of an inch thick. Such boards are generally not attached to a roofing frame with each board abutting another. Such spacing is required to compensate for expansion possibilities due to changes in moisture content during the lifetime of the roof itself. As such, there is needed a manner of providing sealing between the spaces of such roof component boards. This is typically accomplished with tape, or any other like material. The tape is applied to ends of adjacent boards and across such spaces.

[0003] Also necessary of such roof structures and thus the component boards thereof is the capacity to withstand excessive weights due to the loads of workers present on the roof during construction as well as the materials applied during such a construction project (and, furthermore, the combined weight of a worker carrying such materials on said roof). Additionally, there is a need to ensure that such boards that constitute the roof structure must stay in place for sufficient time to be permanently attached to the underlying roofing frame.

[0004] In order to permit such an outcome, there have been utilized certain devices in the form of clips that contact the outside edges of adjacent boards (on both the top and bottom thereof). Such clips, known in the industry as H-clips, exhibit disadvantages, however, that render them highly undesirable for such a purpose. For instance, such H-clips make it difficult to apply adhesive tape (for, among other purposes, sealing seams to prevent water penetration therein and air leaks) along the spaces between boards conjoined by such clips, particularly since such clips are applied to the exterior of such boards. The adhesive tape applied to such boards must thus be in contact with such clips as well as such boards, thereby exhibiting a certain reduction in potential adherence thereto and compromising the effectiveness of such tape (or like adhesive material). Also, it has been problematic to apply certain load forces to roof structures including such H-clips, particularly during manufacturing steps thereof, as such clips exhibit a propensity for disengaging upon application of excessive weight on certain portions of component boards. As such, there exists a need and desire to remove such H-clips from utilization for such a purpose while still providing a viable manner of permitting effective connection between adjacent boards during roof construction, and while simultaneously allowing for application of materials via adhesion thereof to adjacent boards without losing the effectiveness of such adhesive materials. To date, the wood board roofing component industry has not been accorded such an improvement.

ADVANTAGES AND BRIEF DESCRIPTION OF THE INVENTION

[0005] It is an advantage of the present invention to provide a simple manner of reliably connecting building roof component wood boards together during roof construction therewith. Another advantage of such a device and method is the ability of a user to easily install such devices within target wood boards and further connect an adjacent wood board thereto through the utilization of at least one such device in order to keep such wood boards in place for a sufficient period of time prior to attachment to a roof frame.

[0006] The invention herein may be summarized as a structure for an edifice selected from the group consisting of a roof and a wall, wherein said structure is comprised of at least a first wood board and a second wood board, each of said first and second wood boards having a top portion and a bottom portion, and each having four peripheral edges, wherein at least one peripheral edge of each wood board includes at least one cavity therein for the insertion of at least one connection device; wherein said connection device is made of a durable material and having a first end and a second end and wherein each of said first and second end is configured to be inserted within said at least one cavity of each wood board; wherein when said first and second wood boards are contacted simultaneously with said device, said peripheral edges into which said device is inserted are parallel to each other, but are not in contact with one another, and wherein said device does not contact the top or bottom portion of said first and second wood boards. Furthermore, the roof or wall structure as defined above may include limitations such as: wherein said first end and said second end are shaped exactly the same and of the same dimensions, wherein said device is configured in such a manner that either of said first or second end may be placed within said at least one cavity within said peripheral edge of said first wood board, said cavity exhibiting a shape and dimension that is complementary to said first or second end of said device, and wherein when present within said cavity of said first wood board, said second wood board may then be contacted with said second end of said device in relation to the same type of cavity as defined for said first wood board within said peripheral edge of said second wood board. A method of manufacturing a roof in accordance with such a scheme and utilizing at least two such wood boards for such a purpose is encompassed within this invention as well.

[0007] Such a device should therefore preferably be symmetrical in shape and measurements in order to exhibit the necessary ability to be inserted within cavities of any wood board used therewith. The size of such a device may be of any width, up to the length of the peripheral edge of the target wood board(s) less an inch and a half (i.e., about 3.8 centimeters), generally. As the length of typical spacing between roof joists for roof construction wood boards are about 24 inches on center (i.e., about 61 centimeters), such a device may thus be as wide as 22.5 inches (roughly about 57 centimeters). At its smallest, such a device would be about 1 inch (2.54 centimeters) wide. Preferably, though not necessarily, a multiple amount of such devices would be utilized to connect adjacent boards together during the construction of a roof or wall, mainly because of the facilitation of maneuverability a user would have with smaller devices in hand during roof construction, rather than large materials for such a purpose.

[0008] As such, the device may be incorporated within a roll containing a release liner with an adhesive attaching such multiples of devices to thereto from which they may be peeled and applied within the cavities of wood boards, potentially with the adhesive transferred therewith to permit reliable attachment of such devices to target wood boards. In this manner, a user would have a relatively convenient and safe manner of not only transporting such multiple devices, but also applying an adhesive-including device to a target wood board.

[0009] The utilization of an adhesive is also preferable if the device(s) are transported by a user by different means. As such, an adhesive may be applied by the user by hand prior to utilization, or such devices may have covering strips over an already-applied adhesive area thereon, from which the strip may be removed by the user prior to utilization and insertion within a wood board cavity. Any other manner of adhesive application may also be followed for such a purpose.

[0010] The device itself may be constructed of any durable material, and of any shape and dimension, as long as the overall appearance is, as noted above, symmetrical. Thus, plastics (including high density plastics like polyurethane, polyethylene, polypropylene, polyethylene terephthalate, polyacrylate, polyacetyl, and the like), metals (including iron, steel, aluminum, and the like), and any type of hardwood (oak, cedar, and the like), may be utilized to such an end. Combinations of such materials (such as mixtures of different plastics, a plastic coated metal or wood, and the like), may also be utilized.

[0011] A device having an increased surface area through texturing, roughening, and the like, over the faces or edges or both, thereof, may also be employed, particularly if an adhesive is utilized in conjunction therewith. Such an increase in surface area thus may contribute an increase in adhesive force during utilization and possibly strengthen the joint (like a truss plate, for example).

[0012] As noted above, it was vitally important to provide a manner of connecting adjacent wood boards together wherein such boards do not contact one another during installation. This distance may be from about 1/16 inch to about 1/4 inch, generally, and thus would require the depth of the cavities present within the wood boards to equal less than half the overall length of a single device. Building codes of various jurisdictions have varying requirements in terms of such spacings, but a popular distance is 1/8 inch for such a gap between adjoining edges (to allow for expansion and contraction of the panels due to moisture and/or temperature variations). This may be accomplished by providing an LTD of sufficient length that upon insertion within the cavities of adjoining boards, the gap is substantially uniform and cannot be breached. Alternatively, the LTD may be produced with a post in the center thereof to provide such spacing upon utilization.

[0013] As the cavity should preferably be complementary in shape and dimension to the device, any such shape or dimension may be employed for the device and wood board cavity as long as they meet such requirements. Thus, if the device is an oval-shaped disk, the cavity will likewise exhibit a complementary oval indentation of the same measurements. If the device is a rectangular disk, again, the cavity (slot) will be formed to accept such a shape and measurements. In one particularly preferred embodiment, the device may include a pin at the very middle thereof to aid in distancing the adjacent wood boards from one another. Furthermore, the cavity (slot) may also include a flared portion (or post portion, as noted above) to facilitate insertion of such a flat device therein and further facilitate the insertion of the other end of such a device within the cavity of a second wood board during roof construction.

[0014] Additionally, and as noted above, the need to permit reliable application of tape thereto necessitated development of a device that would not have any contact with both the top and bottom of a wood board during utilization. Thus, the overall method would permit insertion of such a device, or plurality of devices, within at least two wood boards simultaneously without any contact between the two wood boards, but with them residing in parallel relation to one another, and without any contact between the device, or plurality of devices, and the top and bottom portion of either wood board connected thereto.

[0015] Such a method provides more than just a manner of connecting roof or wall component wood boards prior to attachment to a roofing or wall frame, as well as more than just a manner of permitting tape to be reliably adhered to the subject wood boards in the areas in which they are not in contact with one another. In addition to those highly desirable results, it was surprisingly realized that such a method imparts a heretofore unforeseen ability to withstand larger than usual load forces associated with the weight of a construction worker and the materials such a person would normally be required to transport over a roof during construction thereof. Such load bearing results are discussed in greater detail below.

[0016] The wood boards that may be utilized for such roof construction may be of any type, including oriented strand board, plywood, and the like.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The above-mentioned and other objects of invention will become apparent by reference to the following description in conjunction with the accompanying drawings, in which:

[0018] FIG. **1** is a cross-sectional view of an oval-shaped disk inserted within the cavities of peripheral edges of adjacent wood boards.

[0019] FIG. **2** is a cross-sectional view of an oval-shaped disk exhibiting an increased surface area.

[0020] FIG. **3** is a cross-sectional view of a rectangular-shaped disk exhibiting an increased surface area.

[0021] FIG. **4** is a cross-sectional view of a rectangular-shaped disk having a pin present at its midpoint and inserted within the cavities of two wood boards, each exhibiting flares to facilitate insertion thereof during use.

DESCRIPTION OF A PREFERRED EMBODIMENT

[0022] FIG. **1** shows a cross-sectional perspective of a disk **10** inserted within the cavities **12**, **14** of peripheral edges **13**, **15** of two adjacent wood boards **16**, **18**. As can be seen, the disk **10** is flush with the internal portions of said cavities **12**, **14** to the degree that a distance between both boards **16**, **18** is evident. A tape (not illustrated) may then be applied in contact with the top portions **20**, **22** of both wood boards **16**, **18**. When multiple disks are utilized, the distance between the wood boards **16**, **18**, will be roughly uniform along the peripheral edges **13**, **15**.

[0023] The disks of FIGS. **2** and **3** merely show that such devices, either oval in shape **24**, or rectangular in shape **26**, may be modified or produced originally in such a manner as to impart an increase in surface area thereto to aid in adhering such devices to the cavities in which they are inserted within wood boards (not illustrated).

[0024] FIG. **4** depicts a cross-sectional perspective of a different potential embodiment wherein the disk **28** includes a pin at its midpoint **30** to aid in keeping the distance between the boards **32**, **34** uniform and in parallel relation thereto. If such boards **32**, **34** are not kept parallel to one another, the skewed result could deleteriously affect the spacing of other portions of the target roof. Also, the flared portions **36**, **38** of the wood boards **32**, **34** allow for insertion of the disk **28** having portions near the midpoint that complement the shape of such flares **40**, **42**, thereby facilitating insertion of the disk **28** within the cavities **44**, **46** within the peripheral edges **48**, **50** of the wood boards **32**, **34** as well as permitting a firm and snug fit of the disk **28** therein during use.

[0025] To insure that the load transfer device of this invention is capable of providing the necessary load capacity, concentrated load testing was done comparing the load transfer device of this invention to current load transfer devices ("H"-clips) used today in the construction industry. Building codes and regulations generally require that sheathing with a span rating of Roof-24 must not exceed 0.5" of deflection under a 200 pound load. Previous testing conducted using H-clips revealed that the H-clip would fall from the specimen prior to the completion of the test. Sampling of the inventive load bearing/transfer device (biscuit) indicated that it would break the shoulder (the portion of the board that surrounds the cavity into which the biscuit, clip, or other device, is inserted during utilization thereof) either above or below the area where it was placed; however, the specimen would still pass the requirement set forth by the aforementioned building codes and regulations (known in the industry as PS-2). The inventive load transfer device in a manner thus maintains its integrity upon use in such a manner (i.e., the biscuit would remain in place when a concentrated load was applied at its location).

[0026] The cavity in the target wood board may be configured as well in any shape, particularly at the entry point, in order to facilitate ingress of the LTD itself. Thus, the edge of the point of entry may be curved, tapered, or any like effect, to permit such ease in application. This will be important in most instances to facilitate such application while a user has a number of tools and other implements in his/her hands.

[0027] It is accepted that the highest concentrated loads on roof sheathing are anticipated under foot traffic during construction. For example, a 200-lb man carrying an 80-lb bundle of shingles down a roof slope can exert a load up to 68% greater than his combined total weight (Harper, F. C., et al. 1961. *The Forces Applied to the Floor by the Foot in Walking*. Research Paper 32. National Building Studies, London, England). Since the walking loads are applied for less than one second, the total load can be reduced by a load-duration factor of $1/1.22$ for short-term tests, as follows:

$$\frac{(200+80)(1.68)}{1.22} = 386\text{ lbs}$$

[0028] The effective load is even less (up to 280 lbs) if the man stands in one location for a short period of time, and in addition, the load is distributed over a larger area by both feet.

[0029] In the light of the foregoing, a minimum load of 400 lb would give a small margin of safety, which is justified considering the uncertainties of construction. Therefore, it is important that any load transfer device remain intact up to a 400 lb concentrated load.

[0030] Different inventive load transfer/bearing devices (biscuits) made from different materials and of various dimensions were produced and analyzed in order to determine the effectiveness of such devices to withstand such loads upon use. The materials in accordance with the design shown in FIG. **1**, above, were as follows:

	Thickness	
	⅛"	1/16"
Material	Length of LTD	
Wood	1.75"	
Steel	2.2"-3.5"	
Acetyl		2"-3.5"-4.5"
High density polyethylene		2"-3.5"-4.5"
Aluminum		2"-3.5"-4.5"

[0031] The modulus of elasticity of some of these materials were important as well in determining their effectiveness. It was realized that the greater the elasticity, the better the disk, biscuit, etc., made therefrom was able to withstand load bearing weights to a greater degree. It is believed, without intending to be limited to any specific scientific theory, that such greater load bearing capability is provided in relation to the flexibility of the device and thus the capacity of such a material to simultaneously bear weight when applied directly to the area affected, as well as the area adjacent thereto. A material with very high stiffness appeared to force the device to break the shoulder portion of the board before the device itself was injured to any appreciable extent. A material with a much lower stiffness allowed more deflection of the device and joint under concentrated loads. Thus, although any of these materials will suffice within the invention as presented, preferably the device is a material exhibiting a MOE of 10,000,000 psi or below, more preferably lower than 1,000,000 psi, and most preferably from 100,000 to about 500,000 psi. High density polyethylene exhibits a MOE of about 200,000 psi and polyacetal from about 305,000 to about 380,000 psi. Aluminum is as high as 10,000,000. This list is not exhaustive of the potential materials available for this invention, but illustrative thereof.

[0032] The manner of measuring load bearing was undertaken as follows:

[0033] First, a comparison of how the below surface LTD's vs. H-clips performed under a concentrated load was conducted. To meet PS-2 requirements, the panel/LTD must:

[0034] a) Not to exceed 0.5" deflection under a 200 pound concentrated load; and

[0035] b) Exceed 400 pound ultimate load (such as under foot traffic, as described above).

[0036] Another functional product requirement that was deemed important, even if PS-2 requirements were met, is the ability of the entire panel(s) plus LTD not to exhibit any breaking of the shoulders at the placement area of the below surface LTD prior to reaching a 400 lb concentrated load.

[0037] The analysis performed to determine this desired level of effectiveness was an analysis of variance calculation. In essence, in order to avoid the possibility of having a person become injured during actual testing of a constructed roof or a roof being constructed, the subject structures were analyzed in a lab environment for deflection and load bearing capability. A TECO QL-2 Panel Performance Tester was utilized for such analysis. Such an instrument is a fully automated, computer-controlled machine designed to perform testing that is consistent with PS 2-92 concentrated static, impact load and deflection test requirements. The instrument is equipped with a "floating bed" that facilitates impact testing, as well as instrumentation to test for concentrated load and deflection, ultimate (failure) load, impact load, and edge-supported panels. The test panels were about 7/16 inch in thickness (the machine can test for thicknesses between 1/4 and 1 1/8 inches, and the length of subject panels (boards) can be from 16 to 48 inches. In the test utilizing two boards connected via the inventive device, 48 inch boards were used. Generally, simulated joists (three in all) were included within the instrument to permit testing comparable to load bearing of roofing sheathing during installation of boards having dimensions of 48 inches (121.92 cm) by 96 inches (243.84 cm). A board was connected thereto the simulated joists and 4 inventive devices were then inserted within the cavities provided therein the periphery of the board (the devices were about 8 inches in length and inserted widthwise). A second board of the same dimensions and having complementary cavities therein for connection to the already inserted devices was then supplied. That board was then connected via the devices without contacting directly the first board. A floating panel bed was then moved into place beneath the two device-connected boards and pressures were then supplied to specific areas of the boards to measure load bearing and deflection thereof. A pneumatic pressure applicator was utilized and was applied hydraulically at two locations on the subject boards (in accordance with the PS 2-92 test requirements) and read by a 2,000 pound capacity load cell. A high-resolution digital encoder was utilized to record the deflection after the pressure (weight) was applied as well.

[0038] Thus, upon application of the weight (pressures) tested, the measurements were taken as calculation by an analysis of variance (ANOVA) method. Such a method is similar to regression in that it is used to investigate and model the relationship between a response variable and one or more independent variables. However, analysis of variance differs from regression in two ways: the independent variables are qualitative (categorical), and no assumption is made about the nature of the relationship (that is, the model does not include coefficients for variables). In effect, analysis of variance extends the two-sample t-test for testing the equality of two population means to a more general null hypothesis of comparing the equality of more than two means, versus them not all being equal. A two-way analysis of variance tests the equality of populations means when classification of treatments is by two variables or factors.

[0039] It was assumed that the population means in each test was the same and computed a p-value for the sample means in order to determine the difference in the samples means. This method thus considers the likelihood that two sample means would be a certain distance apart if they come from two processes with the same mean. If the p-value is small, it was concluded that the population means were different (i.e., less than 0.05).

[0040] The abbreviations below are as follows:

[0041] DF=Degrees of Freedom. The extent to which the distribution was more spread out. As this measurement gets larger, the distribution dispersion gets smaller.

[0042] SS=Sum of Squares. This represents total variation of measurements.

[0043] MS=the MS error is the pooled standard deviation squared.

[0044] F=F test. Such a test answers the question if the two population variances are different.

[0045] This test determines if the two populations exhibit similar or dissimilar factors and thus uses samples variances between the populations tested. This does not, however, actually test the degree of difference in sample variances, only if they exist. A value of greater than 4 for an F-value is significant whereas as close to 1 as possible means the group means of measurements are very similar between the two populations.

[0046] Thus, the analyses were followed as noted below:

TABLE 1

ANOVA showing deflection under a 200 lb concentrated load using below surface LTD's and H-clips

Source	DF	SS	MS	F	P
Material	5	0.15101	0.03020	4.68	0.002
Error	35	0.22602	0.00646		
Total	40	0.37703			

S = 0.08036 R-Sq = 40.05% R-Sq(adj) = 31.49%

```
                                Individual 95% CIs For Mean Based on
                                Pooled StDev
Level     N  Mean     StDev     --------+---------+---------+---------+-
Acetyl    6  0.25117  0.02522    (-------*--------)
Aluminum  6  0.24100  0.03013   (-------*-------)
H-Clips  10  0.38790  0.09954                     (-----*------)
HDPE      6  0.28133  0.08078       (-------*-------)
Steel     9  0.36578  0.10176                  (------*------)
Wood      4  0.37500  0.06746                (---------*---------)
                                --------+---------+---------+---------+-
                                      0.240     0.320     0.400     0.480
Pooled StDev = 0.08036
```

[0047] The initial testing indicated that Acetyl and Aluminum below surface LTD's were significantly better than H-clips in relation to deflection under a 200 lb concentrated load. The steel, wood and HDPE were not significantly different than H-clips.

[0048] Further testing was then followed to determine if ultimate concentrated loads were different in terms of capability of load bearing by the subject load transfer device(s).

TABLE 2

ANOVA showing ultimate concentrated load of below surface LTD's and H-clips

Source	DF	SS	MS	F	P
Material	5	37397	7479	0.82	0.546
Error	35	320691	9163		
Total	40	358088			

S = 95.72 R-Sq = 10.44% R-Sq(adj) = 0.00%

```
                             Individual 95% CIs For Mean Based on
                             Pooled StDev
Level     N  Mean    StDev   -+---------+---------+---------+--------
Acetyl    6  663.50 145.02                  (-----------*----------)
Aluminum  6  562.67  52.63    (----------*-----------)
H-Clips  10  614.10  81.37          (--------*--------)
HDPE      6  618.00  70.59        (----------*-----------)
Steel     9  584.67  90.97      (---------*--------)
Wood      4  621.50 130.36       (-------------*-------------)
                             -+---------+---------+---------+--------
                             490       560       630       700
Pooled StDev = 95.72
```

[0049] Testing also indicated that all below surface LTD's were not significantly different than H-clips.

[0050] Thickness variations in the inventive devices were then tested.

TABLE 3

ANOVA showing deflection under a 200 lb concentrated load using two diferent thicknesses of below surface LTD's

Source	DF	SS	MS	F	P
Thickness	1	0.09264	0.09264	18.87	0.000
Error	29	0.14236	0.00491		
Total	30	0.23500			

S = 0.07006 R-Sq = 39.42% R-Sq(adj) = 37.33%

```
                           Individual 95% CIs For Mean Based on
                           Pooled StDev
Level  N   Mean    StDev   -----+---------+---------+---------+----
0.0625 18  0.25783 0.05181(------+-----)
0.1250 13  0.36862 0.08978                      (-------*-------)
                           -----+---------+---------+---------+----
                              0.250     0.300     0.350    0.400
Pooled StDev = 0.07006
```

[0051] Testing conducted on the two thicknesses of below surface LTD's indicated that the 0.0625 inch thick LTD's performed significantly better in relation to deflection under a 200 lb concentrated load than the 0.125 inch thick LTD's (See FIG. **3**, for instance).

[0052] Ultimate concentrated load was then tested for the same devices as comparisons.

TABLE 4

ANOVA showing ultimate concentrated load of two different thicknesses of below surface LTD's

Source	DF	SS	MS	F	P
Thickness	1	2646	2646	0.26	0.614
Error	29	295462	10188		
Total	30	298107			

S = 100.9 R-Sq = 0.89% R-Sq(adj) = 0.00%

```
                         Individual 95% CIs For Mean Based on
                         Pooled StDev
Level  N   Mean   StDev  ------+---------+---------+---------+---
0.0625 18  614.7  101.3          (-------------*-------------)
0.1250 13  596.0  100.4  (---------------*---------------)
                         ------+---------+---------+---------+---
                             560       595       630       665
Pooled StDev = 100.9
```

[0053] Testing indicated that there are no significant differences between the two thicknesses investigated in relation to ultimate concentrated load (See Table 4).

[0054] Breaking load was then analyzed for these same devices.

TABLE 5

ANOVA showing breaking load under a concentrated load of two diferent thicknesses of below surface LTD's

Source	DF	SS	MS	F	P
Thickness	1	208121	208121	28.40	0.000
Error	29	212516	7328		
Total	30	420637			

S = 85.60 R-Sq = 49.48% R-Sq(adj) = 47.74%

```
                           Individual 95% CIs For Mean Based on
                           Pooled StDev
Level  N   Mean   StDev   -+---------+---------+---------+--------
0.0625 18  415.28  73.09                          (-----+-----)
0.1250 13  249.23 100.70   (------*------)
                          -+---------+---------+---------+--------
                           210       280       350       420
Pooled StDev = 85.60
```

[0055] Testing has indicated that the 0.0625-inch below surface LTD is significantly better in relation to breaking load than the 0.125-inch below surface LTD.

[0056] Given that concentrated load testing has indicated that below surface LTDs can perform as well as H-clips, continued testing on geometries was conducted to optimize the below surface LTD. Given that it has been determined that the 0.0625-inch below surface LTD performs significantly better in relation to deflection under a 200 lb concentrated load and breaking load than the 0.125-inch below surface LTD's, the 0.125-inch LTD's were dropped from further evaluation.

[0057] Further testing was conducted on the 0.0625-inch thick acetyl, aluminum and HDPE in three sizes: 2.25", 3.5" and 4.5".

TABLE 6

ANOVA showing the deflection at a 200 lb concentrated load in relation to the three sizes of below surface LTD's tested

Source	DF	SS	MS	F	P
Biscuit Size	2	0.01299	0.00649	2.98	0.081
Error	15	0.03264	0.00218		
Total	17	0.04563			

S = 0.04665 R-Sq = 28.46% R-Sq(adj) = 18.92%

```
                              Individual 95% CIs For Mean Based on
                              Pooled StDev
Level  N   Mean     StDev     ---+---------+---------+---------+------
2.25   6   0.25083  0.01951         (---------*---------)
3.50   6   0.22900  0.03472   (---------*---------)
4.50   6   0.29367  0.07030                  (---------*---------)
                              ---+---------+---------+---------+------
                               0.200     0.240     0.280     0.320
Pooled StDev = 0.04665
```

[0058]

TABLE 7

ANOVA showing the ultimate concentrated load between three different sizes of below surface LTD's tested

Source	DF	SS	MS	F	P
Biscuit Size	2	16736	8368	0.80	0.469
Error	15	157778	10519		
Total	17	174514			

S = 102.6 R-Sq = 9.59% R-Sq(adj) = 0.00%

TABLE 7-continued

Level	N	Mean	StDev	Individual 95% CIs For Mean Based on Pooled StDev
				-+---------+---------+---------+--------
2.25	6	571.7	58.2	(------------*-----------)
3.50	6	638.3	75.2	(------------*------------)
4.50	6	634.2	150.0	(------------*-----------)
				-+---------+---------+---------+--------
				490 560 630 700

Pooled StDev = 102.6

[0059]

TABLE 8

ANOVA showing breaking load during concentrated load testing using diferent size below surface LTDs

Source	DF	SS	MS	F	P
Biscuit Size	2	9678	4839	0.89	0.430
Error	15	81146	5410		
Total	17	90824			

S = 73.55 R-Sq = 10.66% R-Sq(adj) = 0.00%

Level	N	Mean	StDev	Individual 95% CIs For Mean Based on Pooled StDev
				------+---------+---------+---------+---
2.25	6	385.83	82.12	(------------*------------)
3.50	6	417.50	92.13	(------------*-----------)
4.50	6	442.50	31.58	(------------*-----------)
				------+---------+---------+---------+---
				350 400 450 500

Pooled StDev = 73.55

[0060] Testing has thus indicated that there are no significant differences in relation to deflection under a 200 lb concentrated load, ultimate concentrated load and breaking load between the different size materials.

[0061] Although there is no significant difference between the different size materials, there seems to be a pattern that indicates that the bigger (longer) below surface LTDs are better suited to meet the requirement of a minimum 400 lb. breaking load. Furthermore, it appeared from the analysis results that the acetyl material exhibited less propensity to break the shoulders above or below the LTD during testing, even at ultimate load, than the other materials. Thus, such a material is preferred over the others, though not required.

[0062] While the invention will be described and disclosed in connection with certain preferred embodiments and practices, it is in no way intended to limit the invention to those specific embodiments, rather it is intended to cover structural equivalents and all alternative embodiments and modifications as may be defined by the scope of the appended claims and equivalence thereto.

We claim:

1. A structure for an edifice selected from the group consisting of a roof and a wall, wherein said structure is comprised of at least a first wood board and a second wood board connected simultaneously to at least one connection device; wherein each of said first and second wood boards has a top portion and a bottom portion, and each has four peripheral edges, wherein at least one peripheral edge of each wood board includes at least one cavity therein for the insertion of at least one connection device; wherein said connection device is made of a durable material and having a first end and a second end; wherein said end of said device is inserted within said at least one cavity of said first board and said second end of said connection device is inserted within said at least one cavity of said second board; wherein said peripheral edges of said first and second wood board into which said connection device is inserted are parallel to each other, but are not in contact with one another; and wherein said connection device does not contact the top or bottom portion of said first and second wood boards.

2. The structure of claim 1 wherein said first end and said second end of said connection device are shaped exactly the same and exhibit the same dimensions.

3. The structure of claim 2 wherein said at least one cavity within said first board and wherein said at least one cavity within said second board are both of a shape and dimensions complementary to that of either of said first end or said second end of said connection device.

4. The structure of claim 1 wherein a plurality of cavities are present within said first and second boards and a plurality of connection devices are inserted within at least two of said plurality of cavities.

5. The structure of claim 4 wherein each of said plurality of connection devices is substantially identical and has a first end and said second end substantially shaped the same and exhibiting substantially the same dimensions.

6. The structure of claim 5 wherein said plurality of cavities within said first and second boards are substantially identical and exhibit substantially the same shape and dimensions, and wherein said cavity shape and dimensions are complementary to that of either of said first end or said second end of said plurality of substantially identical connection devices.

7. The structure of claim 1 wherein said at least one connection device exhibits a roughened appearance on its surface.

8. The structure of claim 1 wherein said at least one connection device exhibits an adhesive layer on its surface.

9. The structure of claim 1 wherein said at least one connection device includes a pin structure to separate said first and second boards a substantially uniform distance.

10. The structure of claim 1 wherein said cavities of said first and second wood boards are flared to facilitate insertion thereof of said at least one connection device.

11. The structure of claim 3 wherein said at least one connection device exhibits a roughened appearance on its surface.

12. The structure of claim 3 wherein said at least one connection device exhibits an adhesive layer on its surface.

13. The structure of claim 3 wherein said at least one connection device includes a pin structure to separate said first and second boards a substantially uniform distance.

14. The structure of claim 3 wherein said cavities of said first and second wood boards are flared to facilitate insertion thereof of said at least one connection device.

15. The structure of claim 4 wherein each of said plurality of substantially identical connection devices exhibits a roughened appearance on its surface.

16. The structure of claim 4 wherein each of said plurality of substantially identical connection devices exhibits an adhesive layer on its surface.

17. The structure of claim 4 wherein each of said substantially identical connection devices includes a pin structure to separate said first and second boards a substantially uniform distance.

18. The structure of claim 4 wherein each of said substantially identical plurality of cavities within said first and second wood boards are flared to facilitate insertion thereof of said plurality of substantially identical connection devices.

19. The structure of claim 6 wherein each of said plurality of substantially identical connection devices exhibits a roughened appearance on its surface.

20. The structure of claim 6 wherein each of said plurality of substantially identical connection devices exhibits an adhesive layer on its surface.

21. The structure of claim 6 wherein each of said substantially identical connection devices includes a pin structure to separate said first and second boards a substantially uniform distance.

22. The structure of claim 6 wherein each of said substantially identical plurality of cavities within said first and second wood boards are flared to facilitate insertion thereof of said plurality of substantially identical connection devices.

* * * * *