BRACKET HAVING A THREE-LAYERED BASE

Inventor: Michael G. Morse, Brookeville, MD (US)

Correspondence Address:
RICHARD L HUFF
19304 OLNEY MILL ROAD
OLNEY, MD 20832

APPL. NO.: 11/097,886
Filed: Apr. 4, 2005

Publication Classification
Int. Cl.
E04B 1/38 (2006.01)
U.S. Cl. 52/698

ABSTRACT
A bracket having a long leg and a base wherein the base has at least two layers. A preferred bracket has lateral support pieces connecting the long leg and the base. A method of holding a second portion of a structure which is subject to a pulling or pushing force tending to separate it from a first portion of the structure is also disclosed. The method comprises providing an “L” shaped bracket having a long leg and a base, laterally attaching the long leg of the bracket to a first portion of the structure and laterally attaching the base of the bracket to the second portion of the structure.
BRACKET HAVING A THREE-LAYERED BASE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of the filing date of provision application Ser. No. ______ filed ______.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] (Not applicable)

REFERENCE TO SEQUENTIAL LISTING, A TABLE, OR A COMPUTER PROGRAM LISTING APPENDIX SUBMITTED ON A COMPACT DISC

[0003] (Not applicable)

BACKGROUND OF THE INVENTION

[0004] 1) Field of the Invention

[0005] This invention is concerned with brackets which add security to those portions of structures which are subjected to forces which tend to pull or push them away from the other portions of the structure and to methods of using the brackets.

[0006] 2) Description of the Related Art

[0007] Every deck builder knows full well the risks inherent in his or her occupation. Most injuries are related to builders getting cut, smashing body parts, getting nicked with saws, or stepping on nails. These are the daily risks that they try to guard against. However, the injuries that are most likely to take everything they have worked so far for are after they have packed up their tools, turned their work over to the homeowner, and are working on the next job. Years later, after they have moved on, timber has shrunk and settled, connections have loosened, and catastrophe occurs. A deck railing fails, giving way and spilling the occupants from the deck. There is no warning; there is no indication of risk, or of imminent danger. Wedding receptions and graduations turn from festive occasions into tragic news events. A few years will pass, depositions will be taken, and the contractor will lose everything.

[0008] Why? Because deck railings are hard pressed to handle the loads placed on them during their full service life. Railings are built with the carpenter not knowing what future demands will be placed on his work. Will a sports team enjoy a picnic on a deck that he or she has built and have eleven men lean or sit on the top rail? Will partygoers begin wrestling and fall into it?

[0009] Who decides what the appropriate load is and what is an acceptable margin of safety? These decisions are under the purview of the building code officials and their code writers. These officials quantify the load that a guardrail and handrail must absorb to obtain a reasonable level of safety. The Code for deck guardrails is found in the International Residential Code (IRC) 2000 and 2003. IRC Tables, R301.4 and R301.5 define the minimum concentrated live load for guardrails and handrails as 200 lbs. The application of that load is described in Footnote "d", Table R301.4 as "[a] single concentrated load applied in any direction at any point along the top".

[0010] In acknowledgment that guardrails and railings in use may be subjected to conditions that are more demanding than those experienced in the testing process, the IRC employs an appropriate “safety factor”. Extreme conditions and variables such as improper installation, weathering, and excessive “in-use” loading may require that a safety factor be applied to the load minimum.

[0011] The inventor’s testing indicated that the current guardrail designs do not meet IRC code requirements for load. Guardrails must be capable of resisting a load of 200 lbs, applied in any direction. Footnote “d” to Table R301.4 (IRC, 2000) defines the application of the 200 lb. load: with a safety factor of 2.5 (200 lbs. x 2.5 = 500 lbs.). Restated, each guardrail member must successfully withstand a load of 500 lbs., applied in any direction, to be IRC Building Code compliant.

[0012] Forensic examination of guardrail failures reveals weak links in construction as being the deck guardrail post attachment to the deck band board and the band board attachment to the deck joist. When an occupant of the deck leans against the guardrail, he or she is using his or her weight to work against these points of connections. This force, along with others, gradually weakens and ultimately causes connections to fail. Because of this, much research has been done to understand and improve these connections.

[0013] In an effort to address this problem, the inventor spent several years examining the construction details of deck connections, defining the various modes of connection failure, and developing practical mechanisms to reinforce components in ways that resist the most prevalent modes of failure.

[0014] Historically, the guardrail post has been attached to the deck using one of two types of fasteners: lag bolts or carriage bolts. The process for installing each fastener type is similar; both requiring two fasteners to be installed near the bottom of the post and to be connected to the deck band board. However, each of these fasteners exhibits different modes of failure.

[0015] Lag bolts are installed by drilling through the post and into the band board and then screwing the lag into the board. The threads of the lag are intended to grip the timber fibers of the band board. Ideally, the holes in the post and in the band board are made with different drill bits; one sized to allow the lag to pass through the post, and one sized to allow the threads to grip the band board. Although this connection has a rather large capacity to resist vertical loads, its ability to resist lateral loads applied to the post is limited. This limitation is due to the low capacity of lag bolts in tension due to pullout of the bolts through the timber band board.

[0016] Carriage bolts are installed in a similar fashion. Holes are drilled in the same location as with lag bolts, but the holes are sized to allow the carriage bolt to pass through both the post and the band board. The connection is achieved by the installation of a washer and retainer nut on the carriage bolt. When tightened, the assembly provides a through-bolted connection between the post and the band board of the deck. As with the lag bolt, this connection resists vertical loads well and its ability to resist lateral loads applied to the post is limited. However, its limitation is related to the connection of the band board to the joists of the
deck. While the connection of the post and band board generally remains intact, the load applied to the post causes the band board to be peeled off the ends of the deck joints. This is due to the method of connection typically used for band boards. Band boards are virtually always affixed to the deck with 16-penny nails installed in the end grain of the deck joints. This method possesses a surprisingly low resistance in tension, allowing pullout with relatively little force.

**BRIEF SUMMARY OF THE INVENTION**

[0017] To counter the above shortcomings, the inventor developed brackets that, among other things, greatly increase the lateral load-carrying capacity of the guardrail post-to-deck connection. These brackets replace the lag bolt and augment the carriage bolt or through-bolt connection to create a much stronger connection that directs the force into the contiguous deck members, absorbing and distributing the energy of the load with reduced risk of injury to the deck occupants. The effect of this distribution is evidenced through bending of the timber post, twisting of the timber band board, and most importantly, deformation of the brackets. These distortions not only increase the ability of the railing system to accommodate lateral load, they also provide ample warning to the occupants of the deck that something is amiss.

[0018] The brackets of this invention have a long, first, leg which fits against either the supporting portion of a structure or the portion to be supported, a short, second, leg, or base, which fits against either the supporting portion of a structure or the portion to be supported, and, preferably, two lateral supports. The portion to be supported may be a second portion which tends to be pushed or pulled away from a first, supporting, portion of a structure. The reason that the brackets give superior, unexpected results is that the leg connected to the portion of the structure to be supported contains at least two layers. These layers will move in different directions at different times and different speeds. Therefore, there is no sudden breaking, but instead, a gradual movement which alerts the occupants in sufficient time to avoid the area and to have the weakened connections repaired. With the use of the brackets of the present invention, personal injury and the loss of life due to the present inferior deck connections can be avoided.

[0019] Another feature of the present invention is the method in which the brackets are used. The long, first, leg of a bracket is attached to either the side of a joist of a deck or other weight-bearing, stationary portion of a structure or to the deck guard rail posts or deck band boards or other portions of structures which are subjected to forces which tend to pull or push them away from the stationary portions of the structure. The attachment is made by bolts or other attachment means passing laterally through the long leg of the bracket and into or through the portion of the structure to which the first leg is being attached. The short, second, leg of the bracket fits against the deck guard rail posts or deck band boards or other portions of structures which are subjected to forces which tend to pull or push them away from the stationary portions of the structure or the side of a joist of a deck or other weight-bearing, stationary portion of a structure. The attachment is made by at least one bolt or other attachment means passing laterally through the short leg of the bracket and into or through the portion of the structure to which the second leg is being attached.

**BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS**

[0020] FIG. 1 is a plan view of a punched-out sheet for preparing the bracket having lateral support pieces.

[0021] FIG. 2 is an elevational top view of the bracket having lateral support pieces.

[0022] FIG. 3 is an elevational front view of the bracket having lateral support pieces.

[0023] FIG. 4 is an elevational side view of the bracket having lateral support pieces.

[0024] FIG. 5 is an elevational perspective view of the bracket of this invention having lateral support pieces.

[0025] FIG. 6 is a plan view of the positioning of the bracket and rail post for test 1.

[0026] FIG. 7 is a plan view of the positioning of the bracket and rail post for test 2.

[0027] FIG. 8 is a plan view of the positioning of the bracket and rail post for test 3.

[0028] FIG. 9 is a plan view of the positioning of the bracket and rail post for test 4.

[0029] FIG. 10 is a plan view of the positioning of the brackets and rail post for test 5.

[0030] FIG. 11 is a plan view, partly in cut-away, of the positioning of brackets and a rail post showing inner and outer brackets used for additional strengthening to support the rail post.

[0031] FIG. 12 is an elevational perspective view of a bracket wherein the short leg is attached to a rail post and band board, the long leg is attached to a deck joist, and the rail post is on the inner aspect of the band board.

[0032] FIG. 13 is an elevational perspective view of a bracket wherein the short leg is attached to a rail post and band board, the long leg is attached to a deck joist, and the rail post is on the outer aspect of the band board.

[0033] FIG. 14 is an elevational perspective view of a pair of brackets wherein the short legs are attached to a band board and the long legs are attached to deck joists and the rail post is situated between the joists.

[0034] FIG. 15 is an elevational perspective view of a bracket of this invention having lateral support pieces wherein the short leg is attached to band boards and the long leg is attached to support joists.

[0035] FIG. 16 is an elevational perspective view of a bracket of this invention having no lateral support pieces wherein the short leg is attached to a rail post and band board, the long leg is attached to a deck joist, and the rail post is on the outer aspect of the band board.

[0036] FIG. 17 is an elevational front view of brackets attached to a stairway.

**DETAILED DESCRIPTION OF THE INVENTION**

[0037] This invention discloses brackets 2 for securing second portions 4 of structures which are subject to pulling or pushing forces which would tend to separate the second
portions from first (support) portions 6 of those structures. The description is concerned with securing deck rails to decks, but it should be realized that the invention is not so limited. Basically, any second portion 4 of a structure subject to a force which would tend to separate it from a first portion 6 of a structure by a pulling or pushing force may be secured to the first 6 portion of the structure using the bracket 2 of the present invention. Examples of such other uses are attachments of rails to docks and headers to joists.

[0038] The bracket of the preferred embodiment of this invention is shown in FIG. 5 and may be described as being an “L”-shaped bracket 2 having a long, first, leg 8, a short, second, leg (base) 10, and two lateral support pieces 12, the base 10 being made up of at least two layers 14. The legs 8, 10 meet at an angle of about 90°. The bracket 2 has at least one hole 16 in the long leg 8 for attachment devices 18 and at least one hole 16 in the base 10 for attachment devices 18.

It should be understood that the configuration of the brackets 2 may be reversed. Therefore, when it is disclosed that the first leg 8 is attached to a first feature and the second leg 10 is attached to a second feature, it is contemplated that the first leg 8 may be attached to the second feature and the second leg 10 may be attached to the first feature.

[0039] One method of preparing the bracket 2 is set forth below.

[0040] The method involves a first step of providing a sheet of material, preferably metal, and most preferably steel, depending on the intended use. The metal, when used, may be a metal which has been treated by known methods so as to be resistant to chemical deterioration when exposed to atmospheric, chemical, wood preservative, or oceanographic conditions.

The thickness of the metal is suitable for the manufacture of a bracket 2 for holding a second portion 4 of a structure which is subject to a pulling or pushing force tending to separate it from a first portion 6 of the structure.

A ¼" thickness is an example of such a thickness when the bracket 2 is to be used to strengthen house decks or boat docks. The material is so marked as to form an outline 20 of the shape of a long leg 8, with one lateral support piece 12 coming from each side thereof, and the long leg 8 and the two lateral support pieces 12 have extensions 22 of at least about ½ of the length of the long leg 8. The sheet is trimmed so that it has the shape of a long leg 8 with one lateral support piece 12 coming from each side thereof and the long leg 8 and the two lateral support pieces 12 have extensions 22 of at least about ½ the length of the long leg 8. The shape of the lateral support piece 12 is not critical. Lateral support pieces for “L”-shaped brackets are known in the art, as seen in U.S. Pat. No. 5,467,570 granted to L. Nov. 21, 1995 and U.S. Pat. No. 6,311,449 granted to Morse et al. Nov. 6, 2001. Thus, those skilled in the art are capable of formulating designs for lateral support pieces 12 which will offer adequate support. The sheet is then cut, preferably by punching, so as to form a blank 24. The extensions 22 of the long leg 8 and the two lateral support pieces 12 are folded upwardly by known methods of bending metal. The two lateral support pieces 12 along with their extensions 22 are then folded inwardly relative to the long leg 8. It is preferable that the extension 22 of the long leg 8 is on top. The sequence of folding the extension 22 is not critical. Appropriate holes 16 may be drilled or punched for attachment devices.

[0041] Other methods, such as welding one or more layers 14 to the short leg 10 of a bracket 2, may also be used to make the desired bracket.

[0042] Another bracket of the present invention as best seen in FIG. 16 contains a long leg 8, a short leg 10 containing at least two layers 14, and holes 16 for attachment devices 18. The two legs 8, 10 meet at an angle of 90°.

[0043] As noted above, the bracket 2 of this invention is adapted to be used for holding a second portion 4 of a structure which is subject to a pulling or pushing force tending to separate it from a first portion 6 of the structure. Additionally, other brackets may be used in this method. The bracket may be used by laterally connecting the long leg 8 to a first portion 6 of a structure, preferably by fitting attachment devices 18 through pre-prepared holes 16 for this purpose. The base 10 of the bracket is then laterally attached to a second portion 4 of the structure by fitting at least one attachment device 18 through at least one hole 16 in the base 10 of the bracket into a the second portion 4 of the structure. The attachment device 18 may be a screw or a through bolt. More than one bracket may be used in a given area. If two brackets are to be used opposite the same portion 4, 6 of the structure, such as a joist, they may be placed on opposite sides of the joist and be connected by common through bolts. “Laterally”, is intended to mean that plane which is substantially parallel with horizontal.

[0044] Because of the three-layered 14 base 10, the bracket 2 of the present invention has unique properties. The existence of these unexpected beneficial properties is demonstrated by the following tests.

[0045] During research performed at the University of Maryland’s Department of Civil Engineering, the inventor assessed test units replicating five different configurations that simulated current industry-standard methods for connecting timber deck guardrail posts to deck structures. For each of the five configurations, three samples were tested to eliminate anomalies and for comparison of results.

[0046] The test units were constructed using pressure-treated SPF 4×4×4”s attached to 2½×8” band boards using hex-bolts, and the band boards in turn were connected to the deck joists using four 16-penny nails. Each unit was then tested on a fabricated steel load frame. A lateral load was applied to the top of each of the posts at a point 36” above the deck surface to simulate the load typically experienced by a deck railing post.

[0047] These tests do not take into account the effects of weathering. Deck components and their connections deteriorate over time. The load capacity of screws, nails, hardware, and wood products diminish with use and age. These test units were constructed with new lumber and fasteners. It is most probable that the load capacity of these, or any connections, would diminish with the effects of time and weathering.

Test Load Frame:

[0048] To compare the effectiveness of the test units, a fabricated steel load frame was constructed. The purpose of the load frame was twofold: to support the test units to simulate real life conditions, and to provide a mechanism with which load could be applied and quantified as the test units were stressed to failure.
The load frame used for the following tests was fabricated from 2" angle steel, welded into a 4'x5' rectangular test bed. By welding angle steel legs to the frame, slots were created to confine the deck joists. Holes were drilled through the steel slots where 1/2" pins would be inserted to lock the test units into the load frame. Steel risers were welded to the load frame to hold the test units above the frame. This allowed the guardrail post and the deck band board that was being tested to react and move independently without contacting or binding on the load frame itself.

Load was applied by means of a cable puller with one end hooked to a calibrated and certified dynamometer and the other to a steel ring attached to the 4"x4" timber post being tested. The ring was positioned at a height of 36" above the deck surface, as required by IRC Building Code.

This series of tests assumed that, in failing failure, the deck joists remain in place. The tests simulated this condition by affixing the deck joist to the steel frame such that only the joists were anchored. For each test, lateral force was applied to the top of the 4"x4" until failure occurred or until the force exceeded that which the equipment could safely withstand (1,350 lbs. to 1,500 lbs.). For this series of tests, guardrail post failure was defined as a condition where deck occupants would no longer be safely corralled by the guardrail. As long as the post remained in a semi-vertical position and retained structural integrity, the test continued.

The tests were stopped by catastrophic events, such as post failure or excessive movement of the post. Each of the five configurations was tested with three separate samples (A, B, and C) to allow results to be averaged.

Test Unit Configurations

Test 1

Control Test Unit:

For this test, the 4"x4" post was mounted outside of the band board, between the connection points of the two deck joists. The band board was attached to the ends of the deck joists using sixteen-penny nails, three on each joist, installed with a pneumatic nail gun. No brackets were used in this test.

Results:

The nails pulled out of the deck joists, dislodging the band board and the attached 4"x4" post at a load of 150 lbs—far below the IRC Code requirement of 500 lbs. Since the band board was attached to each of the three deck joists, each connection provided approximately 50 lbs resistance to pullout.

Bracket Test Units:

The configuration with brackets 2 for Test 1 is shown in FIG. 6. The 4"x4" post was mounted with two 1/2" by 8" hex-bolts with flat washers on each end. The holes were pre-drilled, 5/8" O.C. (on center) apart, 1/8" from the bottom. The 4"x4" was mounted perpendicular to the band board 4.

The post was mounted on the outside of the deck board 4 equidistant from the two deck joists 6. The 2"x8" deck joists 6 were set at 16" O.C. The brackets 2 of this invention were located with the center of their bases 10 located against the inside of the band board 4 and their long sides 8 flush against a deck joist 6. The brackets 2 were attached to the deck joists 6 by two, 2-1/2" long, 1/2" hex-bolts and nuts, utilizing 1/2" flat washers on each side. A 2-1/2" long, 1/2" hex-bolt, with flat washers and retaining nut secured the brackets 2 to the band board 4. All nuts were tightened to approximately 30 lbs/ft of torque.

Results:

1A: Timber failure of the 4"x4" post at 700 lbs.
1B: Timber failure of the band board at 525 lbs.
1C: Timber failure of the band board at 600 lbs.

Test 2

Control Unit:

For this test, the 4"x4" was mounted inside of the band board, between the connection points of the two deck joists. The band board was attached to the ends of the deck joists using sixteen-penny nails, three on each joist, installed with a pneumatic nail gun. No brackets were used in this test.

Results:

The nails pulled out of the deck joists, dislodging the band board and the attached 4"x4" post at a load of 100 lbs. Since the band board was attached to each of the three deck joists, each connection provided approximately 33 lbs resistance to pullout.

Bracket Test Units:

The configuration for test two is shown in FIG. 7. The 4"x4" was mounted with two 1/2" by 8" hex-bolts with flat washers on each end. The holes were pre-drilled, 5/8" O.C. apart, 1/8" from the bottom. The 4"x4" was mounted perpendicular to the band board 4.

The 4"x4" post was mounted on the inside of the deck board 4, between the two deck joists 6. The 2"x8" deck joists 6 were set at 16" O.C. The brackets 2 of this invention were located with their bases 10 against the inside of the band board 4 and their long sides 8 flush against a deck joist 6. The brackets 2 were attached to the deck joists 6 by two, 2-1/2" long, 1/2" hex-bolts and nuts, utilizing 1/2" flat washers on each side. A 2-1/2" long, 1/2" hex-bolt, with flat washers and retaining nut secured the brackets 2 to the band board 4. All nuts were tightened to approximately 30 lbs/ft of torque.

Results:

2A: Timber failure of the 4"x4" post at 525 lbs.
2B: Timber failure of the band board at 525 lbs.
2C: Timber failure of the band board at 500 lbs.

Test 3

Control Unit:

For this test, the 4"x4" was mounted outside of the band board, located adjacent to the point of connection of a single deck joist. The band board was attached to the ends of the deck joists using sixteen-penny nails, three on each joist, installed with a pneumatic nail gun. No brackets were used in this test.
Results:

[0062] The nails pulled out of the deck joists, dislodging the band board and the attached 4"x4" post at a load of 75 lbs. Since the band board was attached to each of the three deck joists, each connection provided approximately 25 lbs resistance to pullout.

Bracket Test Units:

[0063] The configuration for test three is shown in FIG. 8. The 4"x4" is mounted with two ½" by 8" hex-bolts with flat washers on each end. The holes were pre-drilled, 5½" O.C. apart, 1½" from the bottom. The 2"x8" deck joists 6 were set at 16" O.C. The 4"x4" was mounted perpendicular to the band board 4.

[0064] For this test, the 4"x4" was mounted outside of the band board 4, located adjacent to the point of connection of a single deck joist 6. One bracket 2 according to this invention was utilized to anchor the 4"x4" through the band board 4 to the deck joist 6. The bracket 2 was located with its base 10 against the inside of the band board 4 and the long side 8 flush against a deck joist 6. The bracket 2 was attached to the deck joist 6 by two 2½" long, ½" hex-bolts and nuts, utilizing ½" flat washers on each side. All nuts were tightened to approximately 30 lbs/ft of torque.

Results:

3A: Timber failure of the 4"x4" post at 600 lbs.
3B: NO FAILURE Test stopped at 1,500 lbs to avoid damage to testing equipment.
3C: NO FAILURE Test stopped at 1,350 lbs to avoid damage to testing equipment.

Test 4

Control Unit:

[0065] For this test, the 4"x4" was mounted inside of the band board, located adjacent and contiguous to a single deck joist. The band board was attached to the ends of the deck joists using sixteen-penny nails, three on each end, installed with a pneumatic nail gun. No brackets were used in this test.

Results:

[0066] The nails pulled out of the deck joists, dislodging the band board and the attached 4"x4" post at a load of 65 lbs. Since the band board was attached to each of the three deck joists, each connection provided approximately 22 lbs resistance to pullout.

Bracket Test Units:

[0067] The configuration for test four is shown in FIG. 9. The 4"x4" is mounted with two ½" by 8" hex-bolts with flat washers on each end. The holes were pre-drilled, 5½" O.C. apart, 1½" from the bottom. The 4"x4" was mounted perpendicular to the band board 4.

[0068] For this test, the 4"x4" was mounted inside of the band board 4, located adjacent and contiguous to a single deck joist. The 2"x8" deck joists 6 were set at 16" O.C. One bracket 2 according to this invention was utilized to anchor the 4"x4" and band board 4 to the deck joist 6. The bracket 2 was located with its base 10 against the inside of the 4"x4" and the long side 8 flush against a deck joist 6. The bracket 2 was attached to the deck joist by two, 2½" long, ½" hex-bolts and nuts, utilizing ½" flat washers on each side. All nuts were tightened to approximately 30 lbs/ft of torque.

Results:

4A: NO FAILURE. Test stopped at 1,350 lbs to avoid damage to testing equipment.
4B: Timber failure of the 4"x4" post at 900 lbs. The dynamometer jumped to 1,400 lbs indicated when 4"x4" broke.
4C: Timber failure of the 4"x4" post at 525 lbs.

Test 5

Control Unit:

[0069] For this test, the 4"x4" was mounted on the inside of the terminal deck joist to replicate the mounting of a rail post for protection along the side of the deck. The band board and the ledger boards were attached to the ends of the deck joists using both sixteen-penny nails, three on each joist, installed with a pneumatic nail gun, and with ½" deck screws, three on each deck joist. ¾" board deck tread was screwed to the deck joists, but it did not contact the terminal joist on which the 4"x4" was mounted. No brackets were used in this test.

Results:

[0070] The nails and the screws pulled through the ends of the terminal deck joist, splintering the timber at each end, dislodging the band board and the attached 4"x4" post at a load of 220 lbs.

Bracket Test Units:

[0071] The configuration for test five is shown in FIG. 10. The 4"x4" is mounted with two ½" by 8" hex-bolts with flat washers on each end. The holes were pre-drilled, 5½" O.C. apart, 1½" from the bottom. The 4"x4" was mounted perpendicular to the terminal deck joist 4.

[0072] For this test, the 4"x4" was mounted on the inside of the terminal deck joist 4 to replicate the mounting of a rail post for protection along the side of the deck. One bracket 2 according to this invention was bolted to the 4"x4" and to the 2"x8" block and a second bracket 2 was bolted to the deck joist 6 and the 2"x8" block. As in the other tests, the ¾" board deck tread was screwed to the deck joists 6 that were not in contact with the 4"x4" post. The 2"x8" deck joists 6 were set at 16" O.C. One bracket 2 according to this invention was located with its base 10 against the inside of the 4"x4" and the long side 8 flush against the 2"x8" block. The second bracket 2 was located with its base 10 against the deck joist 6 and the long side 8 flush against the 2"x8" block. The brackets 2 were attached to the 2"x8" block by two, 2½" long, ½" hex-bolts and nuts, utilizing ½" flat washers on each side. A 2½" long, ½" hex-bolt, with flat washers and retaining nut secured the brackets 2 to the deck joist 6 and the 4"x4". All nuts were tightened to approximately 30 lbs/ft of torque.

Results:

5A: NO FAILURE. Test stopped at 1,350 lbs to avoid damage to testing equipment.
5B: NO FAILURE. Test stopped at 1,500 lbs to avoid damage to testing equipment.
SUMMARY AND CONCLUSION

The bracket 2 used in the testing was the preferred bracket, that is, an "L"-shaped bracket having a three-layered base 10 and lateral support pieces 12 connecting the base 10 and the long leg 10. This bracket strengthened the connection of the band board or rail post to the joists and allowed the lateral force to be redistributed to other deck components. With every test that was run, the primary failure was ductile, not timber failure. That is, the rail post (4"x4") was allowed to shift slightly, transfer load to the deck structure and then remain substantially intact. This introduces a controlled predictable mode of failure and moves catastrophic failure to a secondary failure position. The brackets 2 exhibited excellent ductility allowing for a reasonable warning for the occupants of the deck that the restraint system (deck guardrail) was in danger of being overloaded and pushed to failure. That same ductility also allowed for a realignment of the timber members of the deck to more effectively absorb energy.

It should be noted that there was inconsistency in the load capacity between the 4"x4"s used in the testing. Each timber was examined carefully, picked for those with the fewest knots, cracks, or checking. Yet the difference in their load strength was surprising. The 4"x4" post from test 2A experienced total failure at 525 lbs., where a similar 4"x4", bought from the same lot, the same store, withstood 1325 lbs. and did not fail. (The test was stopped to avoid damage to testing equipment.)

Meeting building code requirements for load capacity of a deck rail post is challenging because of the geometry involved and the building materials typically used on residential decks. The leverage created by the 36" height of the post (above the tread) requires a substantial anchoring method to meet the 200 lbs. 200 and 500 lbs IRC load requirement. The test units replicating current building techniques did not come close to providing the required load capacity. It was necessary to tie into a much more substantial deck member than just the band board to harvest the necessary stability. By simply attaching the bracket of this invention, the Code conforming load of 500 lbs was met and exceeded in each and every configuration tested.

These tests were performed using new timber, new connectors, and new fasteners. As with all things, exposure to the elements and time likely will weaken the components and reduce their load capacities. This is left for future research and testing.

The table below summarizes the test results. The reader should note the drastically improved lateral load capacity with the novel brackets 2 installed in the novel configuration. The load capacities given in the column titled "Load capacity with bracket" reflect the average of the three test units in each configuration. Please note that, in each test of every configuration, the minimum load required by the IRC was met and exceeded.

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Load capacity without bracket</th>
<th>Load capacity with bracket</th>
<th>Percentage increase</th>
<th>Mode of Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Unit 1</td>
<td>150 lbs</td>
<td>608 lbs</td>
<td>305%</td>
<td>Timber</td>
</tr>
<tr>
<td>Test Unit 2</td>
<td>100 lbs</td>
<td>217 lbs</td>
<td>117%</td>
<td>Timber</td>
</tr>
<tr>
<td>Test Unit 3</td>
<td>75 lbs</td>
<td>1,150 lbs</td>
<td>143%</td>
<td>Timber*</td>
</tr>
<tr>
<td>Test Unit 4</td>
<td>65 lbs</td>
<td>2,500 lbs</td>
<td>259%</td>
<td>Timber*</td>
</tr>
<tr>
<td>Test Unit 5</td>
<td>220 lbs</td>
<td>1,400 lbs</td>
<td>536%</td>
<td>None</td>
</tr>
</tbody>
</table>

*Includes some or all units that did not fail.

Although the invention has been described and illustrated in detail, it is to be clearly understood that the same is by way of illustration and example, and is not to be taken by way of limitation. The spirit and scope of the present invention are to be limited only by the terms of the appended claims.

1. An "L"-shaped bracket having a first leg and a second leg forming an angle of about 90° wherein the second leg is made up of at least two layers.
2. The bracket of claim 1, wherein the second leg has two layers.
3. The bracket of claim 1, wherein the second leg has three layers.
4. The bracket of claim 1, wherein lateral support pieces connect the first leg and the second leg.
5. The bracket of claim 1, wherein each of the first leg and the second has at least one hole therethrough for the passage of attachment devices.
6. The bracket of claim 1, wherein the bracket is metal and the metal has been treated to resist chemical deterioration.
7. A bracket prepared by the process of providing a sheet of material so marked as to form an outline of the shape of a long leg, with one lateral support piece coming from each side thereof, and the long leg and the two lateral support pieces have extensions of at least about ¼ of the length of the long leg, trimming the sheet of material so that it has the shape of a long leg with one lateral support piece coming from each side thereof and the long leg and the two lateral support pieces have extensions of at least about ¼ of the length of the long leg, folding the two lateral support pieces forward about 90° relative to the long leg, folding the extension of the long leg forward about 90° and folding the extensions of the two lateral support pieces inwardly to form a three-layered base.
8. The bracket of claim 7, wherein each of the long leg and the base has at least one hole therethrough for the passage of attachment devices.
9. The bracket of claim 7, wherein the bracket is metal and the metal has been treated to resist chemical deterioration.
10. The method of holding a second portion of a structure which is subject to a pulling or pushing force tending to separate it from a first portion of the structure, which comprises: providing an "L"-shaped bracket having a first leg and a second leg, laterally attaching the first leg of the bracket to a first portion of the structure and laterally attaching the second leg of the bracket to the second portion of the structure.
11. The method of claim 10, wherein the second leg of the bracket has at least two layers.

12. The method of claim 11, wherein each of the first leg and the second leg of the bracket has at least one hole therethrough for the passage of attachment devices.

13. The method of claim 12, wherein the attachment steps are performed by: fitting at least one attachment device through at least one hole in the first leg of the bracket into or through a first portion of the structure and fitting at least one attachment device through at least one hole in the second leg of the bracket into or through the second portion of the structure.

14. The method of claim 13, wherein the bracket has supporting pieces connecting the first leg and the second leg.

* * * * *