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(54) **MOMENT RESISTING CONNECTION APPARATUS AND METHOD**

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Publication Classification

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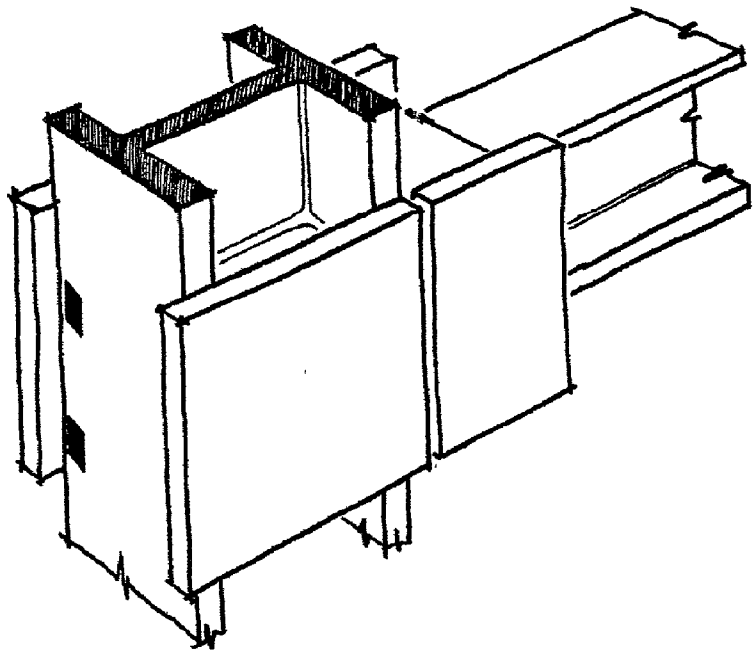
(52) **U.S. Cl.** **52/655.1**; 403/230

(57) **ABSTRACT**

The present invention comprises a moment resisting connection that comprises a column connection, a girder connection, and a field weld that couples the column connection to the girder connection. The column connection includes a column and a pair of column side plates in which each column side plate is coupled to the flanges of the column. The girder connection comprises a girder and a pair of girder side plates in which each girder side plate is operatively coupled to a doubler plate that is coupled to each girder flange. Alternatively, each girder side plate is joined to each girder flange. The field weld is performed by positioning the girder connection so that it may be welded to the column connection. The present invention also teaches a method comprising the steps of welding each column side plate to the flanges of the column. Additionally, the steps of fixedly coupling each girder side plate to the flanges of the girder is described.



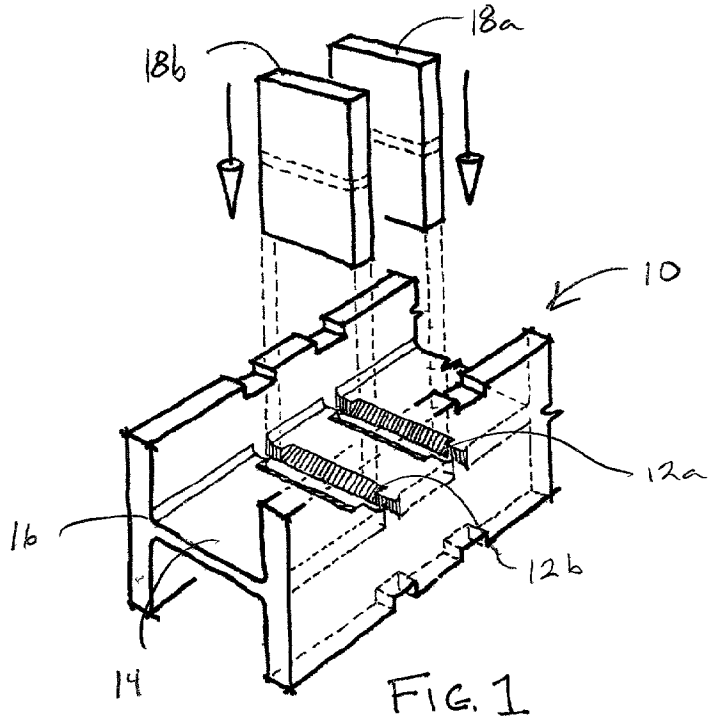


FIG. 1

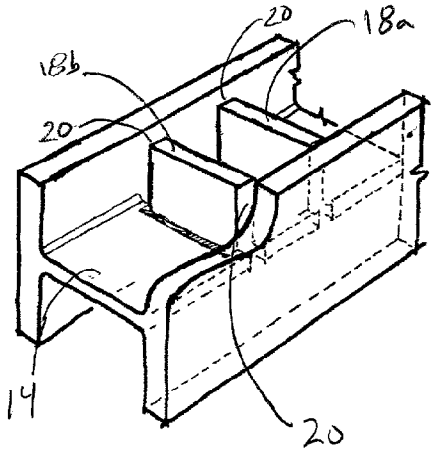


FIG. 2

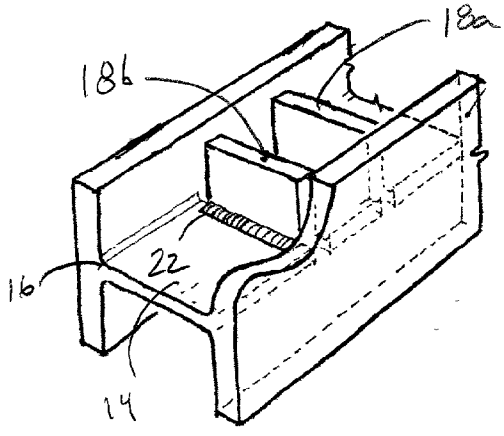


FIG. 3

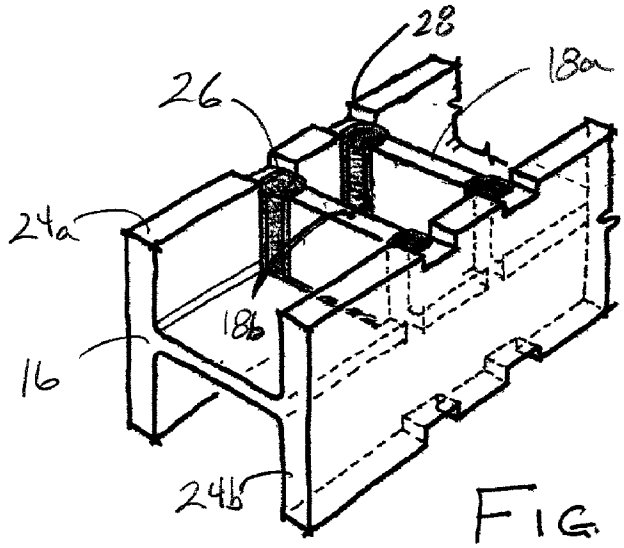


FIG. 4

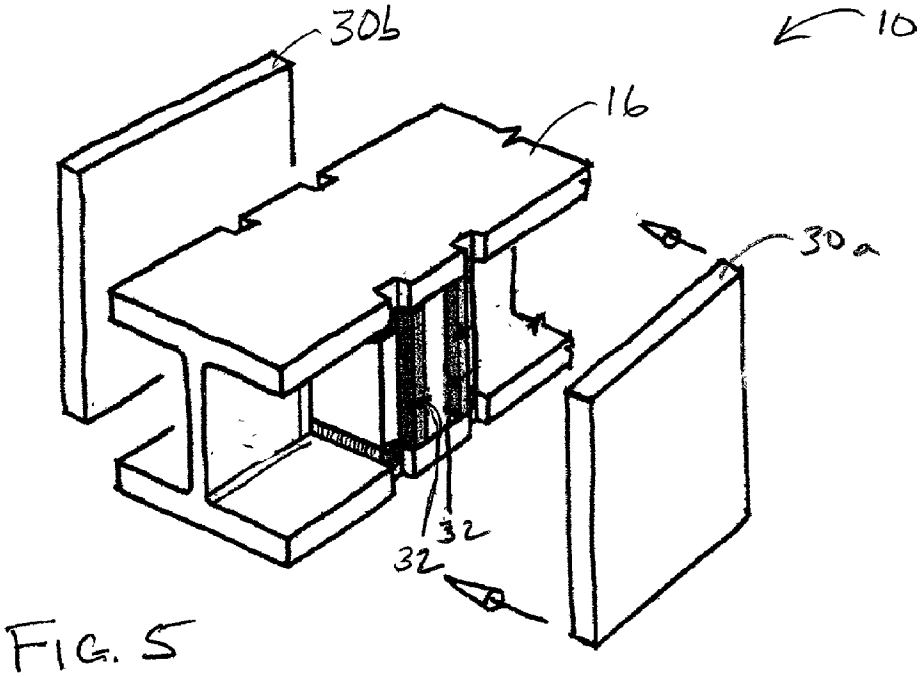


FIG. 5

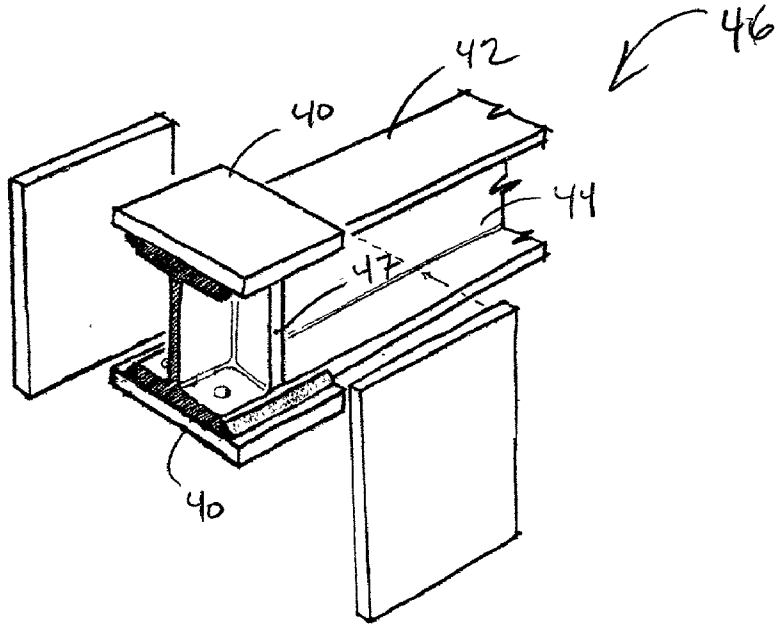


FIG. 6

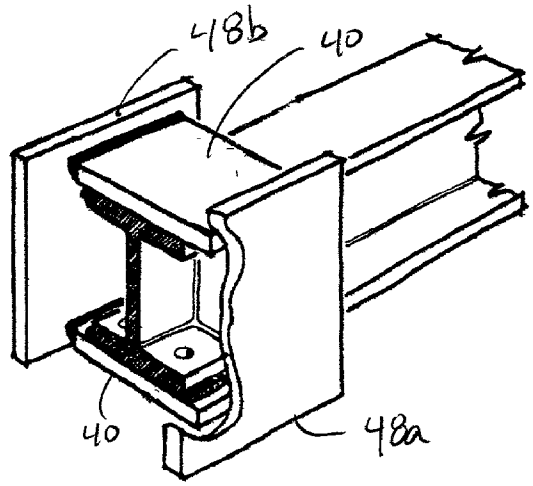


FIG. 7

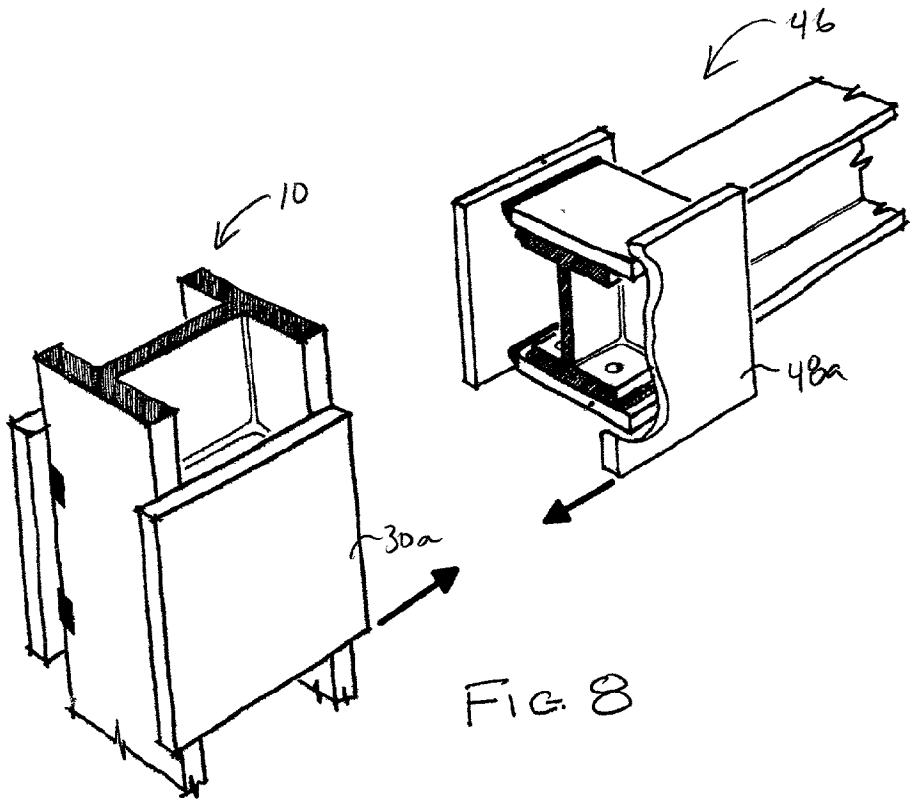


FIG. 8

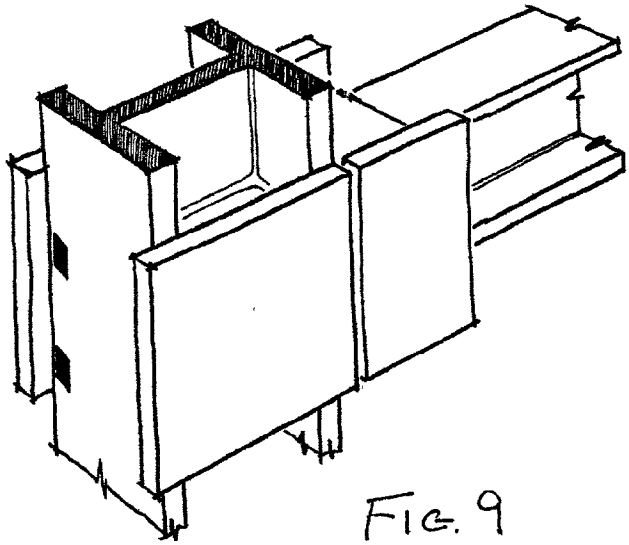


FIG. 9

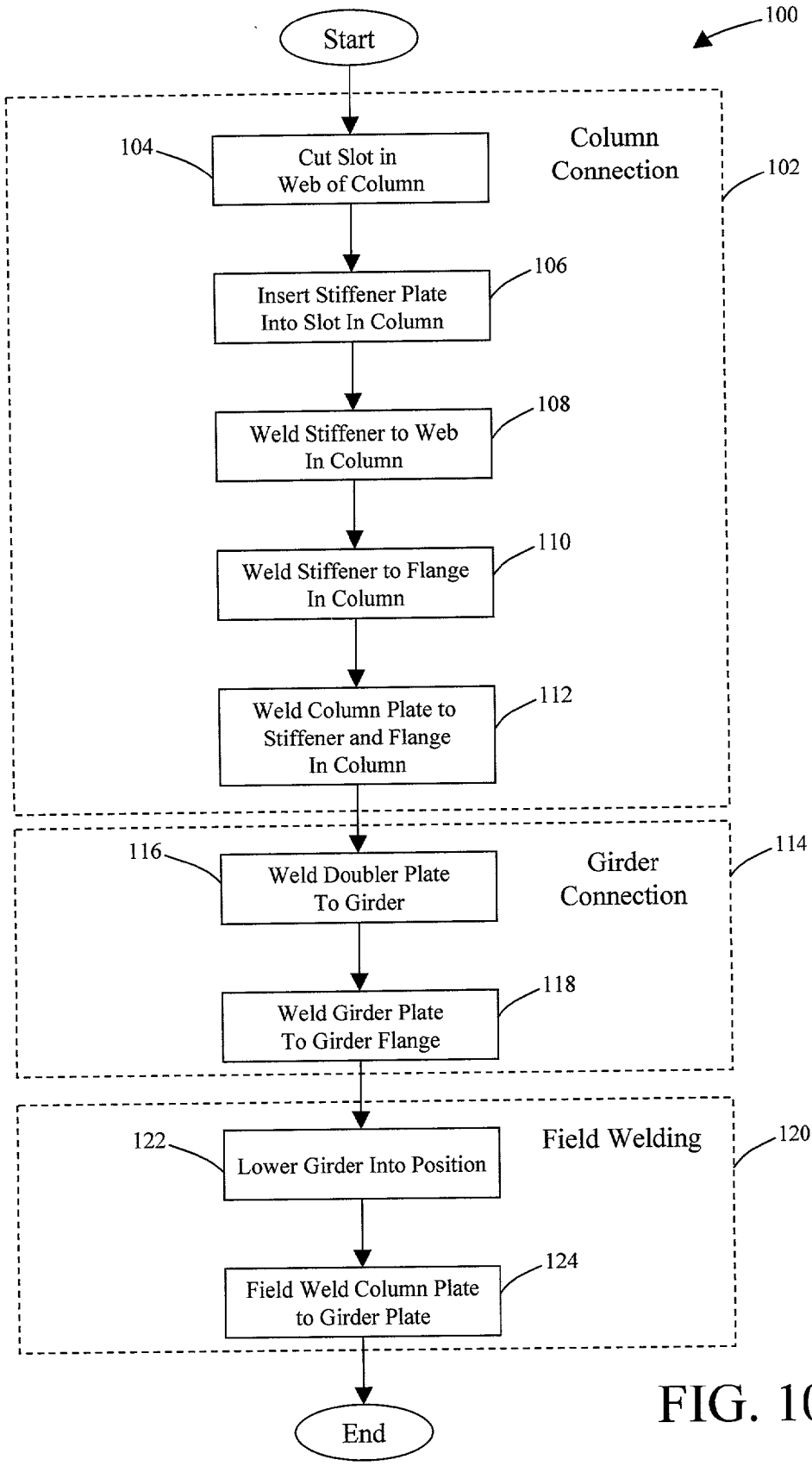

100
Start
Column Connection
102
104
Cut Slot in Web of Column
106
Insert Stiffener Plate Into Slot In Column
108
Weld Stiffener to Web In Column
110
Weld Stiffener to Flange In Column
112
Weld Column Plate to Stiffener and Flange In Column
Girder Connection
114
116
Weld Doubler Plate To Girder
118
Weld Girder Plate To Girder Flange
Field Welding
120
122
Lower Girder Into Position
124
Field Weld Column Plate to Girder Plate
End

FIG. 10

MOMENT RESISTING CONNECTION APPARATUS AND METHOD

CROSS REFERENCES TO RELATED APPLICATIONS

[0001] This patent application is a continuation-in-part of provisional patent application 60/267,926 filed on Feb. 8, 2001 and titled "A Moment Resisting Side Plate Weld".

BACKGROUND OF THE INVENTION

[0002] 1. Field of Invention

[0003] The present invention is a moment resisting connection apparatus and method. More particularly, the moment resisting connection apparatus and method is simple to manufacture and provides the structural integrity.

[0004] 2. Description of Related Art

[0005] The related art includes steel moment resisting frame beam to column connections such as described by Houghton in U.S. Pat. No. 5,660,017, hereinafter referred to as "the '017 patent". In the '017 patent, Houghton teaches the use of a plate to connect the vertical column with the horizontal beam. More particularly, Houghton describes a steel moment resisting frame (SMRF) connection that connects a vertical column to a horizontal beam. The SMRF connection includes a primary trunk assembly comprised of two, vertical, parallel plates which are welded to the vertical column on opposing sides and which plates extend from the column along the sides of a horizontal beam. A secondary branch assembly is comprised of the horizontal beam and horizontal plates which are welded to the flanges of the horizontal beam. Such plates are welded also to the vertical parallel plates, thereby connecting the column to the beam. Additionally, Houghton teaches the use of flange cover plates that are welded to the flanges of the horizontal beam. The vertical plates are then welded to the flange cover plates of the horizontal beam.

[0006] In subsequent U.S. Pat. No. 6,138,427, hereinafter referred to as "the '427 patent", Houghton modifies the use of the vertical parallel plates to retrofits. Note, that Hougton also refers to the vertical parallel plates as "gusset" plates or "gusset plate technology". More particularly, Houghton adapts the gusset plate concept to field retrofit applications having floors, walls and roofs already in place and attached to the beams and columns. The '427 describes the use of "angle irons" that are bolted to the web of the horizontal beam. The angle irons are then welded to the vertical or gusset plates.

[0007] Although the prior art Houghton patents teach an improved SMRF connection, the Houghton patents include "gusset" technology that is unnecessary and an inefficient. Additionally, the use of Houghton gusset technology is expensive to fabricate. Furthermore, the transportation costs for using the gusset technology are quite high because the column welding to the beam must be transported to the job site.

[0008] Therefore, there is a need for a cost effective SMRF connection.

[0009] Additionally, there is a need for an SMRF connection that can be easily transportable.

[0010] Furthermore, there is a need for a SMRF connection having the structural integrity needed to increase lateral and vertical stability.

[0011] Further still, there is the need for a SMRF connection that results in lighter steel beams and columns being used because of the strength of the column-to-beam connection.

SUMMARY OF INVENTION

[0012] The present invention comprises a moment resisting connection that comprises a column connection, a girder connection, and a field weld that couples the column connection to the girder connection. The column connection includes a column and a pair of column side plates in which each column side plate is coupled to the flanges of the column. The girder connection comprises a girder and a pair of girder side plates in which each girder side plate is operatively coupled to a doubler plate that is coupled to each girder flange. Alternatively, each girder side plate is joined to each girder flange. The field weld is performed by positioning the girder connection so that it may be welded to the column connection. The present invention also teaches a method comprising the steps of welding each column side plate to the flanges of the column. Additionally, the steps of fixedly coupling each girder side plate to the flanges of the girder is described.

[0013] The above description sets forth, rather broadly, the more important features of the present invention so that the detailed description of the preferred embodiment that follows may be better understood and contributions of the present invention to the art may be better appreciated. There are, of course, additional features of the invention that will be described below and will form the subject matter of claims. In this respect, before explaining at least one preferred embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of the construction and to the arrangement of the components set forth in the following description or as illustrated in the drawings. The invention is capable of other embodiments and of being practiced and carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein are for the purpose of description and should not be regarded as limiting.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Preferred embodiments of the present invention are shown in the accompanying drawings wherein:

[0015] **FIG. 1** shows two slots being cut in a web of a column.

[0016] **FIG. 2** shows the insertion of two stiffeners into the slots.

[0017] **FIG. 3** shows two stiffeners being welded to the web of the column.

[0018] **FIG. 4** shows the stiffeners being welded to flanges of the column.

[0019] **FIG. 5** shows the welding of a column side plate to the column.

[0020] **FIG. 6** shows a doubler plate being welded to flanges of a girder.

[0021] **FIG. 7** shows two girder side plates being welded to the doubler plates.

[0022] **FIG. 8** shows the field positioning of the girder and column.

[0023] **FIG. 9** shows the field welding of the girder connection and column connection.

[0024] **FIG. 10** is a flowchart of the method for manufacturing the moment resisting connection described in **FIG. 1** through **FIG. 9**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0025] In the following detailed description of the preferred embodiments, reference is made to the accompanying drawings, which form a part of this application. The drawings show, by way of illustration, specific embodiments in which the invention may be practiced. It is to be understood that other embodiments may be utilized and structural changes may be made with out departing from the scope of the present invention.

[0026] Referring to **FIG. 1** there is shown a column that is being prepared as a column connection. The column connection **10** is manufactured by first cutting two slots **12***a* and **12***b* in the web **14** of the column **16**. The two slots **12***a* and **12***b* are adapted to receive stiffeners **18***a* and **18***b*. By way of example and not of limitation, each slot **12** and **12***b* is ¾" wider than the width of the stiffener **18***a* and **18***b*. Additionally, a 30-degree bevel is cut on either side of the stiffener.

[0027] Referring to **FIG. 2** there is shown the insertion of two stiffeners **18***a* and **18***b* into the slots of the column connection **10**. Each stiffener plate **18***a* or **18***b* is inserted in the respective slot so that ½ of the stiffener plate is below the web **14** and ½ of the stiffener plate is above the web **14**. By way of example and not of limitation, the width of the stiffener will be 1.5" narrower than the inside dimension of the column flanges, thereby providing enough room to generate a 0.75" weld gap on either side of the stiffener. Preferably, the 0.75" weld gap forms a weld cavity for electroslag welding. Preferably, the electroslag system that is used is the VertaSlag system manufactured by Arcmatic Integrated Systems. The issued U.S. Pat. 6,297,472 and patent application 09/804,686 titled "A Modular Welding System" teaches the underlying principles of electroslag welding and is hereby incorporated by reference.

[0028] Referring to **FIG. 3** there is shown the two stiffeners **18***a* and **18***b* being joined to the web **14** of the column **16**. During the welding process, two back-up bars are placed under the web **14** and on each side of the stiffener to hold a backup flux for the multipass flux cored arc welds. This backup flux eliminates the need for back gouging. A multipass flux cored arc weld **22** is then made on either side of the stiffener.

[0029] At **FIG. 4** there is shown the stiffeners **18***a* and **18***b* being welded to flanges **24***a* and **24***b* of the column **16**. Preferably, the VertaSlag welding system described above is used to make four electroslag welds **26** that join the flanges **24***a* and **24***b* to the column **16**. After the electroslag welds **26** have been completed, then the electroslag welds are cleaned on the top and bottom. A 0.75" inch slot **28** is then cut into each flange at the location where the electroslag weld **26** was completed. The slot **28** provides room for the guide tube used in the subsequent electroslag welds described below in **FIG. 5**.

[0030] At **FIG. 5** there is shown the welding of a column side plate to the column **16**. The column **16** described in **FIG. 4** is rotated 90 degrees to receive the column side plates **30***a* and **30***b*. One face of the weld cavity is defined by each stiffener **18** and the column flange **24**. The other face of the weld cavity is defined by the column side plate **30**. The third face of the weld cavity is defined by steel backup shoes **32** that are placed along the inside surface of each stiffener. The fourth face of the weld cavity is defined by copper cooled shoes that are used in the electroslag system that is incorporated by reference.

[0031] During electroslag welding, a sump (not shown) is welded to the bottom of the weld cavity and run-off tabs (not shown) are welded to the top of the weld cavity. A guide tube (not shown) is inserted into the weld cavity and an electroslag weld is completed to join the sides of the stiffeners **18***a* and **18***b* and the flanges **24** to the column side plates **30***a* and **30***b*.

[0032] The column connection **10** is completed by the steps described in **FIG. 1** through **FIG. 5**. Preferably, the column connection **10** is performed in a welding fabrication environment so that the electroslag welds may be performed efficiently. It shall be appreciated by those skilled in the art having the benefit of this disclosure that the preparation of the column connection **10** is substantially more efficient when compared to methods that require extensive fillet welds and the use of structural bolts.

[0033] Before joining the column connection to the girder connection, the girder connection must also be prepared. Referring to **FIG. 6** there is shown the joining of a doubler plate **40** to the flanges **42** of a girder **44** for the girder connection **46**. Additionally, there is shown a stiffener **47** that is preferably welded using the electroslag system that is incorporated by reference. As shown in **FIG. 6**, the four corners of the of flanges **42** are beveled for the length of the doubler plate **40**. Subsequently, four groove welds are then used to weld the doubler plates **40** to the girder **44**. Preferably, these welds are performed with the "Gantry" welder described in patent application Ser. No. 09/872,357 and titled "High Deposition Submerged Arc Welding System" which is hereby incorporated by reference. By using the Gantry weld time can be on the order of minutes rather than hours. Alternatively, if the Gantry is not used to make the groove welds, then conventional fillet welds can be made with the Gantry or manually. In yet another embodiment, the doubler plate **40** may be removed and the girder slide plates is joined directly to the flange **42** of girder **44**.

[0034] Referring to **FIG. 7** there is shown two girder side plates **48***a* and **48***b* being welded to the doubler plates **40** with either partial-penetration welds or with full penetration welds. As described above, the Gantry is preferably used in this application to join both sides of the doubler plate **40** to the girder side plates **48***a* and **48***b* at the same time and in one single pass. Using the Gantry weld time can be reduced to minutes.

[0035] The girder connection is completed once the steps described in **FIG. 6** and **FIG. 7** are completed. Preferably,

the girder connection is completed in a welding fabrication facility. The girder connection includes a pair of girder side plates that are joined to a doubler plate which is joined to the flange of the girder. Additionally, a stiffener is welded to the girder **40**. In an alternative embodiment, the girder side plate is joined directly to the flange of the girder.

[**0036**] The column connection is then joined to the girder connection. Referring to **FIG. 8** there is shown the field positioning of the girder connection **46** and the column connection **10** for field welding. During the process of conducting the field welding, the girder having girder connection **46** is lowered into position and bolted to the column connection **10** with a temporary connection (not shown). The temporary connection must hold the girder in position so that a minimum 0.75" gap is maintained between the column side plate **30***a* and girder side plate **48***a*. Sumps (not shown) are then welded to the bottom of the column side plates **30***a* and girder side plate **48***a* and run-off tabs (not shown) are welded to the top.

[**0037**] Referring to **FIG. 9** there is shown the joining of the girder connection and column connection. Preferably, one electroslag field weld is performed to join the column side plate **30***a* and the girder side plate **48***a* and an additional field weld is performed to join the column side plate **30***b* (not shown) and the girder side plate **48***a* (not shown). The electroslag field welds use a pair of copper shoes to help define the weld cavity for the electroslag welding. Additionally, the copper shoes are beveled so that the molten weld puddle makes a fillet weld on the inside of the weld cavity as the weld is being made. The weld process simultaneously joins the column side plate **30** and the column flange **24** with the girder side plate **48**. After the two welds that join the column side plate **30** and the girder side plate **48** are completed, the sumps and run-off tabs are cut off and the field welds are completed.

[**0038**] Referring to **FIG. 10** there is shown a flowchart of the method for manufacturing the moment resisting connection of the present invention. The flow chart provides a summary of the steps that were performed from **FIG. 1** through **FIG. 9**.

[**0039**] The method **100** for manufacturing the moment resisting connection of the present invention includes the first step of performing the column plate welding **102** which is defined by the process boundary conditions that include process blocks **104** though **112**. At process block **104**, the two slots **12***a* and **12***b* in the web **14** of the column **16** are cut. The two slots **12***a* and **12***b* are adapted to receive stiffeners **18***a* and **18***b* as described in **FIG. 1**. The method then proceeds to block **106**.

[**0040**] At block **106**, the two stiffeners **18***a* and **18***b* are inserted into the slots of the column connection **10**. By way of example and not of limitation, the width of the stiffener will be 1.5" narrower than the inside dimension of the column flanges, thereby providing enough room to generate a 0.75" weld gap on either side of the stiffener. As described in **FIG. 2** above, the 0.75" weld gap forms a weld cavity for electroslag welding. The method then proceeds to process block **108**.

[**0041**] At block **108**, the two stiffeners **18***a* and **18***b* are joined to the web **14** of the column **16**. During the welding process, two back-up bars are placed under the web **14** and on each side of the stiffener to hold a backup flux for the multipass flux cored arc welds. This backup flux eliminates the need for back gouging. A multipass flux cored arc weld **22** is then made on either side of the stiffener. The method then proceeds to process block **110**.

[**0042**] At block **110** the stiffeners **18***a* and **18***b* are welded to flanges **24***a* and **24***b* of the column **16** using the VertaSlag welding system described above. After the electroslag welds **26** have been completed, then the electroslag welds are cleaned on the top and bottom. A 0.75" inch slot **28** is then cut into each flange at the location where the electroslag weld **26** was completed. The slot **28** provides room for the guide tube used in the electroslag welds described below in process block **112**.

[**0043**] At block **112** the welding of a column side plate to the column **16** is performed. The column **16** described in block **110** is rotated 90 degrees to receive the column side plates **30***a* and **30***b*. A guide tube is inserted into the weld cavity and an electroslag weld is completed to join the sides of the stiffeners **18***a* and **18***b* and the flanges **24** to the column side plates **30***a* and **30***b*.

[**0044**] The process of generating the column connection **102** is completed by following the steps described in process blocks **104** through **112**. Preferably, the method for generating the column connection **10** is performed in a welding fabrication environment. It shall be appreciated by those skilled in the art having the benefit of this disclosure that the present method for making a column connection does not require extensive fillet welds and the use of structural bolts.

[**0045**] The process of generating the girder connection **114** includes the process block **116** and **118**. At block **116** the doubler plate **40** is joined to the flanges **42** of a girder **44** for the girder connection **46**. Preferably, a stiffener **47** has already been welded to the girder **44** before the doubler plate is joined to the flanges **42**. It is also preferable that the doubler plate **40** be joined to flanges **42** using the Gantry. Alternatively, if the Gantry is not used to make groove welds, then conventional fillet welds can be made with the Gantry or manually. In yet another embodiment, the doubler plate **40** may be removed and the girder slide plates are joined directly to the flange **42** of girder **44**. The method then procceds to process block **118**.

[**0046**] At process block **118**, the two girder side plates **48***a* and **48***b* are joined to the doubler plates **40** with either partial-penetration welds or with full penetration welds. As described above, the Gantry may also be used in this application to join both sides of the doubler plate **40** to the girder side plates **48***a* and **48***b* at the same time and in one single pass.

[**0047**] To achieve manufacturing efficiencies, the girder connection described in blocks **116** and **118** is conducted in a welding fabrication facility. The girder connection includes a pair of girder side plates that are joined to a doubler plate which is joined to the flange of the girder. Additionally, a stiffener is welded to the girder **40**. In an alternative embodiment, the girder side plate is joined directly to flange of the girder.

[**0048**] During the field welding step described by the blocks within boundary condition **120**, the column connection **10** is then joined to the girder connection. At block **122** the girder connection **46** and the column connection **10** are

positioned for field welding. During the process of conducting the field welding, the girder having girder connection **46** is lowered into position and bolted to the column connection **10** with a temporary connection (not shown) that provides a minimum of a 0.75" gap between the column side plate **30***a* and girder side plate **48***a*. The method then proceeds to block **124**.

[**0049**] At block **124**, the girder connection and column connection are joined using an electroslage field weld. The electroslag field welds use a pair of copper shoes to define the weld cavity for the electroslag welding. The weld process simultaneously joins the column side plate **30** and the column flange **24** with the girder side plate **48**. After the two welds that join the column side plate **30** and the girder side plate **48** are finished the field welds are completed.

[**0050**] Although the description above contains many specifications, these should not be construed as limiting the scope of the invention but as merely providing illustrations of some of the presently preferred embodiments of this invention. The specification, for instance, makes reference to bonus prizes. However, the present invention is not intended to be limited to bonus prizes. Rather it is intended that the present invention can be used independently as a stand-alone game. Thus, the scope of the invention should be determined by the appended claims and their legal equivalents rather than by the examples given.

What is claimed is:

1. A moment resisting connection, comprising;

a column connection including,

a column having two column flanges, and

a pair of column side plates, each of said pair of column side plates is joined to each said column flange;

a girder connection including,

a girder having two girder flanges, and

a pair of girder side plates, each of said pair of girder side plates is fixedly coupled to each said girder flange; and

a field weld that joins said column connection to said girder connection.

2. The moment resisting connection of claim 1 wherein said fixedly coupling of said pair of girder side plates to said girder flange further comprises a doubler plate that is joined to one of said girder flanges.

3. The moment resisting connection of claim 2 wherein one of said girder side plates is joined to said doubler plate.

4. The moment resisting connection of claim 1 wherein said column connection comprises at least one stiffener plate that is joined to each of said column flanges.

5. The moment resisting connection of claim 1 wherein said girder connection comprises at least one stiffener plate that is joined to each of said girder flanges.

6. The moment resisting connection of claim 4 wherein said at least one stiffener plate is joined to each of said column flanges with an electroslag weld.

7. The moment resisting connection of claim 5 wherein said at least one stiffener plate is joined to each of said girder flanges with an electroslag weld.

8. The moment resisting connection of claim 1 wherein said field weld is an electroslag weld.

9. A moment resisting connection, comprising;

a column connection including,

a column having two column flanges, and

a pair of column side plates, each of said pair of column side plates is joined to each said column flange;

a girder connection including,

a girder having two girder flanges,

two doubler plates wherein each doubler pate is joined to one of said girder flanges, and

a pair of girder side plates, each of said pair of girder side plates is joined to each said doubler plate; and

a field weld that joins said column connection to said girder connection.

10. The moment resisting connection of claim 9 wherein said column connection comprises at least one stiffener plate that is joined to each of said column flanges.

11. The moment resisting connection of claim 9 wherein said girder connection comprises at least one stiffener plate that is joined to each of said girder flanges.

12. The moment resisting connection of claim 10 wherein said at least one stiffener plate is joined to each of said column flanges with an electroslag weld.

13. The moment resisting connection of claim 11 wherein said at least one stiffener plate is joined to each of said girder flanges with an electroslag weld.

14. The moment resisting connection of claim 9 wherein said field weld is an electroslag weld.

15. A method for generating a moment resisting connection, comprising,

generating a column connection having a column side plate joined to each flange of a column;

generating a girder connection having a girder side plate configured to be fixedly coupled to each flange of a girder; and

performing a field weld that joins said column connection and said girder connetion by joining said girder side plate to said column side plate.

16. The method of claim 15 further comprising inserting a first stiffener into said column connection before joining said column side plate to said flange of said column.

17. The method claim 16 further comprising inserting a second stiffener into said girder connection before joining said girder side plate to said flange of said girder.

18. The method of claim 17 further comprising joining a doubler plate to each said girder flange after having inserted said second stiffener and then joining said girder side plate to said doubler plate.

19. The method of claim 15 wherein said field weld is performed by electroslag welding.

20. The method of claim 16 wherein said first stiffener is joined to said column by electroslag welding.

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