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SHELTERED BUILDING CONSTRUCTION METHOD

Field of the Invention

This invention relates to a method for constructing a building under a temporary shelter, in particular a temporary shelter for protection from weather, for example rain, hail, snow, sun and the like.

Background of the Invention

It is known to provide a temporary shelter over a building site to protect the building site from weather such as rain, hail, snow and sun to prevent such weather from impeding construction. With reference to Figures 17a and 17b of the accompanying drawings, previously known methods for constructing a building 110 under a temporary shelter 12 employ overhead cranes 114 attached to the underside of a temporary roof 116. The overhead cranes 114 are able to move horizontally with respect to the temporary roof 116 for horizontal transportation of building materials. A cargo lift 118 or a rafter jib crane 120 mounted atop the temporary roof 116 is used for vertical transportation of building materials. The rafter jib crane 120 is also used for the installation and/or height adjustment of masts 122 which support the temporary roof 116.

It is necessary for the temporary roof 116 to be made with relatively heavy structural members as it must be sufficiently strong to support the overhead cranes 114 and the rafter jib crane 120.

In another previously known arrangement, the temporary roof is suspended on horizontal jib cranes. This arrangement has the disadvantage of requiring additional cranes to dismantle the temporary roof.

The applicant has determined that it would be beneficial for there to be provided a method of constructing a building under a temporary shelter which does not require such heavy structural members in the temporary roof, and which does not require additional cranes to dismantle the temporary roof.

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Summary of the Invention

In accordance with one aspect of the present invention, there is provided a method of constructing a structure at a construction site, said method including the steps of supporting a roof of a shelter above the construction site, constructing the structure beneath said roof using a jib crane, raising a jib of the jib crane relative to the roof such that the jib is above the roof, and using said jib crane to dismantle said roof.

Preferably, said jib crane is arranged such that the jib is able to rotate horizontally.

Preferably, the roof is supported on at least one mast which is height adjustable. More preferably, the height of the at least one mast is increased by inserting at least one additional length of mast therein.

Preferably, prior to or during the step of raising the jib, the jib is rotated about a substantially vertical axis from a first position in which the jib is at least partially beneath the roof to a second position in which the jib is capable of being raised without being obstructed by the roof.

Alternatively, prior to or during the step of raising the jib, at least a portion of the roof is rearranged from a first configuration in which the jib is at least partially beneath the roof to a second configuration in which the jib is no longer beneath the roof. Preferably, the roof has a movable flap which is substantially horizontal in said first configuration and is substantially vertical in said second configuration.

Preferably, the jib crane has a roof support above the level of the jib, and the roof is supported on said roof support. More preferably, the jib crane includes a bearing element which enables the jib to rotate without rotating the roof support. Preferably, the bearing element is equipped with a roller element. Preferably, said roof support is in the form of a crane mast extension.

Preferably, the jib crane is provided with connecting means for connecting the jib crane

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to the roof, and the connecting means is able to be operated to disconnect the crane from the roof.

Preferably, the roof is supported on at least one mast located outside of a space which is able to be reached by a hoist of the jib crane, so that the mast does not obstruct rotation of the jib.

Preferably, the jib of the jib crane is extendable and/or retractable.

Preferably, the roof is used as a working platform for assembling or reassembling facilities for the roof dismantling procedure.

Preferably, the roof is made from the same material or materials as a roof of the building. More preferably, the structure is a building and the roof is arranged to form a roof of the building upon completion of the construction.

In a preferred embodiment of the invention, the roof is supported by a plurality of masts, and scaffolding is mounted to said plurality of masts for accessing the building. Preferably, the scaffolding is mounted to lifting elements of the masts such that the scaffolding may be raised or lowered. More preferably, scaffolding supports are provided between the scaffolding and the building. Preferably, said scaffolding supports are in the form of removable and/or relocatable ties.

Preferably, support means are provided between said at least one mast and the building. Preferably, said support means is in the form of at least one tie between said at least one mast and the building.

Preferably, there is provided a plurality of jib cranes for constructing the building.

Preferably, the jib crane(s) is/are arranged such that the entire area below the roof is able to be reached by a hoist of the jib crane(s).

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Preferably, the roof is supported by a plurality of masts and/or a plurality of jib cranes. More preferably, horizontal beams are provided between the plurality of masts and/or the plurality of jib cranes for supporting the roof.

Preferably, the or each jib crane is provided with a jib-rotating unit for enabling the jib of the or each jib crane to rotate horizontally, and the jib-rotating unit is able to slide along a mast of the or each jib crane.

Preferably, the method includes the step of constructing the roof of the shelter using the jib crane. More preferably, the roof is constructed by said jib crane before the crane is located beneath the roof.

Preferably, the method includes the steps of mounting an additional crane on a roof supporting mast, and using the additional crane to dismantle the jib crane after the step of using the jib crane to dismantle the roof.

Preferably, the method includes the step of partially supporting the roof by internal masts.

In accordance with another aspect of the present invention there is provided an apparatus for constructing a structure on a construction site, including a shelter having a roof for sheltering the construction site and a jib crane for constructing the structure beneath the roof, wherein the jib crane and the roof are arranged such that a jib of the jib crane is capable of being raised above the roof for dismantling the roof upon completion of said construction.

Preferably, said jib crane is a horizontal jib crane.

Preferably, the roof is supported on at least one mast which is height adjustable. More preferably, the height of the at least one mast is increased by inserting at least one additional length of mast therein.

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Preferably, the jib crane is located such that a mast of the crane is able to be extended to a height above the roof without being obstructed by the roof.

Alternatively, the roof has a movable portion which is movable from a first configuration in which the movable portion shelters the jib crane to a second configuration in which the movable portion is arranged to enable the jib of the crane to be raised above the roof.

Preferably, the jib crane has a roof support above the level of the jib, and the roof is supported on said roof support. More preferably, the jib crane includes a bearing element which enables the jib to rotate without rotating the roof support. Preferably, the bearing element is equipped with a roller element. Preferably, said roof support is in the form of a crane mast extension.

Preferably, the jib crane is provided with connecting means for connecting the jib crane to the roof, and the connecting means is able to be operated to disconnect the crane from the roof.

Preferably, the roof is supported on at least one mast located outside of a space which is able to be reached by a hoist of the jib crane, so that the mast does not obstruct rotation of the jib of the jib crane.

Preferably, the jib of the jib crane is extendable and/or retractable.

Preferably, the roof is used as a working platform for assembling and reassembling facilities for the roof dismantling procedure.

Preferably, the roof is made from the same material or materials as a roof of the building. More preferably, the structure is a building and the roof is arranged to form a roof of the building upon completion of the construction.

It is preferred that the roof is supported by a plurality of masts, and scaffolding is

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mounted to said plurality of masts for accessing the building. Preferably, the scaffolding is mounted to lifting elements of the masts such that the scaffolding may be raised or lowered. Preferably, scaffolding supports are provided between the scaffolding and the building. More preferably, said scaffolding supports are in the form of removable and/or relocatable ties.

Preferably, support means are provided between said at least one mast and the building. More preferably, said support means is in the form of at least one tie between said at least one mast and the building.

Preferably, there is provided a plurality of jib cranes for constructing the building.

Preferably, the jib crane(s) is/are arranged such that the entire area below the roof is able to be reached by a hoist of the jib crane(s).

Preferably, the roof is supported by a plurality of masts and/or a plurality of jib cranes. Preferably, horizontal beams are provided between the plurality of masts and/or the plurality of jib cranes for supporting the roof.

Preferably, the or each jib crane is provided with a jib-rotating unit for enabling the jib of the or each jib crane to rotate horizontally, and the jib-rotating unit is able to slide along a mast of the or each jib crane.

Preferably, the roof is constructed by the jib crane. More preferably, the roof is constructed by the jib crane before the crane is located beneath the roof.

Preferably, an additional crane is provided on a roof supporting mast for dismantling the jib crane after the jib crane has been used to dismantle the roof.

Preferably, the roof is partially supported by internal masts.

In accordance with yet another aspect of the present invention, there is provided a jib crane for use in the method of constructing a structure as claimed herein, wherein the jib crane

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includes a jib and a roof support for supporting the roof of the shelter.

Preferably, the jib crane includes a height-adjustable mast.

Brief Description of the Drawings

Preferred embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figures 1a to 1e are a series of side views of a temporary shelter including two roof-supporting masts, showing a method of constructing a structure in accordance with a first embodiment of the present invention;

Figure 1f is a top view of the temporary shelter shown in Figures 1a to 1e;

Figures 2a to 2f are a series of side views of a height-adjustable mast having an automatic lengthening means, showing the insertion of an additional mast length for lengthening the mast;

Figure 2g is a cross-sectional view of the height-adjustable mast shown in Figures 2a to 2f, taken through the section G-G;

Figures 3a to 3c are a series of side views of a temporary shelter including a temporary roof having movable portions in the form of movable flaps, showing a method of constructing a structure in accordance with a second embodiment of the present invention;

Figures 4a to 4d are a series of side views of a temporary shelter including a roof having a movable dismantling portion, showing a method of constructing a structure in accordance with a third embodiment of the present invention;

Figures 4e and 4f are top views of the temporary shelter shown in Figures 4a to 4d;

Figures 5a and 5b are side views of a temporary shelter including a temporary roof having a movable dismantling portion, in accordance with a fourth embodiment of the present invention;

Figures 6a to 6f are a series of top views of a building and a temporary shelter including a main horizontal jib crane, four roof-supporting masts, and an additional crane assembled on one of the roof supports for dismantling the main horizontal jib crane, showing a method of constructing a structure in accordance with the present invention;

Figures 7a and 7b are side views of a temporary roof supported by two horizontal jib cranes, each of the horizontal jib cranes having an extendable mast extending through a jib-rotating unit, in accordance with a fifth embodiment of the present invention;

Figure 7c is a top view of the temporary roof shown in Figure 7a;

Figure 8 is a side view of a temporary roof supported by two horizontal jib cranes, each of the horizontal jib cranes having an extendable mast extending through a jib-rotating unit and a climbing unit frame, in accordance with the present invention;

Figures 9a to 9d are a series of side views of a temporary shelter, including two roof-supporting masts and two horizontal jib cranes, each crane having a bearing element and a support beam, showing a method of constructing a structure in accordance with a sixth embodiment of the present invention;

Figure 9e is a top view of the temporary shelter shown in Figures 9a to 9d;

Figures 10a, 10d and 10e are side views of temporary shelters with framework mounted to lift elements of two masts and two horizontal jib cranes, in accordance with a seventh embodiment of the present invention;

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Figure 10b is a cross-sectional view of the temporary shelter shown in Figure 10a, taken through the section H-H;

Figure 10c is a top view of a temporary shelter of the type shown in Figure 10a, showing the temporary roof and the jibs of the horizontal jib cranes;

Figures 11a to 11d are side views of a temporary shelter and a building, the temporary shelter having a temporary roof component which is also the roof of the building, showing a method of constructing a structure in accordance with an eighth embodiment of the present invention;

Figures 12a to 12f are a series of top views of a building and a temporary shelter, including two horizontal jib cranes and two roof-supporting masts, showing a method of constructing a structure in accordance with the present invention;

Figures 13a to 13f are top views of various embodiments of temporary shelters for use in methods of constructing a structure in accordance with the present invention;

Figures 14a to 14f are top views of various embodiments of temporary shelters for use in methods of constructing a structure in accordance with the present invention;

Figures 15a and 15b are side views of a horizontal jib crane with an extendable jib, in accordance with the present invention;

Figure 16 is a top view of an embodiment of a temporary shelter which uses two horizontal jib cranes of the type shown in Figures 15a and 15b;

Figure 17a is a side view of a temporary shelter including overhead cranes attached to the underside of the temporary roof, and a rafter jib crane, showing a previously known method of constructing a building beneath a temporary shelter; and

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Figure 17b is a side view of a temporary shelter including overhead cranes attached to the underside of the temporary roof, and a rafter jib crane, showing a previously known method of constructing a building beneath a temporary shelter.

Detailed Description of the Drawings

Figures 1a to 1f show a first embodiment of the method of constructing a structure in accordance with the present invention. In Figure 1a, two horizontal jib cranes 10 are used for constructing a roof 12. In this embodiment, masts 14 of the horizontal jib cranes 10 are located outside the roof 12 so that the masts 14 can be extended vertically without being obstructed by the roof 12. The roof 12 is supported on two height-adjustable roof-supporting masts 16, which are located so as to not obstruct rotation of the jibs 18 of the horizontal jib cranes 10. The jibs 18 are elevated to different heights with respect to each other so that the jibs 18 can rotate freely to deliver materials to the entire building area 20. The masts 14 of the horizontal jib cranes 10 and the roof-supporting masts 16 are equipped with a self-extension mechanism 22 as shown in Figures 2a to 2g, so that they can extend when the roof 12 is raised.

With reference to Figures 2a to 2g, height of the mast 24 is increased by jacking up an outer frame 26 of the mast 24 by way of a hydraulic jack 28. Movement of the outer frame 26 along the mast 24 is guided by guide rollers 30 located between the outer frame 26 and the mast 24. Once the outer frame 26 is raised sufficiently for there to be a suitable space 32 above the mast 24, lock pins 34 are engaged to lock the position of the outer frame 26 in relation to the mast 24. A winch 36 located near the top of the mast 24 is used to lift an additional length 38 of mast and to insert the additional length of mast into the space 32. A base 40 of the hydraulic jack 28 may then be moved upwards, having a new reaction point at the newly inserted length 38 of mast as shown in Figure 2f. After the lock pins 34 provided on the mast 24 are released, the mast 24 is able to be extended further to raise the crane mast 14 or the roof-supporting mast 16 as the case may be.

Subsequently, the roof 12 is brought above the jibs 18 of the cranes 10 by lowering the jibs 18 along the masts 14 of the cranes 10 and/or by extending the roof-supporting masts 16

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to raise the roof 12, as shown in Figure 1b. Then, the cranes 10 are used to transport construction materials from outside the building area 20 to construct a structure 42 beneath the roof 12, and the roof 12 and cranes 10 are elevated according to the progress of the construction of the structure 42, as shown in Figure 1c. Note also that support means in the form of ties 44 between the masts and the structure 42 are provided for stabilising the roof 12 and cranes 10.

After the structure 42 is completed, the jibs 18 of the horizontal jib cranes 10 are then rotated to be generally parallel to edges of the roof 12. The jibs 18 can be raised above the level of the roof 12 by climbing up the respective mast 14 whilst being in a generally horizontal configuration, as shown in Figure 1e. The cranes 10 are then used to dismantle the roof 12 by extending one of the jibs 18 to access the entire area of the roof 12. This can be performed by using the rooftop as a platform and by engaging one crane 10 to dismantle and reassemble the jib 18 of the other crane 10 for expanding the working radius. After the roof 12 is dismantled, the cranes 10 can be made to climb down their respective masts 14 to ground level where movable cranes are used to dismantle the horizontal jib cranes 10. Thus, the structure 42 can be built to a high quality standard under a rainproof roof 12, and the rooftop can be used as a platform for disassembling and reassembling the horizontal jib cranes 10.

Figure 1f shows a top view of the temporary shelter of Figures 1a to 1e, and shows the roof 12 being supported by two roof supporting masts 16. Figure 1f also shows there being two horizontal jib cranes 10 such that, as illustrated by the swept areas 46 and 46a of the cranes 10, substantially all the area of the construction is able to be reached by hoists 47 and 47a of the cranes 10.

Figures 3a to 3c show a second embodiment of a method of constructing a structure according to the present invention, wherein a roof 12 is provided with flap portions 48 which are movable from a first substantially horizontal configuration (see Figure 3a), in which the flap portions 48 shelter the jib cranes 10, to a second substantially vertical configuration (see Figures 3b and 3c), in which the flap portions 48 are retracted to enable the jibs 18 of the cranes 10 to be raised above the roof 12 without being obstructed by the roof 12. First, the structure 42 is built with the cranes 10 located under the roof 12 as shown in Figure 3a. After the structure 42

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is completed, the jibs 18 are rotated to be generally parallel to edges of the roof 12 along which the movable flap portions 48 of the roof 12 are provided. The movable flap portions 48 of the roof 12 are opened, and the jibs 18 are raised above the roof 12 to dismantle the roof 12, and the cranes 10 are disassembled in the same manner described in the first embodiment.

Figures 4a to 4f show a third embodiment of a method of constructing a structure, in which a movable dismantling portion 48a of the roof 12 is provided in a middle section of the roof 12, and wherein by way of the movable dismantling portion 48a of the roof, a crane 10 can be raised above or lowered below the roof 10. After the structure 42 is completed, temporary supports 50 are provided between the structure 42 and the roof 12 at locations on either side of the movable dismantling portion 48a of the roof. When the movable dismantling portion 48a of the roof is opened, the crane 10 can be raised above the level of the roof 12, as shown in Figure 4c. A plan view of this arrangement is shown in Figures 6a and 6b. As shown in Figures 4d to 4f, after the jib 18 is raised above roof-supporting mast 16, an additional crane 10a can be installed at the top of the roof-supporting mast 16. The roof 12 can be dismantled before, after or during installation of the additional crane 10a. After changing relative vertical positions of the two cranes 10, 10a, the additional crane 10a can be used to disassemble the crane 10 located in the structure 42, and the additional crane 10a can be made to climb down the roof-supporting mast 16 to be disassembled by a movable crane at ground level.

Figures 5a and 5b show a fourth embodiment of a method of constructing a structure in accordance with the present invention, wherein a movable dismantling portion 48a of the roof 12 provided in a middle section of the roof 12 is opened without temporary supports between the structure 42 and the roof 12. In this embodiment, the roof 12 is reinforced by temporary supports in the form of temporary buttresses 50a or other ways not using the structure 42 for providing temporary support to the roof 12. As in the previous embodiment, once the movable dismantling portion 48a of the roof 12 is opened, the jib 18 is able to be raised above the level of the roof 12 to dismantle the roof 12. After the roof 12 is dismantled, the crane 10 may be dismantled by an additional crane similar to the one shown in Figures 4d to 4f.

With reference to Figures 6a to 6f, there is provided a shelter having a roof 12 which is

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supported above a structure 42 by four masts 16. A horizontal jib crane 10 is used in the construction of the structure 42. As indicated by the swept area 46, the four masts 16 are placed relative to the horizontal jib crane 10 such that a hoist 47 of the crane 10 is able to reach the boundaries of the upper surface of said structure 42 during construction of the structure 42 (see Figure 6a). As seen in Figure 6b, once the roof 12 is no longer needed, in accordance with one embodiment of the present invention, part of the roof 12 directly above a mast of the crane is dismantled such that the crane 10 may be raised above said roof 12. Temporary supports 50 mounted internally of the area sheltered by the roof are used to support the roof 12 during this procedure. Once above said roof 12, the crane 10 is used to dismantle the roof 12. As shown by the swept area 46a in Figures 6c and 6d, once above the roof 12, a jib 18 of the crane 10 may be extended to reach the boundaries of the roof 12. After the roof 12 is dismantled, an additional crane 10a is assembled on the roof support 16 and is used to dismantle the horizontal jib crane 10 as shown in Figure 6e.

Figures 7a to 7c show a fifth embodiment of a method of constructing a structure according to the present invention, wherein the roof 12 is supported by height-adjustable roof-supporting masts 16, and by height-adjustable masts 14 of horizontal jib cranes 10, and the structure 42 is constructed under the roof 12. First, as shown in Figure 7a, the roof 12 is supported by the roof-supporting masts 16 and by the crane masts 14, the crane masts 14 extending from the top of the jibs 18 to abut on the roof 12. In accordance with the progress of the construction of the structure 42, the roof-supporting masts 16 and the crane masts 14 are extended further to raise the roof 12 and the jibs 18 simultaneously. As shown in Figure 7b, the cranes 10 are then separated from the roof 12 after temporary supports 50 are installed between the structure 42 and the roof 12, and the jibs 18 are raised above the level of the roof 12. The raising of the jibs 18 above the roof 12 may be facilitated by rotating the jibs 18 to be generally parallel with corresponding edges of the roof 12. Then, in a manner similar to that of previous embodiments, the roof 12, the temporary supports 50, the roof-supporting masts 16 and the cranes 10 are dismantled in order. Figure 7c is a top view of the temporary shelter of Figures 7a and 7b.

In comparing the jib cranes 10 shown in Figures 7a and 8, the former has a space 32 for

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inserting an additional length 38 of mast into the height-adjustable mast 14 of the crane 10 below the jib 18 of the crane 10, whereas in Figure 8 a space 32 for inserting an additional length 38 of mast is above the jib 18. The jib crane 10 shown in Figure 8 also has a winch 36 for raising an additional length 38 of mast, the winch 36 being mounted at the top of the mast 14. In Figure 7a, the jib 18 of the horizontal jib crane 10 is mounted to the extendable mast 14 by a jib-rotating unit 52, the extendable mast 14 extending through the jib-rotating unit 52 such that the jib 18 is able to be rotated about a substantially vertical axis without rotating a roof support portion 54 of the mast 14. The jib-rotating unit 52 is also able to be slid up and down along the extendable mast 14 such that the jib 18 may be raised or lowered. In Figure 8, the jib is mounted to a climbing unit frame 56 which is able to climb up or down along a portion of the extendable mast 14. The extendable mast 14 extends through both the climbing unit frame 56 and the jib-rotating unit 52.

Figures 9a to 9e show a sixth embodiment of a method of constructing a structure in accordance with the present invention, wherein the structure 42 is built under a roof 12 which is supported by height-adjustable roof-supporting masts 16, and by connecting beams 58 which are in turn supported by crane masts 14. First, as shown in Figure 9a, the roof 12 is supported by both two roof-supporting masts 16 and by two horizontal jib cranes 10, each of the cranes 10 being provided with a roof support in the form of a crane mast extension 54 above the level of a jib 18 of the crane 10. A connection beam 58 is supported on top of the crane mast extension 54 and connects the jib crane 10 to the roof 12 such that the roof 12 is supported by the jib crane 10. At a location between the jib 18 and the roof support 54, the jib crane 10 is provided with a bearing element 60 which enables the jib 18 to rotate without rotating the roof support 54, the bearing element being equipped with a roller element so that the jib's horizontal displacement of the rotating point can be allowed below the roof. The roof-supporting masts 16 are installed outside of the rotating area of the jibs 18, as shown in Figure 9e. As the structure 42 is built, and it becomes necessary to raise the roof 12, the crane masts 14 and the roof-supporting masts 16 are raised simultaneously (see Figure 9b). Then, after construction of the structure 42 is completed, as shown in Figure 9d, the cranes 10 are separated from the roof 12 by disconnecting the connecting beams 58 after temporary supports 50 are installed to provide temporary support for the roof 12. In Figure 9d, the temporary supports are in the form

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of struts 50 between the structure 42 and the connecting beams 58. The connecting beams 58 may be disconnected by cutting them at a location 62 near a mast 14 of the corresponding jib crane 10 so that the jib 18 of the jib crane 10 is able to be raised above the roof 12 for dismantling the roof 12. After disconnection of the connecting beams 58, the cranes 10 are able to be raised above the roof 12, and the roof 12, the temporary supports 50, the roof-supporting masts 16, and the cranes 10 are dismantled in order.

Figure 9e is a top view of the temporary shelter shown in Figures 9a to 9d, and shows the roof 12 being supported by two horizontal jib cranes 10 and two roof supporting masts 16.

The arrangement at the end not shown in Figures 9a to 9d is similar to the arrangement at the previously-described end, in that the roof 12 is supported at both sides, this being made possible by the provision of a connecting beam 58 and a temporary support 50.

Figures 10a to 10c show a seventh embodiment of a method of constructing a structure in accordance with the present invention, wherein the structure 42 is constructed with scaffolding 64 which is supported by height-adjustable roof-supporting masts 16 and by crane masts 14. In particular, there is provided a roof 12 supported on two height-adjustable roof supporting masts 16 (only one height-adjustable roof supporting mast 16 being visible in the end view of Figures 10a, 10d and 10e), two horizontal jib cranes 10 with height-adjustable masts 14 for constructing a structure 42 beneath the roof 12, and scaffolding 64 mounted to lifting elements 66 in the form of outer frames of the masts such that the scaffolding 64 may be raised or lowered in accordance with progress of the construction of the structure 42. The scaffolding 64 is used for gaining access to the structure 42, for example for the purpose of finishing the exterior of the structure 42, and may also be used for other purposes such as for sound insulation with sheets extending around the scaffolding. In the embodiment shown, there are also provided scaffolding supports in the form of relocatable ties 68 between the structure 42 and the scaffolding 64. The ties 68 are relocatable such that they can be relocated to different locations on the structure 42 when the scaffolding 64 is raised and/or lowered in relation to the structure 42.

In Figure 10c, two extendable roof supporting masts 16, and two horizontal jib cranes

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10 are shown. Each of the horizontal jib cranes 10 is provided with a jib-rotating unit 52 which is able to be slid up and down along the mast 14 of the respective horizontal jib crane 10, and which enables a jib 18 of the jib crane 10 to be rotated about a substantially vertical axis. Each of the jib cranes 10 in that Figure is also provided with a connection beam 58 for supporting the roof 12.

After construction of the structure 42 is completed, in a similar manner to that in the third embodiment, the roof 12, cranes 10, and roof-supporting masts 16 are dismantled in order.

Figures 11a to 11d show an eighth embodiment of a method of constructing a structure in accordance with the present invention, wherein a structure 42 in the form of a building is constructed under a roof 12a of a shelter, the roof 12a of the shelter comprising the same roof 12a which will become a roof 12a of the building once the structure 42 is completed, entirely or partially. By doing this, savings in materials and cost can be achieved. As shown in Figure 11b, before installing the roof 12a onto the structure 42, the jibs 18 are rotated to extend along corresponding edges of the roof 12a such that the jibs 18 are able to be raised above the level of the roof 12a. Then, as shown in Figure 11c, the roof 12a is lowered down the roof-supporting masts 16 to the structure 42. After the roof 12a is mounted on the structure 42, the roof-supporting masts 16 and the cranes 10 are disassembled in order. It is also possible to reassemble the roof 12a onto the structure 42 by using the cranes 10.

With reference to Figures 12a to 12f, there is shown a shelter having a roof 12 (indicated by dotted lines), the roof 12 being supported by horizontal beams 70, which in turn are supported by four masts 14, 16 with masts 14 being part of horizontal jib cranes 10. As can be seen by the swept area 46, 46a of the cranes 10, the entire area below the roof 12 is able to be reached by at least one hoist 47, 47a of the jib cranes 10. A structure 42 is then constructed on a construction site beneath the roof 12, the construction site being sheltered by the roof 12 such that the effect from adverse weather on progress of the construction is minimised. As the structure 42 is constructed, height adjustable masts 14, 16 supporting the roof 12 can be raised to keep up with the height of the structure 42. Masts 16 are roof-supporting masts, and masts 14 are part of jib cranes 10.

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Once construction of the structure 42 beneath the roof 12 is completed, as shown in Figure 12c, the jibs 18 of cranes 10 are rotated from underneath the roof 12 so that as the masts 14 of the cranes 10 are raised, the jibs 18 being raised past the roof 12 without being obstructed by the roof 12. Such rotation to clear the roof 12 is best seen in end view in Figure 11b. Although the orientation of the jib 18 in that drawing is substantially parallel to a side of the roof 12, depending on the arrangement of the crane 10 in relation to the roof 12, other orientations of the jib 18 may also be possible for clearing the roof 12. See for example Figure 12b in which jibs 18 of the jib cranes 10 are not parallel to sides of the roof 12 but may still be raised above the roof 12 in that orientation without being obstructed by the roof 12.

Referring now to Figure 12d, once above the roof 12, the jibs 18 are then rotated to extend above the roof 12, and the cranes 10 are then used to dismantle the roof 12. The cranes 10 may also be used to lower themselves and/or to dismantle other masts 16 as shown in Figures 12e and 12f, while the masts 16 can lower themselves through the reverse sequence shown in Figures 2a to 2f. Figure 12f shows the completed structure 42 after the roof 12, masts 16 and cranes 10 have been dismantled.

Note that in Figure 12b, the horizontal beams 70 are cut at locations 72 near the masts 14 of the jib cranes 10 to enable the masts 14 of the jib cranes 10 to be raised relative to the roof 12. To compensate for the loss of support resulting from the cutting of the horizontal beams 70, temporary supports 50 are inserted between the beams 70 and the structure 42.

Examples of suitable arrangements for constructing a structure 42 in accordance with the present invention are shown in Figures 13a to 13f and Figures 14a to 14f, wherein the structure 42 is shown in thick lines, and the roof 12 is shown in dotted lines. It can be seen that the size of the roof 12 required will depend on the size of the structure 42, the placement of masts 14, 16, the use of horizontal beams 70 between the masts 14, 16, and the use of an extendable jib 74. More particularly, Figures 13a to 13c all relate to a similar rectangular structure 42, however the size of the roof 12 required in Figure 13a, in which horizontal beams 70 are used, is significantly smaller than the size of the roof 12 required in Figure 13b, in which

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horizontal beams are not used, as the masts 16 in Figure 13b are placed outside of a space which is able to be reached by hoists 47, 47a of the cranes 10 so that jibs 18 of the jib cranes 10 can be rotated freely. In the embodiment shown in Figure 13c, there are provided jib cranes 10 which have extendable jibs 74 such that the jibs 74 can be rotated past masts 16 by moving the jibs 74 to a retracted configuration. The swept areas of the jibs 74 in retracted and extended configurations are indicated by reference numerals 76 and 78, respectively.

Figures 15 and 16 show a crane 10 with an extendable jib 74 in the form of a telescopic jib, the jib 74 being in a retracted configuration in Figure 15a, and the jib 74 being in an extended configuration in Figure 15b. This crane 10 can be utilised in the first to fifth embodiments described above, and in the examples shown in Figures 12 to 14.

Figure 16 is a top view of an embodiment of the present invention which uses two horizontal jib cranes 10 of the type shown in Figures 15a and 15b. As can be seen by the swept areas of the cranes in the retracted 76 and extended 78 configurations respectively, the jibs 74 of the cranes 10 may be extended and retracted to reach different parts of the structure 42 and the roof 12, whilst accommodating roof supporting masts 16. Advantageously, the maximum and minimum lengths of the jib 74 are such that the roof-supporting masts 16 can be located with greater freedom with respect to the masts 14 of the jib cranes 10 since the lengths of the jibs 74 can be altered.

The preferred embodiments have been described by way of example only and modifications are possible within the scope of the invention. In particular, although typically two cranes are employed in the embodiments described above, it should be noted that the present invention can also work with a single crane or with more than two cranes. Also, although in the above description roof-supporting masts are generally described as being outside of the building area, it should be noted that roof-supporting masts can also be located inside the building area from the ground or from an intermediate level of the structure whereby a base of the roof-supporting masts can climb up in accordance with climbing of the roof.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A method of constructing a structure at a construction site, said method including the steps of:
 - supporting a roof of a shelter above the construction site;
 - constructing the structure beneath said roof using a jib crane;
 - raising a jib of the jib crane relative to the roof such that the jib is above the roof;
 - and
 - using said jib crane to dismantle said roof.
2. A method of constructing a structure as claimed in claim 1, wherein said jib crane is arranged such that the jib is able to rotate horizontally.
3. A method of constructing a structure as claimed in either claim 1 or claim 2, wherein the roof is supported on at least one mast which is height adjustable.
4. A method of constructing a structure as claimed in claim 3, wherein the height of the at least one mast is increased by inserting at least one additional length of mast therein.
5. A method of constructing a structure as claimed in any one of the preceding claims wherein, prior to or during the step of raising the jib, the jib is rotated about a substantially vertical axis from a first position in which the jib is at least partially beneath the roof to a second position in which the jib is capable of being raised without being obstructed by the roof.
6. A method of constructing a structure as claimed in any one of claims 1 to 4 wherein, prior to or during the step of raising the jib, at least a portion of the roof is rearranged from a first configuration in which the jib is at least partially beneath the roof to a second configuration in which the jib is no longer beneath the roof.
7. A method of constructing a structure as claimed in claim 6 wherein the roof has a movable flap which is substantially horizontal in said first configuration and is substantially vertical in said second configuration.

8. A method of constructing a structure as claimed in any one of the preceding claims, wherein the jib crane has a roof support above the level of the jib, and the roof is supported on said roof support.
9. A method of constructing a structure as claimed in claim 8, wherein the jib crane includes a bearing element which enables the jib to rotate without rotating the roof support.
10. A method of constructing a structure as claimed in claim 9, wherein said bearing element is equipped with a roller element.
11. A method of constructing a structure as claimed in any one of claims 8 to 10, wherein said roof support is in the form of a crane mast extension.
12. A method of constructing a structure as claimed in any one of the preceding claims, wherein the jib crane is provided with connecting means for connecting the jib crane to the temporary roof, and the connecting means is able to be operated to disconnect the crane from the roof.
13. A method of constructing a structure as claimed in any one of the preceding claims wherein the roof is supported on at least one mast located outside of a space which is able to be reached by a hoist of the jib crane, so that the mast does not obstruct rotation of the jib.
14. A method of constructing a structure as claimed in any one of the preceding claims, wherein the jib of the jib crane is extendable and/or retractable.
15. A method of constructing a structure as claimed in any one of the preceding claims, wherein the roof is used as a working platform for assembling or reassembling facilities for the roof dismantling procedure.

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16. A method of constructing a structure as claimed in any one of the preceding claims, wherein the roof is made from the same material or materials as a roof of the building.
17. A method of constructing a structure as claimed in claim 16, wherein the structure is a building and the roof is arranged to form a roof of the building upon completion of the construction.
18. A method of constructing a structure as claimed in any one of the preceding claims, wherein the roof is supported by a plurality of masts, and scaffolding is mounted to said plurality of masts for accessing the structure.
19. A method of constructing a structure as claimed in claim 18, wherein the scaffolding is mounted to lifting elements of the masts such that the scaffolding may be raised or lowered.
20. A method of constructing a structure as claimed in either claim 18 or claim 19, wherein scaffolding supports are provided between the scaffolding and the building.
21. A method of constructing a structure as claimed in claim 20, wherein said scaffolding supports are in the form of removable and/or relocatable ties.
22. A method of constructing a structure as claimed in any one of the preceding claims, wherein support means are provided between said at least one mast and the building.
23. A method of constructing a structure as claimed in claim 22, wherein said support means is in the form of at least one tie between said at least one mast and the building.
24. A method of constructing a structure as claimed in any one of the preceding claims, wherein there is provided a plurality of jib cranes for constructing the building.
25. A method of constructing a structure as claimed in any one of the preceding claims, wherein the jib crane(s) is/are arranged such that the entire area below the roof is able to be reached by a hoist of one or more of the jib crane(s).

26. A method of constructing a structure as claimed in any one of the preceding claims, wherein the roof is supported by a plurality of masts and/or a plurality of jib cranes.
27. A method of constructing a structure as claimed in claim 26, wherein horizontal beams are provided between the plurality of masts and/or the plurality of jib cranes for supporting the roof.
28. A method of constructing a structure as claimed in any one of the preceding claims, wherein the or each jib crane is provided with a jib-rotating unit for enabling the jib of the or each jib crane to rotate horizontally, and wherein the jib-rotating unit is able to slide along a mast of the or each jib crane.
29. A method of constructing a structure as claimed in any one of the preceding claims, wherein said method includes the step of constructing the roof of the shelter using said jib crane.
30. A method of constructing a structure as claimed in claim 29 wherein said roof is constructed by said jib crane before the crane is located beneath the roof.
31. A method of constructing a structure as claimed in any one of the preceding claims, wherein said method includes the steps of mounting an additional crane on a roof supporting mast; and
using said additional crane to dismantle said jib crane after the step of using said jib crane to dismantle said roof.
32. A method of constructing a structure as claimed in any one of the preceding claims, wherein said method includes the step of partially supporting the roof by internal masts.
33. An apparatus for constructing a structure on a construction site, including a shelter having a roof for sheltering the construction site and a jib crane for constructing the structure beneath the roof, wherein the jib crane and the roof are arranged such that a jib of the jib crane is capable of being raised above the roof for dismantling the roof upon

completion of said construction.

34. An apparatus for constructing a structure as claimed in claim 33, wherein said jib crane is a horizontal jib crane.
35. An apparatus for constructing a structure as claimed in either claim 33 or claim 34, wherein the roof is supported on at least one mast which is height adjustable.
36. An apparatus for constructing a structure as claimed in claim 35, wherein the height of the at least one mast is increased by inserting at least one additional length of mast therein.
37. An apparatus for constructing a structure as claimed in any one of claims 33 to 36, wherein the jib crane is located such that a mast of the crane is able to be extended to a height above the roof without being obstructed by the roof.
38. An apparatus for constructing a structure as claimed in any one of claims 33 to 36, wherein the roof has a movable portion which is movable from a first configuration in which the movable portion shelters the jib crane to a second configuration in which the movable portion is arranged to enable the jib of the crane to be raised above the roof.
39. An apparatus for constructing a structure as claimed in any one of claims 33 to 38, wherein the jib crane has a roof support above the level of the jib, and the roof is supported on said roof support.
40. An apparatus for constructing a structure as claimed in claim 39, wherein the jib crane includes a bearing element which enables the jib to rotate without rotating the roof support.
41. An apparatus for constructing a structure as claimed in claim 40, wherein said bearing element is equipped with a roller element.
42. An apparatus for constructing a structure as claimed in any one of claims 39 to 41,

wherein said roof support is in the form of a crane mast extension.

43. An apparatus for constructing a structure as claimed in any one of claims 33 to 42, wherein the jib crane is provided with connecting means for connecting the jib crane to the roof, and the connecting means is able to be operated to disconnect the crane from the roof.
44. An apparatus for constructing a structure as claimed in any one of claims 33 to 43, wherein the roof is supported on at least one mast located outside of a space which is able to be reached by a hoist of the jib crane, so that the mast does not obstruct rotation of the jib.
45. An apparatus for constructing a structure as claimed in any one of claims 33 to 44, wherein the jib of the jib crane is extendable and/or retractable.
46. An apparatus for constructing a structure as claimed in any one of claims 33 to 45, wherein the roof is used as a working platform for assembling or reassembling facilities for the roof dismantling procedure.
47. An apparatus for constructing a structure as claimed in any one of claims 33 to 46, wherein the roof is made from the same material or materials as a roof of the building.
48. An apparatus for constructing a structure as claimed in claim 47, wherein the structure is a building and the roof is arranged to form a roof of the building upon completion of the construction.
49. An apparatus for constructing a structure as claimed in any one of claims 33 to 48, wherein the roof is supported by a plurality of masts, and scaffolding is mounted to said plurality of masts for accessing the building.
50. An apparatus for constructing a structure as claimed in claim 49, wherein the scaffolding is mounted to lifting elements of the masts such that the scaffolding is capable of being raised or lowered.

51. An apparatus for constructing a structure as claimed in either claim 49 or claim 50, wherein scaffolding supports are provided between the scaffolding and the building.
52. An apparatus for constructing a structure as claimed in claim 51, wherein said scaffolding supports are in the form of removable and/or relocatable ties.
53. An apparatus for constructing a structure as claimed in any one of claims 33 to 52, wherein support means are provided between said at least one mast and the building.
54. An apparatus for constructing a structure as claimed in claim 53, wherein said support means is in the form of at least one tie between said at least one mast and the building.
55. An apparatus for constructing a structure as claimed in any one of claims 33 to 54, wherein there is provided a plurality of jib cranes for constructing the building.
56. An apparatus for constructing a structure as claimed in any one of claims 33 to 55, wherein the jib crane(s) is/are arranged such that the entire area below the roof is able to be reached by a hoist of one or more of the jib crane(s).
57. An apparatus for constructing a structure as claimed in any one of claims 33 to 56, wherein the roof is supported by a plurality of masts and/or a plurality of jib cranes.
58. An apparatus for constructing a structure as claimed in claim 57, wherein horizontal beams are provided between the plurality of masts and/or the plurality of jib cranes for supporting the roof.
59. An apparatus for constructing a structure as claimed in any one of claims 33 to 58, wherein the or each jib crane is provided with a jib-rotating unit for enabling the jib of the or each jib crane to rotate horizontally, and wherein the jib-rotating unit is able to slide along a mast of the or each jib crane.
60. An apparatus for constructing a structure as claimed in any one of claims 33 to 59,

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wherein said roof is constructed by said jib crane.

61. An apparatus for constructing a structure as claimed in claim 60, wherein said roof is constructed by said jib crane before the crane is located beneath the roof.
62. An apparatus for constructing a structure as claimed in any one of claims 33 to 61, wherein an additional crane is provided on a roof supporting mast for dismantling said jib crane after said jib crane has been used to dismantle said roof.
63. An apparatus for constructing a structure as claimed as claimed in any one of claims 33 to 62, wherein said roof is partially supported by internal masts.
64. A jib crane for use in a method of constructing a structure as claimed in any one of claims 1 to 32, the jib crane including a jib and a roof support for supporting the roof of the shelter.
65. A jib crane as claimed in claim 64, wherein the jib crane includes a height-adjustable mast.