Title: SYSTEM FOR FORECASTING ERECTION ACCURACY OF FABRICATING BLOCKS OF SHIP, METHOD, AND MEDIA THEREOF

Abstract: The present invention relates to a technique of previously calculating a numerical value deviation of ship blocks to be combined before ship blocks are directly erected and optimizing a numerical value of an erection block to be erected so that the erection block can be erected in a ship block by a one-time erection process. In the technique, a basic block assembled in a ship block and an erection block to be combined in the basic block are measured, and the basic block and the erection block are displayed in three-dimensions on a program screen for forecasting an erection dimensional accuracy, and the basic block and the erection block are combined virtually. Then, a deviation between measuring results of the basic block and the erection block is calculated, and the calculated deviation is displayed as a three-dimensional vector so that an operator can easily identify a deviation value of the erection block.

**Fig. 2**

- Block File Storage Unit
- Erection Dimensional Accuracy Forecasting Unit
- User Interface
- Design File Storage Unit
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SYSTEM FOR FORECASTING ERECTION ACCURACY OF FABRICATING BLOCKS OF SHIP, METHOD, AND MEDIA THEREOF

[Technical Field]

The present invention generally relates to a system for forecasting an erection dimensional accuracy of ship block, a method and a record media thereof. More specifically, the present invention relates to a technique to previously calculate dimensions deviation of ship blocks which are to be combined before ship blocks are directly erected, and optimize dimensions of the erection blocks so that the erection blocks may be erected on basic blocks by a one-time erection process.

[Background Art]

A marine structure including a ship is generally assembled by cutting, processing are welding accessories such as metal thick pipes, scantlings, timbers and design materials. In case of ship, 100 or more blocks are assembled. Depending on the assembly order for completion of ship, a thick plate, which is a kind of a metal board, is first processed and cut according to a draft, and welded in the previously assembled ship body part. Then, a next thick board is welded in this welded portion. Each block for constituting the ship body has a large size and is made of metal, so that its external shape may be transformed through the cutting, processing and welding processes. That is, the external shape may be changed unlike the draft. In assembly of the ship, dimensions are measured based on an
erection block and a basic block, which have been previously assembled in the ship body, and the erection block is re-processed using the measurement result to be welded in the basic block. Hereinafter, the "basic block" means a ship block that has been previously assembled in the ship body, and the "erection block" means a ship block that is to be combined with the "basic block."

Referring to Fig. 1, a conventional process for forecasting an erection dimensional accuracy of ship blocks is described.

In a conventional art, an operator measures a main part in which a basic block is connected to an erection block by a light wave measuring instrument (1), and a main part in which the erection block is connected to the basic block by the light wave measuring instrument (2). The light wave measuring instrument measures three-dimensional coordinates of a measuring point focused by the operator. Measuring data corresponding to the three-dimensional coordinates are stored in a Personal Digital Assistant (PDA).

A computer reads measuring data of the basic block and the erection block from the PDA, and compares the measuring data to calculate a deviation between the measuring points and output a result based on a test.

Thereafter, the operator outputs a draft and writes three-dimensional numerical values represented by the text in the draft, thereby finishing an erection dimensional accuracy report (4). The operator matches the three-dimensional numerical values to the erection block using an empirical space concept so as to understand a
transformation degree of the erection block, and writes the three-dimensional numerical values in a two-dimensional erection dimensional accuracy report, so that the high proficiency of the operator is required.

By using the erection dimensional accuracy report, an erection block is cut so that the erection block may be re-processed. The reprocess accuracy of the erection block is determined by the accuracy of the erection dimensional accuracy report.

As for the erection process, the erection block is lifted up and located on the contact surface of the basic block of a ship in a conventional art. Then, dimensions combination state of the contact surface between the basic block and the erection block is measured using a graduated ruler in a temporarily combined state. After the erection block is cut and processed using an actually measured result, the erection block is located on the contact surface of the basic block by a crane so as to confirm the combination state. When the measured result is not exact while the erection block is temporarily combined with the basic block, the erection process of erection blocks is repeated several times using a crane to secure the erection dimensional accuracy of the erection blocks.

The conventional technique of erection ship blocks has the following shortcomings.

First, an operator forecasts an erection dimensional accuracy directly with three-dimensional coordinate values, so that the proficiency of the operator is required.
Second, since the technique depends on the proficiency of the operator, considerable time and cost are required to improve the proficiency of the operator.

Third, since the operator forecasts an erection dimensional accuracy directly with three-dimensional coordinate values, it is not easy to manage numerical values of erection blocks in a complicated-shaped block.

Fourth, the erection dimensional accuracy of only two blocks can be forecasted based on the contact surface, and it is impossible to automatically judge whether a deviation corresponding to the forecast result is a gap or an overlap.

Fifth, erection blocks are generally assembled using a crane in a block erection process of a ship. However, if the forecast of the erection dimensional accuracy of erection blocks is not precise, the crane usage time increases by a repeated re-erection process. A currently used crane requires a considerable additional cost as the crane usage time increases.

Additionally, when a measuring and cutting operation is performed in an erection state, it takes much time, and the operation is neither precise nor stabilized.

In order to solve the aforementioned problems, a technique is required to precisely measure and manage the size of the basic block and the erection block, and finish a block erection process by a one-time processing and erection process.

[Detailed Description of the Invention]
It is an object of the present invention to provide a method for outputting a three-dimensional view of a basic block and an erection block on a monitor, comparing a measured value of the erection block with a measured value of the basic block on the contact surface of the basic block and the erection block, and calculating a deviation to forecast an erection dimensional accuracy, thereby automatically preparing an erection dimensional accuracy report in which a deviation corresponding to an erection dimensional accuracy forecast result is represented on the erection block. Also, the present invention improves the erection dimensional accuracy of erection blocks to reduce an erection process time using a crane, thereby simplifying a ship block erection and welding process.

[Brief Description of the Drawings]

Fig. 1 is a diagram illustrating a conventional process for forecasting an erection dimensional accuracy of ship blocks.

Fig. 2 is a diagram illustrating a system for forecasting an erection dimensional accuracy of ship blocks according to an embodiment of the present invention.

Fig. 3 is a diagram illustrating an output example of a program screen to forecast an erection dimensional accuracy used in the system for forecasting an erection dimensional accuracy of ship blocks according to an embodiment of the present invention.

Fig. 4 is a flow chart illustrating a treating process before measuring ship blocks according to an embodiment of the present invention.
Fig. 5 is a flow chart illustrating a method for forecasting an erection dimensional accuracy of ship blocks according to an embodiment of the present invention.

Fig. 6 is a diagram illustrating a display example of measuring points on an erection dimensional accuracy forecasting program screen according to an embodiment of the present invention.

Fig. 7 is a diagram illustrating a method for connecting blocks based on a point location according to an embodiment of the present invention.

Fig. 8 is a diagram illustrating a method for connecting blocks passively according to an embodiment of the present invention.

Figs. 9 to 12 are diagrams illustrating an example of using a deviation vector according to an embodiment of the present invention.

Figs. 13 and 14 are diagrams illustrating a method for moving blocks according to an embodiment of the present invention.

Figs. 15 and 16 are diagrams illustrating a method for rotating blocks according to an embodiment of the present invention.

Fig. 17 is a diagram illustrating a completion check sheet according to an embodiment of the present invention.

[Best Modes]

The present invention provides a system for forecasting an erection dimensional accuracy of ship blocks configured to measure, compare and analyze erection accuracy of a basic block and an erection block in order to combine the erection block with the basic block of a ship. The system comprises: a user interface configured to
receive a command for forecasting an erection dimensional accuracy of ship blocks from an operator to display a performance result on the command as a three-dimensional graph; a design file storage unit configured to store a design file for the basic block and the erection block; an erection dimensional accuracy forecasting unit interlocked with the user interface and configured to provide a check sheet in which control points of the basic block and the erection block are displayed and compare measuring points of the erection block with those of the basic block to provide a finish check sheet based on the deviation; and a block file storage unit configured to store a block file combined with the measuring points of the basic block and a block file combined with the measuring points of the erection block under control of the erection dimensional accuracy forecasting unit.

Preferably, the erection dimensional accuracy forecasting unit is configured to display selected control points in a design file of the basic block selected by the user interface, combine the control points with the design file so as to generate a block file, and store the block file in the block file storage unit.

Preferably, the erection dimensional accuracy forecasting unit is configured to match the measuring points with the control points combined with the block file of the basic block, and combine the measuring points with the block file so as to be stored in the block file storage unit.

Preferably, the erection dimensional accuracy forecasting unit is configured to display selected control points in the erection block
selected by the user interface, and store a block file in which the control points are combined in the erection block with the block file storage unit.

Preferably, the erection dimensional accuracy forecasting unit is configured to match measuring points with control points combined with the block file of the erection block, and combine measuring points with the block file so as to be stored in the block file storage unit.

Preferably, the erection dimensional accuracy forecasting unit is configured to compare measuring points combined with the block file of the erection block with those combined with the block file of the basic block so as to display a deviation corresponding to the comparison result in the user interface.

Preferably, the measuring points have three-dimensional coordinate values, and the deviation is represented by a three-dimensional vector.

Preferably, when the erection block is moved or rotated, the erection dimensional accuracy forecasting unit moves three-dimensional coordinate values of the measuring points depending on movement or rotation states of the erection block so as to re-calculate a deviation on the measuring points of the erection block and the basic block.

Preferably, the three-dimensional vector is represented by a different symbol depending on the degree so that an overlap or gap state is distinguished between the two measuring points.

Preferably, the erection block is one or more.
The present invention provides a method for forecasting an erection dimensional accuracy of a ship block configured to measure, compare and analyze erection accuracy of a basic block and an erection block in order to combine the erection block with the basic block of a ship. The method comprises: (a) matching measuring coordinates of measuring points of the basic block with design coordinates of control points of the basic block to combine the measuring points with the basic block in order to calculate the erection dimensional accuracy of the erection block; (b) matching measuring coordinates of measuring points of the erection block with design coordinates of control points of the basic block to combine the measuring points with the erection block in order to calculate the erection dimensional accuracy of the basic block; (c) connecting the erection block with the basic block to compare the measuring points of the erection block with those of the basic block; and (d) analyzing a deviation of each measuring point based on the comparison result of each measuring point to calculate a deviation value of each measuring point of the basic block for each measuring point of the erection block.

Preferably, in the step (d), the deviation analysis result for each measuring point is represented by a three-dimensional vector, and a gap or an overlap is formed in each measuring point of the erection block.

Preferably, the erection block and the basic block are represented by a three-dimensional graphic, and the design coordinates of the basic point and the measuring coordinates of the
measuring point are three-dimensional coordinate values.

 Preferably, after the step (c), further comprising moving three-dimensional coordinate values of measuring points of the erection block depending on movement or rotation states of the erection block when the erection block is moved or rotated so as to re-calculate a deviation of measuring points of the basic block and moved measuring points of the erection block.

 Preferably, the movement of the erection block is performed by a one-point or two-point movement method, and the rotation of the erection block is performed by one selected from one-point-axis-rotation (displacement), two-point-axis-rotation (displacement), 1-point-axis-rotation (angle) and two-point-axis-rotation (angle).

 Preferably, in the step (b), the connection between the measuring points of the basic block and the measuring points of the erection block is performed by one selected from a point-name based connection method, a point-location based connection method or a manual connection method.

 Preferably, the method further comprises producing a completion check sheet that includes a deviation value of the basic block on each measuring point of the erection block.

 Preferably, before the step (a), when control points are selected in the basic block that has three-dimensional coordinate values, further comprising combining and storing the control points with the basic block, and producing a check sheet in which coordinate values of each control point of the basic block are displayed.
Hereinafter, the present invention will be described in detail with reference to the accompanying drawings.

Fig. 2 is a diagram illustrating a system for forecasting an erection dimensional accuracy of ship blocks according to an embodiment of the present invention.

The system for forecasting an erection dimensional accuracy of ship blocks comprises a user interface 10, a design file storage unit 12, an erection dimensional accuracy forecasting unit 14 and a block file storage unit 16.

The user interface 10 inputs a command for forecasting an erection dimensional accuracy of ship blocks, and displays a performance result of the command. The user interface 10 may include a program screen for forecasting an erection dimensional accuracy. The program screen includes a graphic operation window 30, an analysis operation window 32, a coordinate axis 33, a legend 34, a tool bar 35, a menu bar 36 and a cursor coordinate display bar 37 as shown in Fig. 3.

The graphic operation window 30 is a region in which various data such as a design model, a measuring data, and a deviation value are represented by three-dimensional graphics. The analysis operation window 32 is a region in which various data such as design coordinates, measuring coordinates, a deviation value can be checked with numerical values. The coordinate axis 33 is a symbol for identifying direction of the whole coordinate axis. The legend 34 is a symbol for identifying a color or a display sign so that the deviation
degree may be represented by a deviation vector for easy identification of the deviation value. The tool bar 35 is a region in which various shortcut icons are disposed. The menu bar 36 is a region in which various commands required to forecast the erection dimensional accuracy of ship blocks are represented by a menu type. The cursor coordinate display bar 37 is a region in which a three-dimensional location of a cursor is displayed on graphics.

In the design file storage unit 12, a three-dimensional design view of each block for constituting a ship body is stored. The three-dimensional design view may include a dxf file, a Trobon vol file, an iges file and a sat file.

In the erection dimensional accuracy forecasting unit 16, an erection dimensional accuracy forecasting program is loaded. The erection dimensional accuracy forecasting unit 16 controls display of a screen of the program represented by the user interface 10, and to forecast the erection dimensional accuracy of erection blocks using measuring coordinates of basic blocks and erection blocks which are inputted through the program screen. When a basic block or an erection block is selected by an operator, the erection dimensional accuracy forecasting unit 16 displays the selected basic or erection block on the graphic operation window 30, and combines a control point generated by selection of the operator with the basic or erection block so as to generate a block file on the basic or erection block. A plurality of the control points are generated on the contact surface, and each control point has design coordinates. The design
coordinates are three-dimensional coordinate values. Thereafter, the erection dimensional accuracy forecasting unit 16 prepares a check sheet in which the control point is represented in the erection block.

When measuring points on the basic block and the erection block are inputted, the erection dimensional accuracy forecasting unit 16 connects the measuring points to the control points combined in the basic block and the erection block, and compares a location of the measuring point of the erection block with that of the basic block so as to calculate the erection dimensional accuracy of the erection block.

The erection dimensional accuracy forecasting unit 16 prepares a completion check sheet of the erection block based on the calculation result of the erection dimensional accuracy. The measuring point has measuring coordinates which are three-dimensional coordinate values.

The design file storage unit 12 stores a block file generated by the erection dimensional accuracy forecasting unit 16. The block file has a type in which control points are combined in the corresponding block, or in which a control point and a measuring point are combined in the corresponding block.

Figs. 4 and 5 are flow charts illustrating a method for forecasting an erection dimensional accuracy of ship blocks according to an embodiment of the present invention.

Fig. 4 is a flow chart illustrating a treating process before measuring ship blocks according to an embodiment of the present invention.

When an erection dimensional accuracy forecasting program is
executed, a screen of the program is outputted on the user interface
10.

When a random block is selected on the program screen (Yes in
5 S42), the erection dimensional accuracy forecasting unit 16 reads a
design file of the block selected from the design file storage unit 12 to
output the design file on the graphic operation window 30 (S44).

When the generation of the control point is selected in the
10 program screen (Yes in S46) while the block is outputted, the control
point selected by the operator is displayed on the block (S48). The
control point, which is a point for controlling the degree, is determined
based on a location which is considered in junction with other blocks.
Preferably, a plurality of the control points may be set. Each control
point may be selected passively by the operator, or generated
automatically in the corner or an important part of the block.

Information of the selected control point may be displayed on
15 the analysis operation window 32 of the program screen. The control
point information may include coordinate values x, y and z
corresponding to control point names and design coordinates.

When check sheet preparation is requested (Yes in S50) while
20 generation of the control point is completed, the erection dimensional
accuracy forecasting unit 16 combines the control point in the block to
generate a block file, and stores the generated block file in the block
file storage unit 14 (S52). The block file includes the control point
information. The erection dimensional accuracy forecasting unit 16
generates a check sheet in which the control point is displayed on the
block (S54).

The check sheet represents design coordinates of the control point, the distance between the control points, size information of the blocks and an angle for reference in the actual measurement of the block and the three-dimensional shape of the block. The check sheet is used as an auxiliary means in the spot measurement.

Fig. 4 shows a process for generating control points of a specific block and producing a check sheet for actual measurement. In the present invention, the process is preferably performed on a basic block and an erection block, respectively. As a result, an operator can obtain a check sheet of the basic block and a check sheet of the erection block.

The operator measures the basic block and the erection block with reference to the check sheets.

For the measurement, a light wave measuring instrument may be used. First, a measuring starting point where the measurement starts is determined, and the measurement is continuously performed in a given direction based on the start point. There are various methods for measuring ship blocks using the light wave measuring instrument, and a conventional method may be used. Data of measuring coordinates of each measuring point measured by the light wave measuring instrument are stored in a storage means connected to the light wave measuring instrument. The storage means includes a Personal Digital Assistant (PDA). The PDA can be connected to the light wave measuring instrument with or without a cable. A file stored
in a memory such as the PDA can be read in a computer that has an
erection dimensional accuracy forecasting program. The
measurement is performed on the basic block and the erection block.

The operator measures the same location of a control point
displayed in the check sheet in an actual block, and manages the
measured location with a measuring point. The number of measuring
points is required to be the same as that of control points displayed in
the check sheet. The information of measuring points includes names
of measuring points and measuring coordinates.

Measuring coordinates of the basic block and the erection block
are inputted in the program so that the erection dimensional accuracy
of the erection block for the basic block can be identified.

Fig. 5 is a flow chart illustrating a process for forecasting an
erection dimensional accuracy of ship blocks according to an
embodiment of the present invention.

When an erection dimensional accuracy forecasting program is
performed, a program screen for forecasting an erection dimensional
accuracy is outputted on the interfaced 10.

When a basic block is selected from the program screen (Yes in
S60), the erection dimensional accuracy forecasting unit 16 reads a
block file of the basic block selected from the block file storage unit 14
so as to output the basic block to the graphic operation window 30.

When a measuring file is selected from the program screen (Yes
in S64), the erection dimensional accuracy forecasting unit 16 reads
the selected measuring file from a PDA so as to output each measuring
point to the graphic operation window 30 (S66). The measuring points displayed through the graphic operation window 30 are represented while maintaining a location relation between each measuring point.

In order to display a measuring point on the basic block, the erection dimensional accuracy forecasting unit 16 matches a control point of the basic block with the measuring point (S68).

A method for matching the measuring point with the control point includes arranging a plurality of measuring points with a plurality of control points and matching the measuring points with the control points. In other words, an arrangement is first performed so that the control points and the measuring points which are combined in the block may correspond to each other one by one. As shown in Fig. 6, the measuring points 62 scattered and distributed and the basic block 61 with which the control points 63 are combined are displayed on the operation window 30 in S66. However, it is difficult for the control points 63 and the measuring points 63 of the basic block 61 to correspond to each other exactly. Particularly, when the block is measured without interlocking with the control points, locations or directions of design points and measuring points are differentiated. In this case, before the control points are connected to the measuring points, the control points and the measuring points are arranged based on a given standard so that they may correspond to each other one by one. For example, the two control points and the two corresponding measuring points can be arranged. The two measuring points to be
changed are selected with a mouse or keyboard input from a dialog box. The first point is a starting point, and the second point forms a basic axis that passes the two points. Next, when the two control points to correspond to the selected measuring points are selected, the rest measuring points are automatically arranged to correspond to the rest control points. This connecting operation can be performed by various methods. For example, an operator may connect control points to measuring points manually or on the basic of the point locations. In the matching method based on the point locations, when a numerical range for matching the control points with the measuring points is inputted, the points only in the corresponding numerical range are matched so that the control points and the measuring points are matched. When the arrangement is finished through the previous steps so that the control points may correspond to the measuring points one by one, the measuring point that is located in a given radius range based on each control point is connected to the control point. The radius is a distance corresponding to a numerical value of a given connection range.

The erection dimensional accuracy forecasting unit 16 stores the block file of the basic block in which the measuring point is combined with the block file storage unit 14 (S70).

Next, the erection dimensional accuracy forecasting unit 16 judges whether an erection block is selected on the program screen (S72).

If the erection block is additionally selected as a judgment result
of S72 (Yes in S72), the erection dimensional accuracy forecasting unit 16 performs the steps from S62 to S70 to connect the measuring point to the selected erection block and store the block file of the erection block with which the measuring point is combined with the block file storage unit 14.

In order to forecast an erection dimensional accuracy of the erection block for the basic block, the present invention performs the steps from S62 to S70 for at least one or more of the erection block and the basic block, thereby combining the measuring points in the erection blocks and the basic blocks. When one erection block is connected to one basic block, there are one block file of the basic block and one block file of the erection block. However, when a plurality of the erection blocks is connected to one basic block, there are block files the corresponding erection blocks.

If there are all block files of the basic block and the erection block, a command for connecting the erection block to the basic block can be performed.

When a command for block connection is performed (Yes in S74) while the basic block and at least one or more erection block are selected on the program screen, the erection dimensional accuracy forecasting unit 16 reads the block files of the selected basic block and erection blocks from the block file storage unit 14 to output three-dimensional graphics of the basic block and the erection block on the graphic operation window 30 of the program screen. A basic block 100 and an erection block 200 are shown on the graphic operation
window 30 of the program screen as shown in Fig. 3.

After setting a measuring point connecting relation between the basic block and the erection block, the erection dimensional accuracy forecasting unit 16 calculates the erection dimensional accuracy of the erection block from measuring coordinates of the basic block and the erection block.

The setting operation for matching the measuring points between the basic block and the erection block is performed to set which measuring point of the erection is matched with one of the basic block 100. The operation of matching the measuring points of the basic block 100 and the erection block 200 may be performed by various ways. Specifically, the measuring points can be connected based on a location of each measuring point, matched based on a name of each measuring point, or manually. The method of matching the measuring points based on the location of the point is to automatically match the measuring point of the erection block 200 which is most approximate to that of the basic block 100.

Fig. 7 is a diagram illustrating a method for connecting an erection block to a basic block based on a point location according to an embodiment of the present invention. After a basic block to be connected to an erection block is selected by a mouse, a matching range is set and inputted. The measuring points which are out of the matching range may not be matched with each other. That is, only the measuring points within the numerical value range of the corresponding connection range can be matched. As a result, the
measuring point of the basic block 100 can be matched with the measuring points of the erection block 200. Here, it is necessary to select whether the block to be erected is an insert block or not. That is, it is required to set the stem and stern relation of the block or the inner and outer relation of the block. The inner and outer relation means that the block is disposed in the inner or outer side in its width direction (y axis) based on a center line of the block in the drawing. Here, it is necessary to determine whether the erection block 200 is combined in the front and thick side or in the left and right side to the basic block 100.

In the method of matching the measuring points based on the point name, the measuring points are automatically matched when the names of the neighboring points of the basic block 100 and the erection block 200 are the same. The method can be performed when the measurement of the erection block 200 is performed in the same order as that of the measuring points of the basic block 100.

Fig. 8 is a diagram illustrating a method for connecting blocks manually according to an embodiment of the present invention.

The method is used when a user manually matches measuring points 210 of the erection block 200 with measuring points 110 of the basic block 100. As shown in Fig. 8, a user clicks measuring points to be matched with each other in a graphic operation window 300 by a mouse so as to select the measuring points, or inputs a block name and a measuring point name in a dialog box so as to match the measuring points directly.
When the measuring point of the basic block is not matched with the measuring point of the erection block, linear interpolation or curve interpolation is performed to match the measuring point of the erection block with the measuring point of the basic block. The linear interpolation generates a straight line with the two measuring points, and generates XY, YZ and ZX plane surfaces that pass one measuring point of the basic block adjacent to the erection block, thereby performing a cross calculation with the straight line so as to generate a pseudo measuring point on the erection block. The curve interpolation generates a curve line using three or more measuring points of the erection block, and generates XY, YZ and ZX plane surfaces that pass one measuring point of the basic block adjacent to the erection block, thereby performing a cross calculation with the straight line so as to a pseudo measuring point on the erection block.

When erection analysis is finished after the measuring point of the basic block is matched with the measuring point of the measuring block in S76, an operator moves or rotates the erection block to adjust an erection analysis result.

Specifically, if the operator inputs a block movement/rotation command in a screen for the erection dimensional accuracy forecasting program, the erection dimensional accuracy forecasting unit 16 displays a deviation corresponding to the erection analysis result as a vector value as shown in Figs. 9 to 12. The deviation vector may be differentiated as identification symbols depending on a deviation degree as shown in Fig. 9. In the present invention, the identification
symbols are distinguished as colors which are used in combination with the legend 3 4 so that the operator may recognize the size of the deviation at one sight. That is, when a deviation vector is displayed using an arrow of a different color depending on the size of the deviation, the degree of the deviation can be recognized at one sight. In the drawing, the deviation vector represents a deviation gap 801 if it is shown as $\leftarrow \rightarrow$, and the deviation vector represents a deviation overlap 802 if it is shown as $\rightarrow \leftarrow$. The deviation vector, which is a calculated value through comparison of the measuring points between the blocks, is obtained by a displaying method as an arrow corresponding to the deviation.

The directions of the deviation vectors can be differentiated in each measuring point as shown in Fig. 10. In the drawing, the deviation between the measuring points is represented in the x-axis direction 803, the y-axis direction 804 and the z-axis direction 805. A method of designating the directions of the deviation vectors may include selecting or dragging one measuring point by a mouse to select several measuring points simultaneously. A user can select the direction of the deviation vector in a subsequent pop-up window.

Referring to Fig. 11, the deviation vector is not shown well because it is hidden by the block in the graphic drawing where the erection block is combined with the basic block. In order to prevent the deviation vector from being hidden, a deviation compensating value is used in the present invention. That is, as shown in Fig. 12, the erection block 200 is at a given distance from the basic block 100,
and the distance is designated with the deviation compensating value. As a result, the deviation value can be calculated with reference to the compensating value as the blocks are combined although the erection block 200 is at a given distance from the basic block 100. The deviation compensating value can be set in three directions of $x$, $y$ and $z$ axes, respectively.

An operator can move and rotate the erection block 200 with reference to the deviation vector, or adjust a deviation of the basic block 100 and the erection block 200 by moving and rotating the erection block 200.

Meanwhile, an operator can re-process the erection block 200 with the deviation obtained from S76. The aforementioned movement and rotation of the erection block are not necessary steps of the present invention. However, a ship block includes a portion for which it is difficult to perform the re-processing and a portion for which it is easy to perform the re-processing. As a result, the measuring point of the erection block is moved and rotated again for precise adjustment, thereby removing or reducing a deviation of the portion for which it is difficult to perform a processing. While the deviation of the portion which is relatively difficult to perform a processing becomes smaller, the deviation of the portion for which it is relatively easy to perform a processing becomes larger. However, the efficiency of the entire operation is improved because it is easy to perform a processing for the portion that has a large deviation.

In the present invention, a method of moving blocks is
performed by a one-point or two-point movement method, and a method of rotating blocks is performed by one selected from one-point-axis-rotation (displacement), two-point-axis-rotation (displacement), 1-point-axis-rotation (angle) and two-point-axis-rotation (angle).

As shown in Fig. 13, the one-point movement is to move an erection block toward global axes (x, y, z axes). That is, a block to be moved is selected by mouse movement, and a movement direction axis is selected. Then, the corresponding block is dragged from the graphic operation window 30 by a mouse, or a movement displacement is directly inputted.

As shown in Fig. 14, the two-point movement is to move two measuring points 901 and 902, respectively, toward a different direction when a different displacement value is moved. The two-point movement is useful when both end points of the block are twisted and rotated. In the same way, two measuring points of the block to be moved are selected from the graphic operation window 30, or a block name and a measuring point name are selected and inputted in a dialog box.

The method of rotating blocks includes a displacement-based rotation and an angle-based rotation. The displacement-based rotation is to rotate blocks using the direction displacement of x, y, z axes of measuring points to be rotated. A general rotation method employs a rotation axis and a rotation angle. However, it is more effective to employ a movement displacement of x, y, z axis directions
at a point to be rotated than to employ a rotation angle in case of erection analysis of blocks. The displacement-based rotation is divided into two ways depending on a method of setting a rotation axis.

Figs. 15 and 16 are diagrams illustrating a method for rotating blocks according to an embodiment of the present invention. As shown in Fig. 15, the one-point-axis rotation (displacement) is to move one measuring point selected by a user and a global axis (x, y, z axis) that passes the measuring point. A measuring point 1001 for a rotation start point is selected from the graphic operation window 30, or a target block name and a measuring point number for a rotation start point are selected from a dialog box. When the rotation start point is selected, a rotation axis is drawn on the graphic operation window 30. Next, a measuring point 1002 for a rotation point which is to be rotated is selected, or a measuring point number for a rotation point is selected from the dialog box. A axis to be used as a rotation axis is selected from the dialog box.

As shown in Fig. 16, the two-point-axis rotation (displacement) employs two measuring points when a rotation axis is set. That is, it is a method of using a straight line, which passes two measuring points 1004 and 1005 selected by a user, as a rotation axis. The two measuring points 1004 and 1005 for a rotation axis are selected by a mouse, or a target block name and a measuring point number for a rotation axis point are selected from a dialog box. Thereafter, a measuring point 1003 for a rotation point which is rotated is selected from the dialog box by a mouse. Finally, a rotation direction and a
rotation displacement are inputted and performed. As a result, the entire measuring points are rotated based on the rotation corresponding to a given displacement.

The angle-based rotation is to rotate a block or a measuring point using a rotation axis and a rotation angle. As explained above, the angle-based rotation includes a one-point-axis rotation (angle) and a two-point-axis rotation (angle). They are substantially similar to the aforementioned one-point-axis rotation (displacement) and two-point-axis rotation (displacement), respectively, except for using an angle instead of a displacement.

The erection analysis is finished through the aforementioned processes. After deviation adjustment of the erection dimensional accuracy is completed, an operator can command completion check sheet preparation.

If the operator commands preparation of a completion check sheet on a program screen for forecasting an erection dimensional accuracy (Yes in S82), the erection dimensional accuracy forecasting unit 16 outputs the completion check sheet which is a final report that includes deviation analysis data between measuring points of a basic block and an erection block (S84).

As a result, a report can be outputted as a designated format to the erection block in which erection analysis is completed. Fig. 17 is a diagram illustrating a completion check sheet according to an embodiment of the present invention. In the completion check sheet, information on a gap or overlap between the blocks is displayed as
numerical values.

In a part displayed as an overlap in the completion check sheet, a portion corresponding to a measuring point displayed as the overlap is cut from the erection block, and the processed erection block is lifted up by a crane and combined with the basic block. A gap between the blocks is welded while the erection block and the basic block are combined, thereby filling a portion corresponding to a measuring point as a gap to finish assembly.

[Industrial Applicability]

Although the present invention exemplifies when one erection block is combined with one basic block, several erection blocks combined and erected on several surfaces of one basic block can be analyzed simultaneously and the same operation can be performed. In the prior art, an erection block is lifted up by a crane, and the erection block is temporarily combined with the previously assembled basic block. At that state, dimensions are measured by a graduated ruler, and the erection block is put down on the earth by a crane. Then, the erection block is processed, and the erection block is lifted up by a crane again. However, in the embodiment of the present invention, an erection process does not need to be repeatedly performed unlike in the prior art. As a result, the present invention can minimize the crane usage, reduce the correcting operation amount, and improve the rotation rate of dock, thereby shortening a construction period of ship.

The system and method for forecasting an erection dimensional accuracy of ship blocks according to the present invention can
precisely forecast the erection dimensional accuracy based on three-dimensional basic and erection blocks, so that measuring and cutting operations do not need to be performed at a temporary erection state using a crane. As a result, the operations are rapid, exact and safe. Furthermore, the present invention does not require high proficiency in usage of a system for forecasting an erection dimensional accuracy based on a three-dimensional graphics. As a result, an operation adapting period can be remarkably shortened, thereby facilitating management of human power effectively.
[What is Claimed is]

1. A system for forecasting an erection dimensional accuracy of ship blocks configured to measure, compare and analyze erection accuracy of a basic block and an erection block in order to combine the erection block with the basic block of a ship, the system comprising:

   a user interface configured to receive a command for forecasting an erection dimensional accuracy of ship blocks from an operator to display a performance result on the command as a three-dimensional graph;

   a design file storage unit configured to store a design file for the basic block and the erection block;

   an erection dimensional accuracy forecasting unit interlocked with the user interface and configured to provide a check sheet in which control points of the basic block and the erection block are displayed and compare measuring points of the erection block with those of the basic block to provide a finish check sheet based on the deviation; and

   a block file storage unit configured to store a block file combined with the measuring points of the basic block and a block file combined with the measuring points of the erection block under control of the erection dimensional accuracy forecasting unit.

2. The system according to claim 1, wherein the erection dimensional accuracy forecasting unit is configured to display selected control points in a design file of the basic block selected by the user
interface, combine the control points with the design file so as to generate a block file, and store the block file in the block file storage unit.

3. The system according to claim 1, wherein the erection dimensional accuracy forecasting unit is configured to match the measuring points with the control points combined with the block file of the basic block, and combine the measuring points with the block file so as to be stored in the block file storage unit.

4. The system according to claim 3, wherein when the measuring points of the basic block are not matched with those of the erection block, the erection dimensional accuracy forecasting unit is configured to generate a straight line with two measuring points of the erection block, generate a XY surface, a YZ surface and a ZX surface that cross one measuring point of the basic block adjacent to the erection block so as to perform a cross calculation with the straight line, and generate a pseudo measuring point on the erection block so as to match the measuring point of the basic block with the pseudo measuring point of the erection block, or

to generate a straight line with three or more measuring points of the erection block, generate a XY surface, a YZ surface and a ZX surface that cross one measuring point of the basic block adjacent to the erection block so as to perform a cross calculation with the straight line, and generate a pseudo measuring point on the erection block so as to match the measuring point of the basic block with the pseudo measuring point of the erection block.
5. The system according to claim 1, wherein the erection dimensional accuracy forecasting unit is configured to display selected control points in the erection block selected by the user interface, and store a block file in which the control points are combined with the erection block in the block file storage unit.

6. The system according to claim 4, wherein the erection dimensional accuracy forecasting unit is configured to match measuring points with control points combined with the block file of the erection block, and combine measuring points with the block file so as to be stored in the block file storage unit.

7. The system according to claim 3 or 6, wherein the erection dimensional accuracy forecasting unit is configured to compare measuring points combined with the block file of the erection block with those combined with the block file of the basic block so as to display a deviation corresponding to the comparison result in the user interface.

8. The system according to claim 7, wherein the measuring points have three-dimensional coordinate values, and the deviation is represented by a three-dimensional vector.

9. The system according to claim 8, wherein when the erection block is moved or rotated, the erection dimensional accuracy forecasting unit moves three-dimensional coordinate values of the measuring points depending on movement or rotation states of the erection block so as to re-calculate a deviation on the measuring points of the erection block and the basic block.
10. The system according to claim 8, wherein the three-dimensional vector is represented by a different symbol depending on the degree so that an overlap or gap state is distinguished between the two measuring points.

11. The system according to claim 1, wherein the erection block is one or more.

12. A method for forecasting an erection dimensional accuracy of a ship block configured to measure, compare and analyze erection accuracy of a basic block and an erection block in order to combine the erection block with the basic block of a ship, the method comprising:

   (a) matching measuring coordinates of measuring points of the basic block with design coordinates of control points of the basic block to combine the measuring points with the basic block in order to calculate the erection dimensional accuracy of the erection block;

   (b) matching measuring coordinates of measuring points of the erection block with design coordinates of control points of the erection block to combine the measuring points with the erection block in order to calculate the erection dimensional accuracy of the basic block;

   (c) connecting the erection block with the basic block to compare the measuring points of the erection block with those of the basic block; and

   (d) analyzing a deviation of each measuring point based on the comparison result of each measuring point to calculate a deviation value of each measuring point of the basic block for each measuring
point of the erection block.

13. The method according to claim 12, wherein in the step (d),

the deviation analysis result for each measuring point is
represented by a three-dimensional vector, and

a gap or an overlap is formed in each measuring point of the
erection block.

14. The method according to claim 13, wherein the erection
block and the basic block are represented by a three-dimensional
graphic, and

the design coordinates of the basic point and the measuring
coordinates of the measuring point are three-dimensional coordinate
values.

15. The method according to claim 14, after the step (c),
further comprising moving three-dimensional coordinate values of
measuring points of the erection block depending on movement or
rotation states of the erection block when the erection block is moved
or rotated so as to re-calculate a deviation of measuring points of the
basic block and moved measuring points of the erection block.

16. The method according to claim 15, wherein the
movement of the erection block is performed by a one-point or two-
point movement method, and the rotation of the erection block is
performed by one selected from one-point-axis-rotation (displacement),
two-point-axis-rotation (displacement), 1-point-axis-rotation (angle)
and two-point-axis-rotation (angle).
17. The method according to claim 12, wherein in the step (b),
the connection between the measuring points of the basic block
and the measuring points of the erection block is performed by one
selected from a point-name based connection method, a point-location
based connection method or a manual connection method.

18. The method according to claim 12, further comprising
producing a completion check sheet that includes a deviation value of
the basic block on each measuring point of the erection block.

19. The method according to claim 12, before the step (a),
when control points are selected in the basic block that has three-
dimensional coordinate values, further comprising combining and
storing the control points with the basic block, and producing a check
sheet in which coordinate values of each control point of the basic
block are displayed.

20. The method according to claim 11, wherein when the
measuring point of the basic block does not match the measuring point
of the erection block, the step (c) includes generating a straight line
with the two measuring points of the erection block and XY, YZ and ZX
planes that intersect one measuring point of the basic block adjacent
to the erection block, and performing an intersection calculation with
the straight line to produce a pseudo-measuring point on the erection
block and match the pseudo-measuring point of the erection block with
the measuring point of the basic block, or
generating a straight line with the three or more measuring
points of the erection block and XY, YZ and ZX planes that intersect one measuring point of the basic block adjacent to the erection block, and performing an intersection calculation with the straight line to produce a pseudo-measuring point on the erection block and match the pseudo-measuring point of the erection block with the measuring point of the basic block.

21. A record media that can be read by a computer that includes a an erection dimensional accuracy forecasting program of a ship block configured to measure, compare and analyze erection accuracy of a basic block and an erection block in order to combine the erection block with the basic block of a ship, the method comprising:

(a) matching measuring coordinates of measuring points of the basic block with design coordinates of control points of the basic block to combine the measuring points with the basic block in order to calculate the erection dimensional accuracy of the erection dimensional accuracy;

(b) matching measuring coordinates of measuring points of the erection block with design coordinates of control points of the erection block to combine the measuring points with the erection block in order to calculate the erection dimensional accuracy of the basic block;

(c) connecting the erection block with the basic block to compare the measuring points of the erection block with those of the basic block;

(d) analyzing a deviation of each measuring point based on the comparison result of each measuring point to calculate a deviation
value of each measuring point of the basic block for each measuring point of the erection block; and

(e) generating a completion check sheet that includes a deviation value of the basic block in each measuring point of the erection block.

22. The record media according to claim 21, wherein before the step (a), when control points are selected in the basic block that has three-dimensional coordinate values, the program further comprises combining and storing the control points with the basic block, and producing a check sheet in which coordinate values of each control point of the basic block are displayed.

23. The record media according to claim 21, wherein the erection block and the basic block are represented by a three-dimensional graphic, and

the design coordinates of the basic point and the measuring coordinates of the measuring point are three-dimensional coordinate values.

24. The record media according to claim 23, wherein the deviation analysis result for each measuring point is represented by a three-dimensional vector, and

a gap or an overlap is formed in each measuring point of the erection block.

25. The record media according to claim 21, wherein after the step (c), the program further comprises moving three-dimensional coordinate values of measuring points of the erection block depending
on movement or rotation states of the erection block when the erection block is moved or rotated so as to re-calculate a deviation on measuring points of the basic block with moved measuring points of the erection block.

26. The record media according to claim 25, wherein the movement of the erection block is performed by a one-point or two-point movement method, and the rotation of the erection block is performed by one selected from one-point-axis-rotation (displacement), two-point-axis-rotation (displacement), 1-point-axis-rotation (angle) and two-point-axis-rotation (angle).

27. The record media according to claim 21, wherein when the measuring point of the basic block does not match the measuring point of the erection block, the step (c) includes generating a straight line with the two measuring points of the erection block and XY, YZ and ZX planes that intersect one measuring point of the basic block adjacent to the erection block, and performing an intersection calculation with the straight line to produce a pseudo-measuring point on the erection block and match the pseudo-measuring point of the erection block with the measuring point of the basic block, or generating a straight line with the three or more measuring points of the erection block and XY, YZ and ZX planes that intersect one measuring point of the basic block adjacent to the erection block, and performing an intersection calculation with the straight line to produce a pseudo-measuring point on the erection block and match the pseudo-measuring point of the erection block with the measuring point of the basic block.
point of the basic block.
[Fig. 3]
START

S42 SELECTING BLOCK?

No

Yes

LOADING DESIGN FILE OF SELECTED BLOCK TO OUTPUT BLOCK ON SCREEN

S44

S46 SELECTING CONTROL POINT GENERATION?

No

Yes

DISPLAYING CONTROL POINT ON BLOCK

S48

S50 SELECTING CHECK SHEET?

No

Yes

STORING BLOCK FILE OF DESIGN MODULE

S52

PREPARING CHECK SHEET HAVING CONTROL POINT ON DESIGN MODULE

S54

END
[Fig. 5]

START

S60 SELECTION BASIC BLOCK? No

READING SELECTED BLOCK FILE TO OUTPUT BLOCK MODULE S62

S64 SELECTING MEASURING FILE? No

OUTPUTTING BLOCK MEASURING POINT AND MODULE COMBINED WITH CONTROL POINT S66

CONNECTING MEASURING POINT WITH CONTROL POINT S68

COMBINING MEASURING POINT IN BLOCK MODULE TO GENERATE BLOCK FILE S70

SELECTING ERECTION BLOCK? S72

COMMANDING BLOCK CONNECTION? No

PERFORMING ERECTION ANALYSIS USING COORDINATES OF SPECIFIC POINT S76

COMMANDING MOVEMENT/ROTATION? Yes MOVING BLOCK USING DEVIATION VECTOR S80

No

COMMANDING COMPLETION CHECK SHEET PREPARATION? S82

OUTPUTTING COMPLETION CHECK SHEET INCLUDING DEVIATION ANALYSIS DATA S84

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<th>DESIGN ELEMENT</th>
<th>DISTANCE (X, Y, Z)</th>
<th>MEASURING VALUE</th>
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[Fig. 6]
### Fig. 9

**File Control Block Connection Analysis Condition Drawing Screen Adjustment View Program Information**

#### Block Erection Error

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<th>Standard Coordinate</th>
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**List Filter**
### Table: Inspection Sheet

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#### Table: Check Sheet Reception

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[Fig. 17]