

DESCRIPTION

METHOD FOR PLANNING STOWAGE OF SHIP, STOWAGE PLANNING
SYSTEM, AND SHIP

Technical Field

[0001]

The present invention relates to a method for planning stowage of cargo in a ship, a system capable of carrying out the method, and a ship to which the system is applied.

Background Art

[0002]

Generally, a ship for carrying cargos such as a container ship is designed to be capable of securing strength enough to withstand long-term operation while carrying as many cargos as possible. Specifically, for example, it is assumed that a ship will have been operated for 25 years under the North Atlantic wave environment, and the maximum load moment (design wave moment M_w (d)) that may occur in the hull due to the wave conditions during that period is estimated. The maximum loading capacity of cargos is determined according to the difference in the design allowable load moment of the ship. In other words, the design tolerance (represented by M_a) of the load moment of the ship is expressed by the

following expression (1). Here, $M_s(d)$ represents a load moment (defined as a design still water moment) which occurs due to the dead weight of the ship, the weight of cargos, and the buoyancy in still water when cargos of an assumed maximum loading capacity are loaded.

$$M_a = M_w(d) + M_s(d) \dots\dots (1)$$

[0003]

In addition, under the operation of a ship, it is required that the sum of the real load moment caused by wave conditions in navigation and the real load moment caused by the dead weight of the ship, the weight of cargos and buoyancy does not exceed the tolerance of the hull. At that time, the load moment (defined as the real wave moment $M_w(r)$) which occurs due to the wave condition is conveniently estimated as $M_w(d)$, and then the amount of the cargos is determined. In other words, the amount of cargo to load in the ship is determined in a range satisfying the following expression (2) so that the total value of the load moment occurring in still water when the cargos are loaded (defined as the real still water moment $M_s(r)$) and the design wave moment $M_w(d)$ does not exceed the design tolerance M_a of the ship.

$$M_s(r) \leq M_a - M_w(d) \dots\dots (2)$$

[0004]

For example, techniques described in the following Patent Literatures 1 and 2 have been proposed as a technique for satisfying these conditions and supporting

the safe operation of ships. These are techniques to be implemented from the viewpoint of ensuring safety in the operation of ships, and it can be said that Patent Literature 1 describes a technique for performing stowage of cargo while satisfying the above expression (2), and Patent Literature 2 describes a technique for performing marine navigation so that the real wave moment $M_w(r)$ does not actually exceed $M_w(d)$.

Citation List

Patent Literature

[0005]

Patent Literature 1: WO2006/003708A1

Patent Literature 2: JP 2019-12029A

Summary of Invention

Technical Problem

[0006]

Of course, ensuring the safety is the most important matter for ships carrying cargos, but it is also likewise important to increase the load capacity of cargos as much as possible. However, with respect to conventional ships, the increase of the load capacity is mainly considered at the time of design as well as ensuring the safety, but only the safety is almost focused in the operation phase. Therefore, under the actual circumstances, the navigation is carried out while a margin is left for the load

capacity. In other words, even when it is sufficiently possible to load more cargos with ensuring safety in view of design, the amount of cargo that can be loaded is underestimated because the importance is focused too much on safety, which has caused an obstacle to enhancement of transportation efficiency.

[0007]

In the present disclosure, in view of such circumstances, a ship stowage planning method, a stowage planning system, and a ship that are capable of easily enhancing the transportation efficiency of cargos while ensuring safety will be described.

Solution to Problem

[0008]

The present disclosure relates to a ship stowage planning method that estimates a real wave moment to occur in a ship due to sea state on a voyage route based on sea state predicted on the voyage route, and plans stowage of cargo based on an estimated value of the real wave moment.

[0009]

In the ship stowage planning method of the present disclosure, the difference between the estimated value of the real wave moment and a design wave moment is calculated as a stowage margin, and it can be determined

based on the stowage margin whether the stowage of cargo is changed or not.

[0010]

In the ship stowage planning method of the present disclosure, the amount of cargo to load can be increased within a range of the stowage margin.

[0011]

In the ship stowage planning method of the present disclosure, an amount of ballast water filled can be reduced within the range of the stowage margin.

[0012]

The ship stowage planning method of the present disclosure can be applied to container ships.

[0013]

Further, the present disclosure relates to a ship stowage planning system configured to be capable of executing the above-mentioned ship stowage planning method.

[0014]

Further, the present disclosure relates to a ship to which the above-mentioned ship stowage planning system is applied.

Effect of Invention

[0015]

According to the ship stowage planning method, the stowage planning system, and the ship of the present

disclosure, it is possible to achieve an excellent effect that the transportation efficiency of cargos can be easily improved while ensuring safety.

Brief Description of Drawings

[0016]

FIG. 1 is a block diagram showing an example of a configuration of a ship stowage planning system according to an embodiment of the present invention;

FIG. 2 is a graph showing an example of a distribution of a moment in a ship; and

FIG. 3 is a flowchart showing an example of a procedure of a ship stowage planning method according to an embodiment of the present invention.

Description of Embodiment

[0017]

An embodiment of the present invention will be described below with reference to the accompanying drawings.

[0018]

FIG. 1 shows a configuration of a ship stowage planning system according to an example of the present disclosure. In the case of the present example, a system is configured in the form of straddling across a ship S and a land L, and transmits a stowage plan formed on the land L side to the ship S side while performing stowage

of cargo based on this stowage plan in the ship S side and transmitting a stowage result to the land L side as needed.

[0019]

The land L side is provided with a voyage route selection unit 1, a wave data storage unit 2, a stowage planning unit 3, a stowage data storage unit 4, a wave moment calculation unit 5, a still water moment calculation unit 6, a stowage margin determination unit 7, a display unit 8, an operation input unit 9, and a communication unit 10. The ship S side is provided with a data storage unit 11, a display unit 12, an operation input unit 13, and a communication unit 14.

[0020]

The voyage route selection unit 1 has a function of assisting the selection of a voyage route of the ship S. The voyage route selection unit 1 is connected to an information service such as Sea-Navi (R), and based on conditions such as a departure point, a destination, a transit point, a water area, and the date and time, the voyage route selection unit 1 can extract candidates of the voyage route meeting the respective conditions, and present the candidates. The voyage route selection unit 1 may be configured to extract an appropriate voyage route from a library stored therein instead of using an external service such as Sea-Navi.

[0021]

The wave data storage unit 2 has a function of storing wave data related to various voyage routes, and can acquire wave data relating to a voyage route presented by the voyage route selection unit 1 as needed. The wave data stored in the wave data storage unit 2 may include forecast data acquired from an external organization such as the Meteorological Agency, may include past wave data, or may include both the data.

[0022]

The stowage planning unit 3 has a function of forming a stowage plan for cargos in the ship S, and can calculate the total weight of cargos to load in scheduled navigation, the amount of stowage of cargo in each internal compartment of the ship, and the like for the ship S based on each of conditions such as the type of the ship S, the maximum loading capacity of the ship S, the design strength, and the types and amounts of cargos.

[0023]

The stowage data storage unit 4 has a function of storing data relating to the stowage plan for the cargos in the ship S (hereinafter, referred to as stowage data) formed by the stowage planning unit 3. The stowage data includes, for example, the total weight of the cargos in the planned navigation, the stowage amount in each internal compartment of the ship, the types of cargos to be loaded, the distribution of the dead weight in the

ship S, the amount of ballast water filled in each ballast tank equipped in the ship S, etc.

[0024]

The wave moment calculation unit 5 has a function of referring to the wave data stored in the wave data storage unit 2 and calculating sea state predicted to be encountered on the voyage route (encounter sea state) which are presented by the voyage route selection unit 1. Further, the wave moment calculation unit 5 has a function of calculating an estimated value of a wave moment (real wave moment $M_w(r)$) to occur in the ship S on the corresponding voyage route based on the calculated encounter sea state and information on the ship S itself (dead weight, ship speed, outer plate shape, etc.).

[0025]

The still water moment calculation unit 6 has a function of calculating the dead weight of the ship S in still water, the weight of the cargos and the ballast water, and a real still water moment $M_s(r)$ occurring in the ship S due to buoyancy based on the stowage data stored in the stowage data storage unit 4.

[0026]

The stowage margin determination unit 7 has a function of calculating a margin for stowage of cargo that can be additionally performed (referred to as a stowage margin ΔM) based on the estimated value of the real wave moment $M_w(r)$ calculated by the wave moment

calculation unit 5 and the real still water moment $M_s(r)$ calculated by the still water moment calculation unit 6. The estimation of the real wave moment $M_w(r)$, the calculation of the real still water moment $M_s(r)$, and the calculation of the stowage margin ΔM will be described later.

[0027]

The display unit 8 is a display for displaying, as needed, information on a voyage route presented by the voyage route selection unit 1, the wave data stored in the wave data storage unit 2, the stowage data which is created by the stowage planning unit 3 and stored in the stowage data storage unit 4, information such as calculation results, etc. of wave moment calculation unit 5, the still water moment calculation unit 6, and the stowage margin determination unit 7, an interface screen for inputting an operation to each unit, and other information.

[0028]

The operation input unit 9 is an interface for inputting an operation to each of the above-mentioned units, and includes, for example, a keyboard, a mouse, a touch panel type display, or the like. When the operation input unit 9 is a touch panel type display, the operation input unit 9 can also serve as some or all of the functions of the display unit 8.

[0029]

The communication unit 10 has a function of communicating with the outside of the system, and can communicate various information (for example, voyage route data, wave data, stowage data, etc.).

[0030]

The data storage unit 11 on the ship S side has a function of storing various data necessary for the operation of the ship S. The various data necessary for the operation of the ship S include, for example, the voyage route information presented by the voyage route selection unit 1 on the land L side, the wave data stored in the wave data storage unit 2, the stowage data which is created by the stowage planning unit 3 and stored in the stowage data storage unit 4, information such as calculation results, etc. of the wave moment calculation unit 5, the still water moment calculation unit 6, and the stowage margin determination unit 7, etc.

[0031]

The display unit 12 is a display for displaying, as needed, various data stored in the data storage unit 11, an interface screen for inputting an operation to each unit constituting the system, and other information.

[0032]

The operation input unit 13 is an interface for inputting an operation to each of the above-mentioned units, and includes, for example, a keyboard, a mouse, a touch panel type display, or the like. When the

operation input unit 9 is a touch panel type display, the operation input unit 13 can also serve as some or all of the functions of the display unit 12.

[0033]

The communication unit 14 has a function of communicating with the outside of the system, and can communicate various information (for example, voyage route data, wave data, stowage data, etc.) with the communication unit 10, etc. on the land L side.

[0034]

The case where the system is configured to straddle the ship S side and the land L side has been illustrated above. However, the system configuration is not limited to the example described above when the ship stowage planning system of the present invention is implemented. For example, in recent years when information processing and communication technology has been developed, most of the system can be constructed on the ship S, or each of the land L side and the ship S side can be provided with the same function regarding the stowage planning. In addition, the ship stowage planning system may have an appropriate configuration as long as it can implement the functions described below.

[0035]

The method for planning stowage of cargo by using the above system will be described. A subject matter of the present invention is to estimate the wave moment

(real wave moment $M_w(r)$) occurring during the navigation of the ship S and plan the stowage of cargo based on this estimation. In other words, in the conventional case, the stowage of cargo is performed with the difference between the design tolerance M_a and the design wave moment $M_w(d)$ set as the maximum loading capacity (see the above expression (2)). However, by using the estimated value of the real wave moment $M_w(r)$ instead of the design wave moment $M_w(d)$, the design strength of the ship has a margin by the amount corresponding to the difference (stowage margin ΔM) between the design wave moment $M_w(d)$ and the real wave moment $M_w(r)$, and this amount will be used for the stowage planning.

[0036]

As described above, the design wave moment $M_w(d)$ is set as a maximum wave moment which is expected to occur in the ship S , for example, during a long-term operation period of the ship S . This value is a maximum value of the wave moment peculiar to each ship S , and the wave moment (real wave moment $M_w(r)$) which actually occurs in the ship S in many actual navigations varies from navigation to navigation in a range which is equal to or less than the design wave moment $M_w(d)$. In other words, there is no safety problem even if the difference (stowage margin ΔM) is actively used in stowage planning, for example, a large amount of cargo is loaded by the amount corresponding to the stowage margin ΔM , and it is

possible to enhance the transportation efficiency of cargos while maintaining safety.

[0037]

For example, it is assumed that the total value of the design wave moment $M_w(d)$ and the design still water moment $M_s(d)$ is distributed in the ship S as indicated by a broken line in FIG. 2. Here, when the stowage of cargo is performed until the design still water moment $M_s(d)$ becomes maximum (so as to satisfy $M_s(r)=M_s(d)$) according to the conventional method, the total value of the real wave moment $M_w(r)$ and the real still water moment $M_s(r)$ is distributed to be lower than the total value of the design wave moment $M_w(d)$ and the design still water moment $M_s(d)$ as indicated by one-dotted line. In the present example, the difference between both the moments (the value corresponding to $M_w(d)-M_w(r)$) is calculated as the stowage margin ΔM and practically used.

[0038]

However, in order to implement this, it is necessary to estimate the real wave moment $M_w(r)$ and calculate the real still water moment $M_s(r)$ with sufficient accuracy. Therefore, this procedure will be described with reference to the flowchart of FIG. 3.

[0039]

In order to estimate the real wave moment $M_w(r)$, it is necessary to select a voyage route and predict sea state encountered on the voyage route as a premise.

Therefore, candidates of the voyage route are first extracted (step S1). The candidates of the voyage route are extracted by using the function of the voyage route selection unit 1, for example, by using an external service such as Sea-Navi, or from information on the voyage route stored in the voyage route selection unit 1. If conditions such as a departure point, a destination, a transit point and a water area are input, a voyage route meeting the respective conditions is extracted, and presented as a candidate.

[0040]

Subsequently, predicted sea state are acquired for the voyage route presented as the candidate (step S2). The function of the wave data storage unit 2 is used to refer to wave data in the same water area and the same season in the past. Alternatively, forecast data provided by the Meteorological Agency or the like is referred to.

[0041]

The wave data acquired in step S2 includes the maximum wave height to be encountered by the ship S in the corresponding voyage route. The wave height most directly affects the comfort of navigation, the load occurring on the ship S, and the like. Therefore, in step S3, a threshold value for the wave height (navigation avoidance limit) is set, and a voyage route which is estimated to have a wave height exceeding the

navigation avoidance limit is excluded from the candidates. Then, a voyage route along which navigation is actually performed is selected from the remaining candidates, and determined (step S4).

[0042]

Further, the stowage planning unit 3 executes stowage planning for the ship S (step S5). The total load capacity of cargos, the load capacity of cargos in each compartment of the ship S, and the amount of ballast water filled in each ballast tank are determined, and stored as stowage data in the stowage data storage unit 4.

[0043]

The wave moment calculation unit 5 calculates an estimated value of the real wave moment $M_w(r)$ based on the sea state predicted to be encountered in the selected voyage route (step S6).

[0044]

A case where a strip method is used as a method of calculating the estimated value of the real wave moment $M_w(r)$ will be described. The load occurring in the ship S can be evaluated by a vertical bending moment, and the vertical bending moment generated by waves can be expressed by the following expression (3). Here, H_s represents a wave height, χ represents a wave direction, and T_s represents a wave period.

$$M_w/H_s = R(\chi, T_s) \dots\dots (3)$$

[0045]

A sea state (H_s , T_s) is included in the wave data acquired in step S2. Therefore, these values (values estimated based on past data and forecasts) are substituted into the above expression (3) to calculate the value of M_w . Since the draft also affects the value of M_w and the draft fluctuates depending on the stowage of cargo, the stowage data is also referred to for the calculation of M_w . The maximum value of M_w thus obtained is used as the estimated value of the real wave moment $M_w(r)$ to be encountered during navigation. Of course, in addition to the strip method, various methods may be used for calculating the estimated value of the real wave moment $M_w(r)$.

[0046]

On the other hand, the real still water moment $M_s(r)$ is determined by the stowage of cargo regardless of the voyage route and the sea state. The still water moment calculation unit 6 refers to the stowage data of the stowage data storage unit 4 to calculate the real still water moment $M_s(r)$ (step S7).

[0047]

The stowage margin determination unit 7 calculates the difference between the real wave moment $M_w(r)$ calculated in step S6 and the design wave moment $M_w(d)$ as the stowage margin ΔM (step S8). The stowage margin ΔM corresponds to an amount that may be further increased in stowage of cargo for the ship S in consideration of the

design tolerance M_a of the load moment in the ship S and the condition of the voyage route. According to the magnitude of the obtained stowage margin ΔM , the amount of cargo which is desired to be loaded, and the like, it is determined whether the stowage of cargo is changed or not (step S9). When the stowage of cargo is not changed, the stowage of cargo is terminated. However, when the stowage of cargo is changed, the processing proceeds to step S10 to change the stowage plan in the stowage planning unit 3, and store new stowage data in the stowage data storage unit 4.

[0048]

When the stowage of cargo is changed, the real still water moment $M_s(r)$ occurring in the ship S changes. Further, as a result of the change of the draft of the ship S , the real wave moment $M_w(r)$ may also change. Therefore, after the stowage plan is changed, the estimated value of the real wave moment $M_w(r)$ and the real still water moment $M_s(r)$ are calculated again (steps S6 and S7) to calculate the stowage margin ΔM (step S8), and the stowage plan is changed according to the value of the stowage margin ΔM (steps S9 and S10). In this way, it is possible to easily perform change of the stowage plan such as increase in amount of cargo to load, based on the value of the stowage margin ΔM . Further, by repeating this operation, the stowage plan is optimized so that the real still water moment $M_s(r)$ is maximized

within a range satisfying the design tolerance M_a of the ship S.

[0049]

Voyage route information and necessary information such as wave data and stowage data are stored in the data storage unit 11 of the ship S. The stowage data changed based on the stowage margin ΔM is also transmitted to the ship S side via the communication units 10 and 14, and stored in the data storage unit 11. Stowage of cargo is performed according to the new stowage data on the ship S side.

[0050]

Such a method can be carried out in various ships S in the form of simply increasing the amount of cargo to load within the range of the calculated stowage margin ΔM (increasing the real still water moment $M_s(r)$ by the weight of the cargo). However, an operation based on a slightly different method is effective especially when targeting container ships.

[0051]

Generally, in the case of ships, ballast water may be poured into the hull for the purpose of maintaining draft or correcting the load moment occurring in the hull, but especially in container ships, a large amount of ballast water is frequently poured into the hull because the specific weight of the cargo is light. Therefore, when the ship S is a container ship and a large amount of

ballast water is poured in a first stowage plan, the foregoing stowage planning method can be applied, for example, by the following procedure.

[0052]

First, the procedure of steps S1 to S8 shown in FIG. 3 is executed, and the amount of cargo to load is increased within the range of the calculated stowage margin ΔM (steps S9 and S10). At this time, with respect to a compartment in which the amount of cargo to load is increased, the ballast water whose amount is equal to the increased amount of cargo is discharged. This causes the value of the real still water moment $M_s(r)$ to be hardly changed from that before the change of the stowage plan, and causes the stowage margin ΔM to remain, so that it is possible to further change the stowage plan and increase the amount of cargo to load.

[0053]

If it is assumed that the value of the real still water moment $M_s(r)$ does not change when the ballast water whose amount corresponds to the increased amount of cargo to load is reduced, it is theoretically possible to increase the amount of cargo to load without considering the stowage margin ΔM as in the present example. However, when the stowage of cargo is actually performed, the position of the ballast tank in the hull is different from the position where cargos are placed, so that even if the ballast water in a ballast tank located as close

as possible to a compartment where the amount of cargo to load is increased is reduced, the value of the real still water moment $M_s(r)$ changes to some extent. For this reason, when an attempt is made to increase the amount of cargo to load without keeping the calculated stowage margin ΔM in mind, there is no standard for determining an allowable increase in the amount of cargo to load, so that even if the ballast water is reduced, the possibility that the load capacity exceeds the tolerance as a result cannot be ruled out. If the stowage margin ΔM is used as in the present example, it is possible to safely increase the amount of cargo to load within a range that does not hinder.

[0054]

The stowage margin ΔM can be utilized in the form of using the stowage margin ΔM to reduce ballast water. In a container ship, ballast water may be poured for the purpose of correcting the load moment occurring in the hull as described above, and in this case, the load of the ballast water acts in the direction of reducing the real still water moment $M_s(r)$. In other words, if the amount of the ballast water filled is reduced, the real still water moment $M_s(r)$ is increased, but the stowage margin ΔM calculated by the foregoing method is used for the increase of the real still water moment $M_s(r)$ to be caused by the reduction of the ballast water. In other

words, the ballast water in the ship S may be discharged within the range of the stowage margin ΔM .

[0055]

Although the ballast water remains in the tank, such an operation is effective to such a case that it is impossible to load more containers due to restriction on cargo space or the like, or such a case that there is simply no more cargo to load. This operation makes it possible to navigate a ship S which is a container ship in a state where the amount of ballast water is small, and it is possible to perform navigation having excellent fuel consumption with the reduced weight of the entire ship S. Of course, the above-mentioned "reduction of ballast water by the increased amount of cargo to load" and "reduction of ballast water within the range of the stowage margin ΔM " may be used in combination as appropriate. Alternatively, it goes without saying that only the amount of cargo to load is merely increased within the range of the stowage margin ΔM without reducing the ballast water.

[0056]

In implementing the method and systems described above, there is no need to modify the hull or other structures, for example in order to ensure safety or increase the load capacity, and it is possible to easily apply them to existing ships and enhance the transportation efficiency of cargos.

[0057]

As described above, in the ship stowage planning method of the present example, the real wave moment $M_w(r)$ occurring in the ship S due to sea state on a voyage route is estimated based on sea state predicted on the voyage route, and stowage planning is performed based on the estimated value of the real wave moment $M_w(r)$. In this way, instead of the design wave moment $M_w(d)$ peculiar to each ship P , the real wave moment $M_w(r)$ whose value is equal to or less than the design wave moment $M_w(d)$ is used to perform stowage planning, whereby the transportation efficiency of cargos can be enhanced with maintaining safety.

[0058]

In the ship stowage planning method of the present example, the difference between the estimated value of the real wave moment $M_w(r)$ and the design wave moment $M_w(d)$ is calculated as the stowage margin ΔM , and it is determined based on the stowage margin ΔM whether the stowage of cargo is changed or not. In this way, the stowage plan can be easily changed based on the stowage margin ΔM .

[0059]

In the ship stowage planning method of the present example, it is possible to increase the amount of cargo to load within the range of the stowage margin ΔM , and in

this way, it is possible to easily increase the amount of cargo based on the stowage margin ΔM .

[0060]

In the ship stowage planning method of the present example, the amount of ballast water filled can be reduced within the range of the stowage margin ΔM , and in this way, a ship S which is a container ship can be navigated with a small amount of ballast water, and it is possible to perform navigation with excellent fuel consumption while the weight of the entire ship S is reduced.

[0061]

The ship stowage planning method of the present example can be applied to container ships, and in this way, the same action and effect as described above can be obtained for the container ships.

[0062]

Since the ship stowage planning system of the present example is configured to be capable of executing the above-mentioned ship stowage planning method, the same action and effect as described above can be obtained.

[0063]

Since the ship of the present example is applied with the above-mentioned ship stowage planning system, the same action and effect as described above can be obtained.

[0064]

Therefore, according to the above example, it is possible to easily enhance the transportation efficiency of cargos while ensuring safety.

[0065]

It should be noted that the ship stowage planning method, the stowage planning system and the ship described in the present disclosure are not limited to the above-described example, and it goes without saying that various changes can be made without departing from the scope of the present invention.

Reference Signs List

[0066]

- 1 Voyage route selection unit
- 2 Wave data storage unit
- 3 Stowage planning unit
- 4 Stowage data storage unit
- 5 Wave moment calculation unit
- 6 Still water moment calculation unit
- 7 Stowage margin determination unit
- 8 Display unit
- 9 Operation input unit
- 10 Communication unit
- 11 Data storage unit
- 12 Display unit
- 13 Operation input unit
- 14 Communication unit

L land

S Ship

Mw(d) Design wave moment

Mw(r) Real wave moment

ΔM Stowage margin

CLAIMS

1. A ship stowage planning method comprising:
 estimating a real wave moment to occur in a ship
 due to sea state on a voyage route based on sea state
 predicted on the voyage route; and
 planning stowage of cargo based on an estimated
 value of the real wave moment.
2. The ship stowage planning method according to claim
1, wherein a difference between an estimated value of the
real wave moment and a design wave moment is calculated
as a stowage margin, and it is determined based on the
stowage margin whether the stowage of cargo is changed or
not.
3. The ship stowage planning method according to claim
2, wherein an amount of cargo to load is increased within
a range of the stowage margin.
4. The ship stowage planning method according to claim
2, wherein an amount of ballast water filled is reduced
within a range of the stowage margin.
5. The ship stowage planning method according to claim
3, wherein an amount of ballast water filled is reduced
within a range of the stowage margin.

6. The ship stowage planning method according to claim 1, wherein the ship stowage planning method is applied to a container ship.

7. A ship stowage planning system configured to be capable of executing the ship stowage planning method according to claim 1.

8. A ship to which the ship stowage planning system according to claim 7 is applied.