

LAND RECLAMATION MANAGEMENT METHOD AND LAND RECLAMATION MANAGEMENT SYSTEM

Technical Field

[0001] The present invention relates to a land reclamation management method and a land reclamation management system.

Background Art

[0002] A construction management system disclosed in Patent Document 1 is an example of an invention to manage dumping of soil in a land reclamation step. In this system, a planned reclamation water area is divided in the form of a mesh, and data on the terrain of the bottom of the water area is created for the divided elements. Also, in this system, predetermined boring positions are associated with corresponding divided elements, data on the ground at the boring positions is created, and estimated ground data for the divided elements in which boring is not performed is created. Before the soil is dumped, the settlement amount corresponding to the amount of soil to be dumped is predicted based on the estimated ground data. During dumping of the soil, the water depth or embankment height is monitored using a narrow multi-beam sounding sonar and a GPS surveying apparatus, and the amount of soil to be dumped, the dumping time, and the dumping frequency are determined using the predicted settlement amount, such that the water depth or the embankment height is as designed.

Related Art Documents

Patent Document

[0003] Patent Document 1: JP 2002-348837A

Summary of Invention

Technical Problem

[0004] If the land reclamation material to be dumped is clay soil, consolidation will occur and the dumped land reclamation material will settle over time along with the original ground. For this reason, if the amount of the land reclamation material to be dumped is determined based on only the estimated value of the settlement amount of the original ground, a difference will occur between the finished shape (accumulation height) and the designed height. In the invention described in Patent Document 1, the settlement amount of the land reclamation material to be dumped is not considered.

[0005] In view of the foregoing background, the present invention provides a means according to which the settlement amounts of original ground and a land reclamation material to be dumped can be estimated respectively.

Solution to Problem

[0006] In order to solve the above-described problem, the present invention provides, as a first aspect, a land reclamation management method including: measuring a physical property of original ground in a land reclamation region prior to land reclamation; specifying a consolidation property corresponding to the measured physical property of the original ground; measuring a three-dimensional shape of the surface of the original ground in the land reclamation region prior to land reclamation; measuring a physical property of a land reclamation material for each dumping of the land reclamation material into the land reclamation region; estimating an accumulation state and shape of the land reclamation material in the land reclamation region, based on the three-dimensional shape of the surface of the original ground, the physical property of the land reclamation material for each dumping of the land reclamation material into the land reclamation region, a dumping date and time of the land reclamation material for each dumping of the land reclamation material into the land reclamation region, a

dumping position of the land reclamation material for each dumping of the land reclamation material into the land reclamation region, and a dumping amount of the land reclamation material for each dumping of the land reclamation material into the land reclamation region; specifying a consolidation property corresponding to the measured physical property of the land reclamation material for each dumping of the land reclamation material into the land reclamation region; and estimating settlement amounts of the original ground and the land reclamation material accumulated on the original ground at a designated position in the land reclamation region at a designated future date and time, based on the three-dimensional shape of the surface of the original ground, the consolidation property of the original ground, the accumulation state and shape of the land reclamation material in the land reclamation region, and the consolidation property of the land reclamation material for each dumping of the land reclamation material into the land reclamation region.

[0007] According to the land reclamation management method of the first aspect, it is possible to estimate the settlement amounts of the original ground and the land reclamation material to be dumped.

[0008] In the land reclamation management method according to the first aspect, it is also possible to employ, as a second aspect, a configuration including determining a dumping position of the land reclamation material to be newly dumped into the land reclamation region, based on estimated settlement amounts of the original ground and the land reclamation material accumulated on the original ground at a designated position in the land reclamation region at a designated future date and time.

[0009] According to the land reclamation management method of the second aspect, the land reclamation material can be dumped properly estimating future settlement such that there is no insufficiency in the finished shape (accumulation height).

[0010] In the land reclamation management method according to the first or

second aspect, it is also possible to employ, as a third aspect, a configuration including performing measurement of the three-dimensional shape of the surface of the land reclamation material in the land reclamation region after dumping of the land reclamation material, and correcting the estimated accumulation shape of the land reclamation material using the measured three-dimensional shape of the surface of the land reclamation material.

[0011] According to the land reclamation management method of the third aspect, the accuracy of estimating the settlement amount can be improved.

[0012] In the land reclamation management method according to the first or second aspect, it is also possible to employ, as a fourth aspect, a configuration including: installing a settlement gauge at a known position in the land reclamation region; and verifying accuracy of the estimated settlement amount and correcting input parameters relating to the consolidation property, using a settlement amount measured by the settlement gauge.

[0013] According to the land reclamation management method of the fourth aspect, the accuracy of estimating the settlement amount can be improved.

[0014] In the land reclamation management method according to the first or second aspect, it is also possible to employ, as a fifth aspect, a configuration including: measuring, at a plurality of times, the three-dimensional shape of the surface of the land reclamation material in the land reclamation region after dumping of the land reclamation material; and verifying accuracy of the estimated settlement amount and correcting input parameters relating to the consolidation property, using the measured three-dimensional shape of the surface of the land reclamation material.

[0015] According to the land reclamation management method of the fifth aspect, the accuracy of estimating the settlement amount can be improved.

[0016] Also, the present invention provides, as a sixth aspect, a land reclamation management system including: an acquisition means for acquiring original ground physical property data indicating a measurement value of a physical property of original ground in a land reclamation region

prior to dumping of a land reclamation material, original ground shape data indicating a measurement value of a three-dimensional shape of the surface of the original ground in the land reclamation region prior to dumping of the land reclamation material, land reclamation material physical property data indicating a measurement value of a physical property of the land reclamation material for each dumping of the land reclamation material into the land reclamation region, and land reclamation material dumping data indicating a dumping date and time, and dumping position, and a dumping amount of the land reclamation material for each dumping of the land reclamation material into the land reclamation region; a shape estimation means for estimating an accumulation state and shape of the land reclamation material in the land reclamation region, based on the three-dimensional shape of the surface of the original ground indicated by the original ground shape data, the physical property of the land reclamation material for each dumping indicated by the land reclamation material physical property data, and the dumping date and time, the dumping position, and the dumping amount of the land reclamation material for each dumping indicated by the land reclamation material dumping data; a consolidation property specifying means for specifying a consolidation property of the original ground based on the physical property indicated by the original ground physical property data, and specifying the consolidation property of the land reclamation material for each dumping based on the physical property indicated by the land reclamation material physical property data; and a settlement amount estimation means for estimating settlement amounts of the original ground and the land reclamation material accumulated on the original ground at a designated position in the land reclamation region at a designated future date and time, based on the three-dimensional shape of the surface of the original ground indicated by the original ground shape data, the accumulation state and shape of the land reclamation material estimated by the shape estimation means, and the

consolidation properties of the original ground and the land reclamation material for each dumping, specified by the consolidation property specifying means.

[0017] According to the land reclamation management system of the sixth aspect, it is possible to estimate the settlement amount of the land reclamation material to be dumped.

Brief Description of the Drawings

[0018] FIG. 1 is a drawing showing the entirety of a configuration of land reclamation management system 1.

FIG. 2 is a diagram showing an example of a result of estimating a settlement amount obtained using a land reclamation material model.

FIG. 3 is a diagram showing a hardware configuration of terminal apparatus 100.

FIG. 4 is a flowchart showing a flow of estimation of a settlement amount of land reclamation material 2.

FIGS. 5(A) and 5(B) are diagrams showing an example of a display screen displaying an accumulation shape.

Detailed Description of the Invention

Embodiment

[0019] Land reclamation management system 1 according to an embodiment of the present invention will be described hereinafter. Land reclamation management system 1 is used for estimation of a settlement amount of a land reclamation material to be used for land reclamation, for example.

[0020] FIG. 1 is a drawing showing the entirety of a configuration of land reclamation management system 1. Land reclamation region A is a region in which land reclamation is to be performed using land reclamation material 2 in a submerged zone. Land reclamation region A is divided into

multiple regions, namely segments a_1 to a_n , and each segment is a $10\text{ m} \times 10\text{ m}$ region, for example. Note that the size of each segment is not limited to the above-described size and may also be another size. Land reclamation material 2, which is to be used to fill land reclamation region A, is, for example, sandy soil or clay soil. Land reclamation material 2 is conveyed by barge 10 and is dumped into land reclamation region A.

[0021] Barge 10 includes computer 20 and satellite positioning apparatus 40. Satellite positioning apparatus 40 measures its position (latitude and longitude) using a signal received from a navigation satellite of the GNSS (Global Navigation Satellite System). Computer 20 is a so-called personal computer, is connected to communication network 3, and performs data communication via communication network 3. Computer 20 (acquisition means) acquires the direction of barge 10 measured using an electronic compass, the position calculated by satellite positioning apparatus 40, physical property information (soil type, density, moisture content, compression index, coefficient of consolidation) of land reclamation material 2 measured on barge 10, and the like, and transmits the acquired information to database 110.

[0022] Surveying ship 11 includes computer 21, narrow multi-beam sounder 30, and satellite positioning apparatus 41. Narrow multi-beam sounder 30 is a measuring device that emits acoustic beams to the bottom of the water area and measures the three-dimensional shape of the bottom of the water area. Computer 21, which is installed on surveying ship 11, is connected to communication network 3 and performs data communication via communication network 3. Computer 21 (acquisition means) acquires the position calculated by satellite positioning apparatus 41 and the measurement result of narrow multi-beam sounder 30, and transmits the acquired information to database 110.

[0023] Database 110 is a database that stores information to be used for estimation of the settlement amounts of original ground G and land

reclamation material 2. As information for estimating the settlement amount of original ground G, database 110 stores information such as physical property information of original ground G (original ground physical property data) for segments a_1 to a_n , a settlement estimation model of original ground G (hereinafter, the settlement estimation model of original ground G will be referred to as “original ground model”) for segments a_1 to a_n , and the three-dimensional shape of the surface of original ground G (original ground shape data) for segments a_1 to a_n measured by narrow multi-beam sounder 30. The original ground model is an example of a consolidation settlement estimation procedure according to the present invention. The original ground model incorporating the consolidation property for estimating the settlement amount resulting from the consolidation of original ground G, and is used for estimation of the settlement amount of original ground G according to the amount of time that has elapsed from the start of land reclamation. For example, one or a combination of two or more of the Cc method, Terzaghi’s principle, the hyperbolic method, and the Asaoka method, which are known, may also be used as the method for constructing an original ground model.

[0024] As information for estimating the settlement amount of land reclamation material 2, database 110 first stores the settlement estimation model for land reclamation material 2 (hereinafter, the settlement estimation model for land reclamation material 2 will be referred to as “land reclamation material model”). FIG. 2 is a diagram showing an example of a result of estimating a settlement amount obtained using the land reclamation material model. The vertical axis in FIG. 2 indicates the settlement amount and the horizontal axis indicates the amount of time that has elapsed since the start of land reclamation. The land reclamation model is an example of a consolidation settlement estimation procedure according to the present invention. The land reclamation material model corresponds to the consolidation property for estimating the settlement

amount resulting from the consolidation of land reclamation material 2, and is used for estimation of the settlement amount of land reclamation material 2 according to the amount of time that has elapsed since the start of land reclamation. Similarly to the original ground model, one or a combination of two or more of a Cc method, Terzaghi's principle, the hyperbolic method, the Asaoka method, and the like, which are known, may also be employed as a method for constructing the land reclamation material model. Note that in the present embodiment, it is assumed that the same method is employed for the construction of the original ground model and the land reclamation material model.

[0025] The land reclamation material model is constructed by incorporating the consolidation property obtained by tests of the soil material that can be used for land reclamation. The consolidation property of the soil material differs depending on the soil type, density, and moisture content, and land reclamation material 2 has a different soil type, density, moisture content, and the like for each unit of dumping. Accordingly, in land reclamation management system 1, a land reclamation material model incorporating the soil type, density, moisture content, and the like of land reclamation material 2 is constructed for each land reclamation soil layer formed for each unit of dumping of land reclamation material 2, these multiple land reclamation material models are combined, and estimation of the settlement amount of land reclamation material 2 is performed.

[0026] Also, as information for estimating the settlement amount of land reclamation material 2, database 110 stores an accumulation shape model for land reclamation material 2 dumped into the submerged zone. The accumulation shape model is a model for estimating the accumulation shape of land reclamation material 2 dumped into the submerged zone. For example, the accumulation shape model is constructed through an experiment in which land reclamation material 2 is dumped into the submerged zone and the accumulation shape is measured.

[0027] Also, database 110 stores dumping information as the information relating to dumped land reclamation material 2. The dumping information includes: the dumping date and time of land reclamation material 2, the dumping position of land reclamation material 2, the direction of barge 10 that dumped land reclamation material 2, the amount (volume) of dumped land reclamation material 2 (referred to above as “land reclamation material dumping data”), and physical property information of dumped land reclamation material 2 (land reclamation material physical property data).

[0028] FIG. 3 is a diagram showing a hardware configuration of terminal apparatus 100. Terminal apparatus 100 includes control unit 101, storage unit 102, operation unit 103, display unit 104, and communication unit 105. Operation unit 103 includes a keyboard and a mouse for operating terminal apparatus 100. Display unit 104 is a liquid crystal display. Display unit 104 displays a screen generated by an operating system or an application program. Communication unit 105 is a communication interface for performing data communication via communication network 3.

[0029] Storage unit 102 stores an operating system. Also, storage unit 102 stores a program for estimating the settlement amounts of original ground G and land reclamation material 2 as an application program. Control unit 101 includes a CPU (central processing unit), a ROM (read only memory), a RAM (random access memory), and the like. The ROM stores firmware for initializing the units of terminal apparatus 100 and starting up the operating system. The RAM is used for storing data to be used when the CPU executes an arithmetic operation.

[0030] Next, a flow of estimation of the settlement amounts of land reclamation material 2 and original ground G will be described. FIG. 4 is a flowchart showing a flow of estimation of the settlement amounts of land reclamation material 2 and original ground G.

[0031] Before land reclamation, the three-dimensional shape of the surface of original ground G of land reclamation region A is measured by narrow

multi-beam sounder 30 (step S1). The operator of terminal apparatus 100 stores the result of measuring the three-dimensional shape of original ground G of land reclamation region A in database 110 from computer 21 of surveying ship 11 (step S2). The operator of terminal apparatus 100 divides the three-dimensional shape of original ground G stored in database 110 in correspondence with multiple segments a_1 to a_n (step S3).

[0032] The operator stores the physical property information indicating the physical properties of original ground G of land reclamation region A obtained through a boring survey, in database 110 for each of segments a_1 to a_n (step S4). For example, the physical properties of original ground G include soil type, density, moisture content, a compression index, a consolidation coefficient, and the like.

[0033] On terminal apparatus 100, the operator performs an operation of instructing generation of a settlement estimation model for original ground G (original ground model). The original ground model is a model for estimating the settlement amount of original ground G according to the amount of time that has elapsed since the start of land reclamation for original ground G due to the load of land reclamation material 2. When this operation is performed, terminal apparatus 100 (consolidation property specifying means) constructs an original ground model incorporating the physical property information for each of stored segments a_1 to a_n (step S5). Note that original ground models incorporating the various pieces of physical property information relating to the original ground may also be constructed in advance, and in step S5, the original ground model incorporating the physical property information of a target segment may also be selected from these original ground models.

[0034] Next, on barge 10, for example, soil type, density, and moisture content are measured before the dumping of land reclamation material 2 as the physical properties of land reclamation material 2 that is to be dumped (step S6). When land reclamation material 2 is dumped from barge 10, the

date and time of dumping of land reclamation material 2 into the submerged zone, the dumping position of land reclamation material 2, the direction of barge 10 when land reclamation material 2 was dumped, the dumping amount of land reclamation material 2, and the measured physical property information of land reclamation material 2 are stored in database 110 as dumping information by operating computer 20 (step S7). That is, information indicating what kind of material was dumped when, where, and at what thickness, and is stored in database 110 as a record of accumulation of land reclamation material 2.

[0035] Next, terminal apparatus 100 estimates the accumulation shape of land reclamation material 2 for each of segments a_1 to a_n based on the three-dimensional shape of original ground G of land reclamation region A stored in database 110, the dumping information of land reclamation material 2, and the accumulation shape model (step S8). FIG. 5(A) is a diagram showing an example of a result of estimating the accumulation shape of land reclamation material 2 dumped the first time, and indicates cross-section SE1 of the accumulation shape of land reclamation material 2. In terminal apparatus 100 (shape estimation means), when an operation of instructing display of the accumulation shape is performed for a segment into which land reclamation material 2 was dumped, the estimation result shown in FIG. 5(A) is displayed (step S9). Note that the estimated accumulation shape may also be corrected using the measured three-dimensional shape of land reclamation region A.

[0036] If the future settlement amount is to be estimated for land reclamation region A, the operator designates a future date and time and performs an operation of instructing estimation of the settlement amount on terminal apparatus 100. When this operation is performed, terminal apparatus 100 (consolidation property specifying means) constructs a settlement estimation model of land reclamation material 2 (land reclamation material model) incorporating the soil type, density, and

moisture content indicated by the dumping information of land reclamation material 2 stored in database 110 (step S10). Note that land reclamation material models incorporating the various pieces of physical property information relating to the land reclamation material may also be constructed in advance, and in step S10, the land reclamation material model incorporating the physical property information of target land reclamation material 2 may also be selected from these land reclamation material models.

[0037] Next, terminal apparatus 100 (settlement amount estimation means) references database 110, calculates the settlement amount of original ground G in segments a_1 to a_n at the designated date and time, based on the three-dimensional shape of original ground G of segments a_1 to a_n , the load of land reclamation material 2 that acts on original ground G of segments a_1 to a_n , and the original ground model (settlement estimation model) of original ground G of segments a_1 to a_n , and calculates the settlement amount of land reclamation material 2 that has accumulated in segments a_1 to a_n , based on the accumulation shape of land reclamation material 2 in segments a_1 to a_n , the record of accumulation of land reclamation material 2 in segments a_1 to a_n (accumulation state: information indicating what kind of material was dumped when, where, and at what thickness), and the land reclamation material model (settlement estimation model) of land reclamation material 2 dumped into segments a_1 to a_n (step S11). Upon finishing calculating the settlement amount of original ground G and the settlement amount of land reclamation material 2, terminal apparatus 100 displays the calculated settlement amounts (step S12).

[0038] When land reclamation material 2 is to be newly dumped, the operator repeats the processing of step S6 and onward. Specifically, in barge 10, the physical property information of land reclamation material 2 that is to be newly dumped is measured (step S6). When land reclamation material 2 is newly dumped from barge 10, the date and time of dumping of

new land reclamation material 2 into the submerged zone, the dumping position of new land reclamation material 2, the direction of barge 10 when new land reclamation material 2 was dumped, the dumping amount of new land reclamation material 2, and the measured physical property information of new land reclamation material 2 are stored in database 110 by operating computer 20 (step S7).

[0039] Next, terminal apparatus 100 estimates the accumulation shape of land reclamation material 2 for each of segments a_1 to a_n based on the three-dimensional shape of original ground G of land reclamation region A stored in database 110, the dumping information of land reclamation material 2 that has already been dumped, and the accumulation shape model (step S8). FIG. 5(B) is a diagram showing an example of a result of estimating the accumulation shape of land reclamation material 2 that has been dumped, and shows cross-section SE1 of the accumulation shape of land reclamation material 2 that was dumped first, and cross-section SE2 of the accumulation shape of land reclamation material 2 that was dumped second. In terminal apparatus 100, when an operation of instructing display of the accumulation shape is performed for a segment into which land reclamation material 2 was dumped, the estimation result shown in FIG. 5(B) is displayed (step S9).

[0040] If a future settlement amount is to be estimated for land reclamation region A after land reclamation material 2 has been newly dumped, the operator designates a date and time on terminal apparatus 100 and performs an operation of instructing estimation of the settlement amount. When this operation is performed, terminal apparatus 100 constructs a settlement estimation model of land reclamation material 2 (land reclamation material model) incorporating the soil type, density, and moisture content indicated by the dumping information of land reclamation material 2 previously stored in database 110 (step S10).

[0041] Next, referencing database 110, terminal apparatus 100 calculates

the settlement amount of original ground G in segments a_1 to a_n at the designated date and time, based on the three-dimensional shape of original ground G of segments a_1 to a_n , the load of land reclamation material 2 that acts on original ground G of segments a_1 to a_n , and the original ground model (settlement estimation model) of original ground G of segments a_1 to a_n . In addition, terminal apparatus 100 calculates the settlement amount of land reclamation material 2 that has previously accumulated in segments a_1 to a_n , based on the previous accumulation shape of land reclamation material 2 in segments a_1 to a_n , the record of accumulation of land reclamation material 2 in segments a_1 to a_n (accumulation state: information indicating what kind of material was dumped when, where, and at what thickness), and the land reclamation material model of land reclamation material 2 dumped into segments a_1 to a_n (step S11). Upon finishing calculating the settlement amount of original ground G and the settlement amount of land reclamation material 2, terminal apparatus 100 displays the calculated settlement amounts (step S12).

[0042] [Modified Examples] The above-described embodiment can be modified in various ways. Examples of these modifications will be given hereinafter. Note that the above-described embodiment and the modified examples disclosed hereinafter may also be combined as appropriate.

[0043] (1) In the present invention, terminal apparatus 100 may also determine the position of barge 10 during dumping of new land reclamation material 2 based on an estimated settlement amount and display the determined position. For example, if there is a segment in which the estimated settlement amount is greater than or equal to a pre-determined threshold value, the position at which land reclamation material 2 accumulates in the segment may be displayed as the position of barge 10 during dumping of new land reclamation material 2.

[0044] (2) In the present invention, for example, a settlement gauge may also be installed at a known position at which land reclamation material 2 is

dumped, and the settlement amounts of original ground G and land reclamation material 2 may be measured. Also, the settlement amount may also be measured for each land reclamation material 2 that is dumped and stacked, using a differential settlement gauge as the settlement gauge. In a configuration in which the settlement amount of land reclamation material 2 is measured using a settlement gauge, the difference from a settlement amount estimated using the measured settlement amount may be obtained, and the obtained difference may be used to correct input parameters relating to the original ground model and the land reclamation material model.

[0045] (3) In the present invention, the three-dimensional shape of land reclamation region A after land reclamation material 2 is dumped may be measured at multiple times (e.g., the time immediately after land reclamation material 2 was dumped, or the time at which a given amount of time has elapsed since land reclamation material 2 was dumped), and the settlement amount of land reclamation material 2 may be calculated based on the result of these multiple instances of measurement. Also, in this configuration, the input parameters relating to the settlement estimation model may be corrected using this calculated settlement amount. Note that if land reclamation region A extends over a wide range, the settlement amount of land reclamation material 2 may also be calculated based on the result of measuring a segment (range) of the smallest necessary limit.

[0046] (4) In the present invention, in terminal apparatus 100, a plan view of segments a_1 to a_n is displayed, and when an operation of clicking on a displayed segment is performed, change in the land reclamation height and settlement amount accompanying elapse of the date may be displayed as a graph for the clicked segment. Also, if an operation of clicking on a date on a displayed graph is performed, terminal apparatus 100 may display the record of accumulation of land reclamation material 2 for the clicked date. In the displayed record, the date and time of dumping, the physical properties of dumped land reclamation material 2, the accumulated

thickness, the depth from the water surface to the layer of land reclamation material 2, and the like may also be displayed for each layer of land reclamation material 2.

[0047] (5) In the present invention, the estimated accumulation shape may also be updated based on the three-dimensional shape of the surface of the land reclamation material in land reclamation region A resulting from the dumping of land reclamation material 2. Specifically, after multiple instances of dumping land reclamation material 2 have ended, the three-dimensional shape of the surface of the land reclamation material in land reclamation region A is measured with narrow multi-beam sounder 30, and the measurement result is stored in database 110 from computer 20 of surveying ship 11. The operator of terminal apparatus 100 divides the three-dimensional shape of the surface of the land reclamation material in land reclamation region A stored in database 110 in correspondence with the multiple segments a_1 to a_n . When an operation of instructing correction of the measured accumulation shape of land reclamation region A is performed, terminal apparatus 100 corrects the estimated accumulation shape stored in database 110 while performing an operation of matching the estimated ground surface height of the accumulation shape with the measured ground surface height. According to this configuration, the estimated accumulation shape can be brought closer to the actual accumulation shape. Note that after the estimated accumulation shape is updated as explained above, subsequent estimations of accumulation shape in step S8 associated with new dumping of land reclamation material 2 may also be performed using the updated accumulation shape.

[0048] (6) In the above-described embodiment, the same method (e.g., a combination of the Cc method and Terzaghi's principle, or the like) was employed in the construction of the settlement estimation model for original ground G (original ground model) and the construction of the settlement model for land reclamation material 2 (land reclamation material model),

but different methods may be used in the construction of these models (e.g., a combination of the Cc method and Terzaghi's principle for the construction of the original ground model, and the Asaoka method for the construction of the land reclamation material model, or the like).

Reference Signs List

[0049] 1 ... Land reclamation management system. 2 ... Land reclamation material. 3 ... Communication network. 10 ... Barge. 11 ... Surveying ship. 20, 21 ... Computer. 30 ... Narrow multi-beam sounder. 40, 41 ... Satellite positioning apparatus. 100 ... Terminal apparatus. 110 ... Database.

What is Claimed is:

1. A land reclamation management method, comprising:
 - measuring a physical property of original ground in a land reclamation region prior to land reclamation;
 - specifying a consolidation property corresponding to the measured physical property of the original ground;
 - measuring a three-dimensional shape of the surface of the original ground in the land reclamation region prior to land reclamation;
 - measuring a physical property of a land reclamation material for each dumping of the land reclamation material into the land reclamation region;
 - estimating an accumulation state and shape of the land reclamation material in the land reclamation region, based on the three-dimensional shape of the surface of the original ground, the physical property of the land reclamation material for each dumping of the land reclamation material into the land reclamation region, a dumping date and time of the land reclamation material for each dumping of the land reclamation material into the land reclamation region, a dumping position of the land reclamation material for each dumping of the land reclamation material into the land reclamation region, and a dumping amount of the land reclamation material for each dumping of the land reclamation material into the land reclamation region;
 - specifying a consolidation property corresponding to the measured physical property of the land reclamation material for each dumping of the land reclamation material into the land reclamation region; and
 - estimating settlement amounts of the original ground and the land reclamation material accumulated on the original ground at a designated position in the land reclamation region at a designated future date and time, based on the three-dimensional shape of the surface of the original ground,

the consolidation property of the original ground, the accumulation state and shape of the land reclamation material in the land reclamation region, and the consolidation property of the land reclamation material for each dumping of the land reclamation material into the land reclamation region.

2. The land reclamation management method according to claim 1, further comprising

determining a dumping position of the land reclamation material to be newly dumped into the land reclamation region, based on estimated settlement amounts of the original ground and the land reclamation material accumulated on the original ground at a designated position in the land reclamation region at a designated future date and time.

3. The land reclamation management method according to claim 1 or 2, further comprising

performing measurement of the three-dimensional shape of the surface of the land reclamation material in the land reclamation region after dumping of the land reclamation material, and

correcting the estimated accumulation shape of the land reclamation material using the measured three-dimensional shape of the surface of the land reclamation material.

4. The land reclamation management method according to claim 1 or 2, further comprising:

installing a settlement gauge at a known position in the land reclamation region; and

verifying accuracy of the estimated settlement amount and correcting input parameters relating to the consolidation property, using the settlement amount measured by the settlement gauge.

5. The land reclamation management method according to claim 1 or 2, further comprising:

measuring, at a plurality of times, the three-dimensional shape of the surface of the land reclamation material in the land reclamation region after dumping of the land reclamation material; and

verifying accuracy of the estimated settlement amount and correcting input parameters relating to the consolidation property, using the measured three-dimensional shape of the surface of the land reclamation material.

6. A land reclamation management system, comprising:

an acquisition means for acquiring original ground physical property data indicating a measurement value of a physical property of original ground in a land reclamation region prior to dumping of a land reclamation material, original ground shape data indicating a measurement value of a three-dimensional shape of the surface of the original ground in the land reclamation region prior to dumping of the land reclamation material, land reclamation material physical property data indicating a measurement value of a physical property of the land reclamation material for each dumping of the land reclamation material into the land reclamation region, and land reclamation material dumping data indicating a dumping date and time, and dumping position, and a dumping amount of the land reclamation material for each dumping of the land reclamation material into the land reclamation region;

a shape estimation means for estimating an accumulation state and shape of the land reclamation material in the land reclamation region, based on the three-dimensional shape of the surface of the original ground indicated by the original ground shape data, the physical property of the land reclamation material for each dumping indicated by the land reclamation material physical property data, and the dumping date and time, the dumping position, and the dumping amount of the land reclamation

material for each dumping indicated by the land reclamation material dumping data;

a consolidation property specifying means for specifying a consolidation property of the original ground based on the physical property indicated by the original ground physical property data, and specifying the consolidation property of the land reclamation material for each dumping based on the physical property indicated by the land reclamation material physical property data; and

a settlement amount estimation means for estimating settlement amounts of the original ground and the land reclamation material accumulated on the original ground at a designated position in the land reclamation region at a designated future date and time, based on the three-dimensional shape of the surface of the original ground indicated by the original ground shape data, the accumulation state and shape of the land reclamation material estimated by the shape estimation means, and the consolidation properties of the original ground and the land reclamation material for each dumping, specified by the consolidation property specifying means.