

DESCRIPTION

TITLE OF INVENTION: WORK MANAGEMENT METHOD FOR CONSTRUCTION MACHINE

TECHNICAL FIELD

[0001] The present invention relates to a work management method for a construction machine.

BACKGROUND ART

[0002] JP2008-8183A discloses a construction machine capable of being automatically operated that does not require an operational manipulation by an operator.

SUMMARY OF INVENTION

[0003] In recent years, in order to improve a construction efficiency, introduction of construction machines capable of being automatically operated, such as those described in JP2008-8183A, has been promoted. However, such construction machines capable of being automatically operated do not necessarily perform works independently and complete all construction, and it is common that a plurality of construction machines including the construction machines capable of being automatically operated complete the construction by respectively performing, in an ordered manner, the works designated in advance.

[0004] As described above, in a case in which the plurality of construction machines including the construction machines capable of being automatically operated perform the work in a predetermined work region, if each of the

construction machines performs individually performs the instructed work, there is a risk in that, for example, the work performed by a construction machine performing a preceding process is obstructed by a construction machine performing a subsequent process, and as a result, a construction efficiency is lowered.

[0005] An object of the present invention is to improve a construction efficiency when a plurality of construction machines including a construction machine capable of being automatically operated perform work in a predetermined work region.

[0006] According to one aspect of the present invention, a work management method executed by a work management system for managing, in a predetermined work region, a plurality of configuration works respectively performed in order by a plurality of construction machines including an automatically operatable construction machine, the work management method includes: a work area setting step of sequentially setting, in the work region, a preceding work area, where a preceding configuration work is to be performed, and a subsequent work area where a subsequent configuration work, which is performed after the preceding configuration work has been performed, is to be performed; and a work completion determination step of determining whether or not the preceding configuration work performed in the preceding work area has been completed, wherein the preceding configuration work or the subsequent configuration work is performed by the automatically operated construction machine, and wherein in the work area setting step, the subsequent work area is set within a range of a region of the preceding work area where the preceding configuration work has been determined to be completed in the work completion determination step, and a new preceding

work area is set so as not to overlap with the region of the preceding work area where the preceding configuration work has been determined to be completed in the work completion determination step.

[0007] According to another aspect of the present invention, a work management method executed by a work management system for managing, in a predetermined work region, N number (wherein N is a natural number of two or more) of configuration works performed by a plurality of construction machines including an automatically operatable construction machine, the configuration works being performed in order by performing a Nth-step configuration work after a (N-1)th configuration work has been performed, the work management method includes: a work area setting step of sequentially setting, in the work region, the N number of work areas from a first work area where a first-step configuration work is performed to an Nth work area where the Nth-step configuration work is performed; and a work completion determination step of determining whether or not (N-1) number of configuration works from the first-step configuration work performed in the first work area to the (N-1)th-step configuration work performed in an (N-1)th work area have been completed, wherein the (N-1)th-step configuration work or the Nth-step configuration work is performed by the automatically operated construction machine, and wherein in the work area setting step, the Nth work area is set in within a range of region of the (N-1)th work area where the (N-1)th-step configuration work has been determined to be completed in the work completion determination step, and a new (N-1)th work area is set so as not to overlap with the region of the (N-1)th work area where the (N-1)th-step configuration work has been determined to be completed in the work completion determination step.

BRIEF DESCRIPTION OF DRAWINGS

[0008]

[FIG. 1] FIG. 1 is a conceptual diagram showing an overall configuration of a work management system suitable for performing a work management method according to an embodiment of the present invention.

[FIG. 2] FIG. 2 is a configuration diagram showing schematic configurations of a site management unit and construction machines in the work management system.

[FIG. 3] FIG. 3 is a block diagram for explaining functions of a work management unit of the work management system.

[FIG. 4A] FIG. 4A is a diagram for explaining an example of a work performed in a work area.

[FIG. 4B] FIG. 4B is a diagram for explaining an example of the work performed in the work area.

[FIG. 4C] FIG. 4C is a diagram for explaining an example of the work performed in the work area.

[FIG. 4D] FIG. 4D is a diagram for explaining an example of the work performed in the work area.

[FIG. 5A] FIG. 5A is a diagram for explaining work areas for the work shown in FIGs. 4A, 4B, 4C, and 4D.

[FIG. 5B] FIG. 5B is a diagram for explaining the work area that is set subsequent to the work area shown in FIG. 5A.

[FIG. 5C] FIG. 5C is a diagram for explaining the work area that is set subsequent to the work areas shown in FIG. 5B.

[FIG. 5D] FIG. 5D is a diagram for explaining the work area that is set

subsequent to the work areas shown in FIG. 5C.

[FIG. 5E] FIG. 5E is a diagram for explaining the work area that is set subsequent to the work areas shown in FIG. 5D.

[FIG. 5F] FIG. 5F is a diagram for explaining another example of the work area that is set subsequent to the work areas shown in FIG. 5A.

[FIG. 6] FIG. 6 is a diagram showing a flow of processing in the work management method according to the embodiment of the present invention.

[FIG. 7A] FIG. 7A is a diagram for explaining another example of the work performed in the work area.

[FIG. 7B] FIG. 7B is a diagram for explaining another example of the work performed in the work area.

[FIG. 7C] FIG. 7C is a diagram for explaining another example of the work performed in the work area.

[FIG. 8A] FIG. 8A is a diagram for explaining the work area for the work shown in FIGs. 7A, 7B, and 7C.

[FIG. 8B] FIG. 8B is a diagram for explaining the work area that is set subsequent to the work area shown in FIG. 8A.

[FIG. 8C] FIG. 8C is a diagram for explaining the work area that is set subsequent to the work areas shown in FIG. 8B.

DESCRIPTION OF EMBODIMENTS

[0009] In the following, a work management method according to an embodiment of the present invention will be described with reference to the drawings.

[0010] A work management system 100 that is suitable for performing the work management method according to the embodiment of the present

invention will be described first with reference to FIGs. 1 to 3.

[0011] As shown in FIG. 1, the work management system 100 is a system constructed to collectively manage works performed by a plurality of construction machines 2 that are deployed in a plurality of work sites 1A, 1B, and 1C and are capable of being automatically and manually operated. The plurality of work sites 1A, 1B, and 1C that are managed by the work management system 100 are, for example, civil engineering work regions that are set at locations remote from each other by several hundred kilometers or more. Note that, the plurality of work sites 1A, 1B, and 1C may be a plurality of work regions that are set within a single civil engineering construction project site.

[0012] In addition, the work sites 1A, 1B, and 1C are not limited to domestic civil engineering work sites, and they may be overseas civil engineering work sites or civil engineering work sites outside the earth, such as those on the lunar surface. In addition, the number of the work sites 1A, 1B, and 1C to be managed may be any number of two or more.

[0013] The work management system 100 includes site management units 30 that are provided at each of the work sites 1A, 1B, and 1C (work regions) and a work management unit 10 that manages, via the site management units 30, the work status of the plurality of construction machines 2 deployed at each of the work sites 1A, 1B, and 1C. The work management unit 10 and each of the site management units 30 are connected to each other via a communication network 50 such as a public network, etc. Note that, in the following, a description will be given for a case in which the work management system 100 manages the works of the construction machines 2 involved a civil engineering work to construct a bank body such as a trapezoidal dam, etc. by

building an embankment material such as CSG (Cemented Sand and Gravel), etc.

[0014] The work management unit 10 is mainly configured with: a microcomputer that includes a CPU (Central Processing Unit) serving as a control unit 11, a ROM (Read Only Memory) and a RAM (Random Access Memory) serving as a storage unit 15, and an input/output interface (I/O interface); a communication unit 12 that exchanges the data with each of the site management units 30 via the communication network 50; a display unit 13 capable of displaying in real time the results computed by the control unit 11 and the work status of each of the work sites 1A, 1B, and 1C; and an input unit 14 that receives the operational manipulation input by the operator who manages the work. In the storage unit 15, a program to be executed by the control unit 11 and data necessary for execution of the program are stored in advance, and the results computed by the control unit 11 are stored sequentially. Note that, the specific control performed by the control unit 11 will be described later.

[0015] In order to collectively manage the works to be performed by the plurality of construction machines 2, which are respectively deployed in the work sites 1A, 1B, and 1C, the work management unit 10 is provided at a location remote from each of the work sites 1A, 1B, and 1C. Note that, the work management unit 10 may also be provided in any of the work sites 1A, 1B, and 1C.

[0016] Next, by referring to FIG. 2, the site management units 30 provided in each of the work sites 1A, 1B, and 1C and the construction machines 2 deployed in each of the work sites 1A, 1B, and 1C will be described. Note that, FIG. 2 shows a schematic configuration at the work site 1A that is one of the

plurality of work sites 1A, 1B, and 1C.

[0017] Similarly to the work management unit 10, the site management unit 30 is mainly configured with: a microcomputer that includes a CPU (Central Processing Unit) serving as a control unit 31, a ROM (Read Only Memory) and a RAM (Random Access Memory) serving as a storage unit 35, and an input/output interface (I/O interface); a communication unit 32 that exchanges the data with the work management unit 10 via the communication network 50; a display unit 33 capable of displaying in real time the results computed by the control unit 11 of the work management unit 10, the situation in the work site 1A, and the state of each of the construction machines 2; and an input unit 34 that receives the operational manipulation input by the operator who manages the work.

[0018] In addition, the site management unit 30 further includes a transmission/reception unit 36 that exchanges the data with each of the construction machines 2 and an image acquisition unit 37 that acquire an image in the work site 1A. The transmission/reception unit 36 is wireless communication means such as LTE (Long Term Evolution), 5G, Wi-Fi®, and so forth, and the image acquisition unit 37 is formed of a plurality of cameras provided at a plurality of locations in the work site 1A. Note that, the site management units 30, which are respectively provided in other work sites 1B and 1C, also have the similar configuration.

[0019] The construction machines 2 deployed at the work site 1A are each configured so as to enable automatic (autonomous) operation by mounting, on a general-purpose construction machine: a position acquisition unit 42 capable of receiving signals from GPS satellites, etc. that form the global navigation satellite system (GNSS); a state detection unit 43 capable of

detecting acceleration, angular velocity, and geomagnetism; a surrounding detection unit 44 capable of detecting surrounding obstacles, etc.; a transmission/reception unit 45 that exchanges the data with the site management unit 30; and a control unit 41 that controls operation of the construction machine 2 on the basis of the information obtained from each of these units.

[0020] The position acquisition unit 42 is a positioning sensor capable of detecting the position of the construction machine 2 (the latitude, the longitude, the altitude) on the basis of the signals from a plurality of positioning satellites, and the state detection unit 43 is a so-called inertial measurement unit (IMU) capable of detecting the state of the construction machine 2 in which an acceleration sensor, a gyro sensor, a barometric pressure sensor, and a geomagnetism sensor are integrated into a unit. Additionally, the state detection unit 43 includes: an engine operation detection sensor that detects operation status of the construction machine 2 (which is the state of the construction machine 2); a voltmeter and/or ammeter that detects the voltage and/or current of a battery and an electrical component of the construction machine 2; and so forth. The surrounding detection unit 44 is a three-dimensional range sensor, such as a laser scanner, etc. (commonly referred to as a 3D-LiDAR (light detection and ranging) sensor), capable of recognizing the surrounding space by emitting light and measuring reflected light reflected by an object. Alternatively, the surrounding detection unit 44 is a radar sensor (RADAR: Radio Detection and Ranging) capable of measuring the distance to a measurement target by using radio waves. The transmission/reception unit 45 is wireless communication means similar to the transmission/reception unit 36 of the site management unit 30.

[0021] The control unit 41 is mainly configured of a CPU (Central Processing Unit) and, by being connected to an existing control unit 48, which is installed on the construction machine 2 in advance, controls steering and other operations of the construction machine 2 so as to autonomously carry out the instructed work by detecting the state and the shape of the target object such as the embankment material, etc. and confirming surrounding safety from the results detected by the surrounding detection unit 44, while also confirming its own position and orientation from the results detected by the position acquisition unit 42 and the state detection unit 43. Note that, the automatic (autonomous) operation of the construction machine 2 may be carried out by sequence control based on a predetermined sequence or judgment, may be carried out or by feedback control based on the shape and amount of the target object, such as the embankment material, etc., measured by the surrounding detection unit 44, or may be carried out by combining these controls.

[0022] In this configuration, the existing control unit 48 is configured to control a steering, engine output, and so forth of the construction machine 2 in response to the operator's operational manipulation of an existing operational manipulation unit 49, such as a handle, a lever, and so forth, which are provided on the construction machine 2 in advance for manual steering and other operations. In other words, by generating, in the control unit 41, a signal equivalent to the signal generated when the existing operational manipulation unit 49 is operationally manipulated, and by transmitting the thus-generated pseudo-signal to the existing control unit 48, it is possible to move the construction machine 2 (i.e. to operate the construction machine 2 by the remote operational manipulation) as if the

operator were actually operationally manipulating it.

[0023] Note that, because the existing operational manipulation unit 49 remains provided on the construction machine 2, it is possible for the operator to board the construction machine 2 and operationally manipulate the construction machine 2 in a manual mode.

[0024] In addition, in order to allow the operator to maneuver the construction machine 2 from a remote location, the construction machine 2 is further provided with: an image acquisition unit 46 capable of acquiring an image of the situation in the work site 1A as seen from the operator's cabin; and sound collection device (not shown) that picks up the operating sound, etc. of the construction machine 2. The image acquisition unit 46 is, for example, a stereo camera capable of acquiring an image of the entire surrounding condition of the construction machine 2, and it is preferably configured so that the image acquisition direction is changed in response to the orientation or the movement of the operator's head performing the operational manipulation by a remote maneuvering unit 20, which will be described later.

[0025] As described above, the construction machine 2 can be operated automatically (autonomously). In addition, the construction machine 2 can also be operated manually in a state in which the operator is on board, or the construction machine 2 can also be operated manually by the operator's operational manipulation from a remote location. In other words, the manual operation of the construction machine 2 described below includes a case in which the operator boards the construction machine 2 and maneuvers the construction machine 2 and a case in which the operator does not board the construction machine 2 and maneuvers the construction machine 2 by the

remote operational manipulation from the remote maneuvering unit 20, which will be described below.

[0026] The construction machine 2, which is configured so as to allow the automatic operation and the manual operation, includes a bulldozer, a dump truck, a vibratory roller, and a backhoe, for example, and the work performed by these different types of construction machines 2 deployed at the work site 1A is managed by the site management unit 30 and also managed by the work management unit 10 via the site management unit 30. Note that, although the configuration of the existing operational manipulation unit 49 differs depending on the type of the construction machine 2, the configurations necessary for enabling the automatic operation and/or the remote operational manipulation are essentially the same.

[0027] The work management system 100 further includes the remote maneuvering unit 20 for remotely maneuvering the construction machines 2, which are deployed at each of the work sites 1A, 1B, and 1C, from a location away from each of the work sites 1A, 1B, and 1C.

[0028] As shown in FIG. 1, the remote maneuvering unit 20 is mainly configured with: a microcomputer with a CPU (Central Processing Unit) serving as a remote control unit 21; a plurality of remote maneuvering devices 24 connected to the remote control unit 21; and a display unit 22 capable of displaying in real time the schedule under which remote maneuvering is performed and the work status of the construction machine 2 that is maneuvered remotely. The remote maneuvering unit 20 may be directly connected to the control unit 11 of the work management unit 10, or the remote maneuvering unit 20 may be connected to the work management unit 10 via the communication network 50. In addition, the remote maneuvering

unit 20 may be provided at the same location as the work management unit 10, or the remote maneuvering unit 20 may be provided at the location away from the work management unit 10 or at any one of the work sites 1A, 1B, and 1C.

[0029] The remote maneuvering devices 24 are each provided with: an operational manipulation unit 27, such as the handle, the lever, and so forth, for maneuvering the construction machine 2; a display unit 26 that displays a video and image acquired by the image acquisition unit 46 provided on the construction machine 2 and also displays the work content; a speaker (not shown) that outputs surrounding sounds around the construction machine 2; and so forth, and their operations are controlled by a control unit 25 that is configured mainly of a CPU (Central Processing Unit). The display unit 26 may be, for example, a head-mounted display worn by the operator.

[0030] Next, the control executed by the control unit 11 of the work management unit 10 in the work management system 100 configured as described above will be described with reference to FIG. 3.

[0031] As shown in FIG. 3, the control unit 11 has: a work area setting unit 11A that sets, in each of the work sites 1A, 1B, and 1C, a work area in which the plurality of construction machines 2 including the automatically operatable construction machines respectively perform configuration work in order on the basis of three-dimensional data, such as a CIM (Construction Information Modeling) data, etc., for each of the work sites 1A, 1B, and 1C; a work planning unit 11B that plans, on the basis of the specifications, etc. of each construction machine 2, the content of the work performed by each construction machine 2 in each work area set by the work area setting unit 11A; a notification unit 11C that displays each work area set by the work area

setting unit 11A on the display unit 13, the display unit 33 of each site management unit 30, and the display unit 22 of the remote maneuvering unit 20; and a determination unit 11D that determines the completion of the work planned by the work planning unit 11B on the basis of the position information of each construction machine 2 and the signal transmitted from each construction machine 2.

[0032] The three-dimensional data such as the CIM data, etc. used in the work area setting unit 11A is stored in the storage unit 15 and the storage unit 35 of each site management unit 30 in advance. Note that, the data used in the work area setting unit 11A may be input by the operator through the input unit 14.

[0033] The work area setting unit 11A sequentially sets, in each of the work sites 1A, 1B, and 1C (the work regions), a preceding work area in which a preceding configuration work is performed and a subsequent work area in which a subsequent configuration work, which is performed after the preceding configuration work has been performed, is performed. Specific examples of the preceding configuration work and the subsequent configuration work will be described below.

[0034] In the work area setting unit 11A, the subsequent work area is set within the range of the region of the preceding work area, in which the determination unit 11D determined that the preceding configuration work has been completed, such that the subsequent work area is set within the range that does not extend beyond the region of the preceding work area. In the work area setting unit 11A, the preceding work area is set so as to be adjacent to the preceding work area, in which the determination unit 11D determined that the preceding configuration work has been completed, and so as not to

overlap with this region. As described above, in response to the completion of the configuration work, the work area setting unit 11A sequentially sets, in each of the work sites 1A, 1B, and 1C, the work areas (the preceding work area, the subsequent work area) in which the plurality of construction machines 2 including the automatically operatable construction machines respectively perform the configurations work in order.

[0035] The specifications of each construction machine 2 used in the work planning unit 11B are input by the operator through an input unit 34 of the site management unit 30 in advance. For example, as the specifications, in a case in which the construction machine 2 is a bulldozer, the blade width, etc. is input, in a case in which the construction machine 2 is a dump truck, the maximum load capacity and travel speed are input, and in a case in which the construction machine 2 is a vibratory roller, the roller width, etc. is input.

[0036] In addition, when the work content is to be planned in the work planning unit 11B, among the construction machines 2 deployed at each of the work sites 1A, 1B, and 1C, the construction machine 2 that is under inspection or repair is excluded from the plan as the target, and only construction machine 2 that is in a state capable of performing the work is targeted in the plan. Whether or not the construction machine 2 is in the workable state is input as needed by the operator through the input unit 34 of the site management unit 30. In addition, because each of the construction machines 2 originally has an abnormality detection function that detects an abnormality in an actuator, etc. for actuating the working machine on the basis of a working oil pressure sensor and a working oil temperature sensor (not shown), it may also be possible to determine at any time whether or not the construction machine 2 is in the workable state on the basis of the

presence or absence of an abnormality transmitted from each of the construction machines 2.

[0037] The work content planned in the work planning unit 11B includes an automatic operation work content in which the construction machine 2 performs the work by the automatic operation in the work area. Specifically the work content includes the start position at which an automatic operation work is started, an end position at which the automatic operation work is ended, a route from the start position to the end position, and so forth, and these are converted into data and transmitted to the construction machine 2 that is designated to the work via the site management unit 30. The automatic operation work content is, for example, the content of the work for the target object, such as the embankment material, etc., and includes information about the working range, in which the work is to be performed, and the target value in the working range (the target shape, the target specification), and as described below, these are respectively set in accordance with the works to be performed by the respective construction machines 2. By setting the working range and the target value in the working range, the construction machine 2 performs the work by the automatic operation in the working range so as to achieve the target value.

[0038] In addition, the work content planned in the work planning unit 11B also includes a manual operation work content in which the construction machine 2 performs work in the work area by the manual operation. The work content planned in the work planning unit 11B is transmitted, via the site management unit 30, to a terminal installed on the construction machine 2 or a tablet terminal, etc. carried by the operator in a case in which the operator boards the construction machine 2, and is transmitted to the remote

maneuvering device 24 in a case in which the operator operationally manipulates the construction machine 2 remotely in the remote maneuvering unit 20.

[0039] The completion status of the work, which is the result of the determination performed by the determination unit 11D, is displayed, in the same manner as each work area set by the work area setting unit 11A, on the display unit 13, the display unit 33 of each site management unit 30, and the display unit 22 of the remote maneuvering unit 20 via the notification unit 11C. In addition, on each display unit, the order and time at which the work planned by the work planning unit 11B is to be performed are displayed in the form of a schedule chart such as a Gantt chart, etc. Thus, it is possible to grasp the progress of the work easily.

[0040] In addition, the determination unit 11D also functions as a monitoring unit that monitors the work performed by each construction machine 2 in each work area set by the work area setting unit 11A. The determination unit 11D monitors whether or not the construction machine 2 performing the configuration work in the work area set by the work area setting unit 11A (the preceding work area, the subsequent work area) is performing the work within the work area on the basis of the position information, etc. of the construction machine 2 acquired by the position acquisition unit 42, and when the determination unit 11D determines that the construction machine 2 has moved out from the work area, an alarm is issued via the notification unit 11C. The alarm is notified to the operator by, for example, flashing a warning message, etc. on the display unit 13, the display unit 33 of each site management unit 30, and the display unit 22 of the remote maneuvering unit 20, a display unit (not shown) of the construction machine 2, as well as by

playing a warning sound.

[0041] Note that, these units, such as the work area setting unit 11A, etc., represent the respective functions of the control unit 11 as virtual units, and do not imply that they physically exist. In addition, the above-described functions are part of the control executed by the control unit 11, and the control unit 11 also executes control related to functions other than those described above as needed.

[0042] Next, the work management method for the construction machine 2 performed by the work management system 100 having the above-described configuration will be described specifically with reference to FIGs. 4 to 6. In the following, as an example, a description will be given to a civil engineering construction project for constructing a bank body by forming a plurality of layers by repeatedly performing a plurality of configuration works as shown in FIGs. 4A, 4B, 4C, and 4D.

[0043] The configuration work shown in FIG. 4A is a first configuration work in which the embankment material transported by an automatically operated dump truck 2B (a transport machine) is leveled by an automatically operated bulldozer 2A (a leveling machine), and the configuration work shown in FIG. 4B is a second configuration work in which the embankment material is further leveled by a manually operated bulldozer 2C (the leveling machine), and is the configuration work that is performed after the first configuration work has been performed. In addition, the configuration work shown in FIG. 4C is a third configuration work in which the surface of the embankment material is compacted by rolling compaction using an automatically operated vibratory roller 2D (a rolling compaction machine), and is the configuration work that is performed after the second configuration work has been

performed. In addition, the configuration work shown in FIG. 4D is a fourth configuration work in which the surface of the embankment material is further compacted by the rolling compaction using a manually operated vibratory roller 2E (the rolling compaction machine), and is the configuration work that is performed after the third configuration work has been performed.

[0044] In other words, one layer in one work location is formed by the following procedure:

- the embankment material is transported by the dump truck 2B (the transport machine);

- the transported embankment material is leveled by the bulldozers 2A and 2C (the leveling machines) to a predetermined thickness (the leveling thickness: 25 cm);

- the embankment material is compacted by the vibratory roller 2D (the rolling compaction machine) through the surface of the leveled embankment material. For example, the rolling compaction is carried out by causing the vibratory roller 2D to move back and forth a predetermined number of times (three times); and

- the rolling compaction is carried out by the vibratory roller 2E (the rolling compaction machine) while shaping a roughness and/or a rut partially formed in the surface of the embankment material, which has been subjected to the rolling compaction.

[0045] As described above, the embankment work, which is a single overall work, is completed by performing the plurality of configuration works for the work area, which is a predetermined region, in order, and thereby, one layer of the bank body is constructed.

[0046] Note that, by performing the second configuration work and the

fourth configuration work by the manual operation respectively after completion of the first configuration work and the third configuration work, which are performed by the automatic operation, it is possible to correct, by the manual operation, the work location (the partially formed roughness and/or rut) that has been insufficiently finished by the automatic operation. In addition, the first configuration work and the third configuration work, which are performed by the automatic operation, are performed by a large construction machine or by a plurality of construction machines, while, in the second configuration work and the fourth configuration work, which are performed by the manual operation, the work requiring a higher precision is performed by a small construction machine or the work is performed by fewer construction machines, and thereby, it is possible to enabling labor reduction and improvement in the construction quality.

[0047] Specifically, for example, in the first configuration work, the work may be performed by the automatic operation by three large bulldozers 2A, while in the second configuration work, the work may be performed by the manual operation by one small bulldozer 2C. In addition, in the third configuration work, the work may be performed by the automatic operation by five vibratory rollers 2D, while in the fourth configuration work, the work may be performed by the manual operation by two vibratory rollers 2E.

[0048] In this embodiment, the target object is so-called embankment material, such as earth, a cement mixture, or the like. The embankment material that has been transported and unloaded by the dump truck 2B is leveled by the bulldozer 2A so as to achieve a preset target thickness (the target shape), for example 25 cm, in other words, such that the height is increased by 25 cm. Subsequently, the rolling compaction is carried out by the

vibratory roller 2D for a predetermined number of times (for example, six times) in accordance with the target specification.

[0049] Therefore, the work content planned in the work planning unit 11B includes: in a case of the bulldozer 2A, the leveling of the embankment material to the target shape (the leveling thickness: 25 cm) within a predetermined range; and in a case of the vibratory roller 2D, the rolling compaction of the surface of the embankment material that has been leveled in a predetermined range by back-and-forth movement in accordance with the target specification (for a predetermined number of times (for example, six times)).

[0050] Next, a specific description will be given for the work area set by the work area setting unit 11A when the four configuration works as described above are each performed in order with reference to FIGs. 5A to 5F.

[0051] FIG. 5A shows a state in which a first work area A1 where the first configuration work by the automatically operated bulldozer 2A, which is a first-step configuration work, is performed is set in an unconstructed area in a work scheduled area A in any one of the work sites 1A, 1B, and 1C (the work regions).

[0052] When the first configuration work performed in the first work area A1 shown in FIG. 5A is completed, as shown in FIG. 5B, a new first work area A1 is set in the unconstructed area in the work scheduled area A so as to be adjacent to a work-completed first work area DA1 and so as not to overlap with this region. In addition, at the same time, a second work area A2 where the second configuration work by the manually operated bulldozer 2C, which is a second-step configuration work, is performed is set within the range of the region of the work-completed first work area DA1, preferably within the range that does not extend beyond the region of the first work area DA1. In the example shown in FIG. 5B, the size of the second work area A2 is the same as

the size of the work-completed first work area DA1.

[0053] In this case, the first configuration work by the automatically operated bulldozer 2A is the preceding configuration work that is performed before the second configuration work by the manually operated bulldozer 2C, the second configuration work by the manually operated bulldozer 2C is the subsequent configuration work that is performed after the first configuration work by the automatically operated bulldozer 2A, the first work area A1 is the preceding work area, and the second work area A2 is the subsequent work area.

[0054] When the first configuration work performed in the first work area A1 shown in FIG. 5B is completed, as shown in FIG. 5C, a new first work area A1 is set in the unconstructed area in the work scheduled area A so as to be adjacent to the work-completed first work area DA1 and so as not to overlap with this region. In addition, when the second configuration work in the second work area A2 shown in FIG. 5B is completed, as shown in FIG. 5C, a new second work area A2 is set within the range of the region of the work-completed first work area DA1 so as to be adjacent to a work-completed second work area DA2 and so as not to overlap with this region, preferably within the range that does not extend beyond the region of the first work area DA1. In addition, at the same time, a third work area A3 where the third configuration work by the automatically operated vibratory roller 2D, which is a third-step configuration work, is performed is set within the range of the region of the work-completed second work area DA2, preferably within the range that does not extend beyond the second work area DA2.

[0055] In this case, the second configuration work by the manually operated bulldozer 2C is the preceding configuration work that is performed

before the third configuration work by the automatically operated vibratory roller 2D, the third configuration work by the automatically operated vibratory roller 2D is the subsequent configuration work that is performed after the second configuration work by the manually operated bulldozer 2C, the second work area A2 is the preceding work area, and the third work area A3 is the subsequent work area. In other words, while the second configuration work is the subsequent configuration work with respect to the first configuration work, the second configuration work becomes the preceding configuration work with respect to the third configuration work.

[0056] When the first configuration work performed in the first work area A1 shown in FIG. 5C is completed, as shown in FIG. 5D, a new first work area A1 is set in the unconstructed area in the work scheduled area A so as to be adjacent to the work-completed first work area DA1 and so as not to overlap with this region. In addition, when the second configuration work in the second work area A2 shown in FIG. 5C is completed, as shown in FIG. 5D, a new second work area A2 is set within the range of the region of the work-completed first work area DA1 so as to be adjacent to the work-completed second work area DA2 and so as not to overlap with this region, preferably within the range that does not extend beyond the region of the first work area DA1. In addition, when the third configuration work in the third work area A3 shown in FIG. 5C is completed, as shown in FIG. 5D, a new third work area A3 is set within the range of the region of the work-completed second work area DA2 so as to be adjacent to a work-completed third work area DA3 and so as not to overlap with this region, preferably within the range that does not extend beyond the second work area DA2. In addition, at the same time, a fourth work area A4 where the fourth configuration work by the manually

operated vibratory roller 2E, which is a fourth-step configuration work, is performed is set within the range of the region of the work-completed third work area DA3, preferably within the range that does not extend beyond the region of the third work area DA3.

[0057] In this case, the third configuration work by the automatically operated vibratory roller 2D is the preceding configuration work that is performed before the fourth configuration work by the manually operated vibratory roller 2E, the fourth configuration work by the manually operated vibratory roller 2E is the subsequent configuration work that is performed after the third configuration work by the automatically operated vibratory roller 2D, the third work area A3 is the preceding work area, and the fourth work area A4 is the subsequent work area. In other words, while the third configuration work is the subsequent configuration work with respect to the second configuration work, the third configuration work becomes the preceding configuration work with respect to the fourth configuration work.

[0058] When each configuration work in each work area A1, A2, A3, A4 shown in FIG. 5D is completed, similarly to the above description, as shown in FIG. 5E, new work areas A1, A2, A3, are A4 are respectively set. In this example, because the fourth configuration work is the final configuration work, a work-completed fourth work area DA4 becomes the work-completed area.

[0059] In this manner, in the work scheduled area A, the height of the bank body is increased in order from the area where all of the configuration works are completed.

[0060] Note that, for example, in a case in which even if the second configuration work designated to the manually operated bulldozer 2C is completed, the first configuration work, which is the preceding configuration

work, has not been completed and the work area for performing the following second configuration work has not been set, the bulldozer 2C becomes unable to move from the work-completed second work area DA2. If the bulldozer 2C remains in the work-completed second work area DA2 as described above, the work area cannot be handed over to the automatically operated vibratory roller 2D that performs the subsequent configuration work, and so, there is a risk in that a delay is caused in the progress of the third configuration work and the fourth configuration work, which is the subsequent configuration work of the third configuration work.

[0061] Therefore, in such a case, in order to hand over most of the work area to the construction machine 2 that is to perform the subsequent configuration work without delay, it is preferable to set, in a part of the work-completed second work area DA2, a waiting area (not shown) where the bulldozer 2C can temporarily wait.

[0062] In addition, in the example shown in FIG. 5B, although a new first work area A1 is set so as to be adjacent to the work-completed first work area DA1, if there is an obstacle, etc. as shown in FIG. 5F, a new first work area A1 may be set at a location separated away from the work-completed first work area DA1. In other words, the location where the new first work area A1 is to be set may be anywhere as long as it is the location that does not overlap with the region of the work-completed first work area DA1, and there may be a non-work area where no work is to be performed between the new first work area A1 and the work-completed first work area DA1. However, in order to reduce the travel distance of the construction machine 2 and to improve the construction efficiency of the configuration work, it is preferable to set the new first work area A1 in the vicinity of the work-completed first work area DA1.

[0063] In addition, in the example shown in FIG. 5B, although the size of the second work area A2 is the same as the size of the work-completed first work area DA1, the second work area A2, which is the subsequent work area, may have any size as long as the second work area A2 is set within the range of the work-completed area in the first work area A1, which is the preceding work area, preferably as long as the second work area A2 is set within the range that does not extend beyond the area where the work has been completed, and as shown in FIG. 5F, the second work area A2 may be within the range smaller than the work-completed first work area DA1.

[0064] In addition, the configuration work is not limited to the work described above, and for example, it may be possible to perform, between the second configuration work and the third configuration work described above, a configuration work in which an edge of a slope face is shaped by an automatic operation or manually operated backhoe (an edge shaping machine) or a configuration work in which a joint cutting board is driven by a vibrating joint cutting machine. In addition, the number of the configuration works is not limited to four, and as long as a plurality of works are performed in order, there may be two works, or five or more works.

[0065] In other words, in a case in which there are N number of (wherein N is a natural number of two or more) configuration works that are to be performed in order, and the Nth-step configuration work is to be performed after the (N-1)th configuration work has been performed, N number of work areas from the first work area A1, in which the first-step configuration work is performed, to the Nth work area, where the Nth-step configuration work is performed, are set sequentially by the work area setting unit 11A according to the above-described procedure in the work scheduled area A in each of the

work sites 1A, 1B, and 1C (the work regions).

[0066] Next, with reference to the flow chart shown in FIG. 6, the flow of the control executed by the work management unit 10 will be specifically explained.

[0067] First of all, in Step S10 (a work planning step), as described above with reference to FIGs. 5A to 5F, the work management unit 10 causes the work area setting unit 11A of the control unit 11 to set, in the work scheduled area A in each of the work sites 1A, 1B, and 1C (the work regions), the preceding work area, where the preceding configuration work is to be performed, and the subsequent work area, where the subsequent configuration work, which is performed after the preceding configuration work has been performed, is to be performed.

[0068] In addition, by the notification unit 11C of the control unit 11, the range of each work area (the preceding work area, the subsequent work area) that is set by the work area setting unit 11A is displayed on the display unit 13, the display unit 33 of each site management unit 30, and the display unit 22 of the remote maneuvering unit 20 in Step S10 (a display step).

[0069] Next, in Step S11 (a work planning step), the work management unit 10 causes the work planning unit 11B of the control unit 11 to plan the work content to be carried out in each work area (the preceding work area, the subsequent work area) on the basis of the specifications, etc. of each construction machine 2 that performs each configuration work (the preceding configuration work, the subsequent configuration work).

[0070] In addition, in Step S11 (a work content transmission step), the work content planned by the work planning unit 11B is transmitted to each of the construction machines 2 from the control unit 11 together with a start

command instructing the start of the work. Note that, in a case in which the construction machine 2 is manually operated and the operator is on board the construction machine 2, the work content and the start command are transmitted to a terminal installed on the construction machine 2 or to a tablet terminal, etc. carried by the operator via the site management unit 30, and in a case in which the construction machine 2 is manually operated type and the operator operationally manipulates the construction machine 2 in the remote maneuvering unit 20 remotely, the work content and the start command are transmitted to the remote maneuvering device 24.

[0071] Each of the construction machines 2 that has received the work content and the start command starts the configuration work on the basis of the work content in each designated work area.

[0072] When each of the construction machines 2 starts the configuration work, in subsequent Step S12 (a monitoring step), the work management unit 10 monitors the works performed by each of the construction machines 2 by a monitoring function of the determination unit 11D of the control unit 11.

[0073] When it is determined that the construction machine 2 has moved outside the designated work area, an alarm is issued through the notification unit 11C as described above. In addition, when the construction machine 2 that has moved outside the work area is automatically operated, in order to ensure the safety, the operation of the construction machine 2 is stopped at the location. When the construction machine 2 that has moved outside the work area is manually operated, a warning is given to the operator maneuvering the construction machine 2 to return the construction machine 2 to a predetermined work area, and for example, when the construction machine 2 is not returned to the work area within a predetermined time, in

order to ensure the safety, the operation of the construction machine 2 is stopped at the location.

[0074] Next, in Step S13 (a work completion determination step), the work management unit 10 causes the determination unit 11D of the control unit 11 to determine whether or not the configuration work has been completed in any of the work areas.

[0075] Whether or not the configuration work by the construction machine 2 has been completed is determined by, for example, whether or not a work completion signal has been received from the construction machine 2 or whether or not it has been confirmed that the construction machine 2 has reached a position designated as a work completion position in the work area.

[0076] In addition, instead of or in addition to the above determination, whether or not the configuration work by the automatically operated construction machine 2 has been completed may be determined by: whether or not the work by each construction machine 2 for the embankment material (the target object) achieved the target values; in a case of the bulldozer 2A, whether or not the leveling thickness of the embankment material has reached the preset target value (for example, 25 cm), for example, whether or not the height (the altitude) of the bulldozer 2A derived from the detection values of the position acquisition unit 42 and the state detection unit 43 has increased by the target leveling thickness in the work area; in a case of the vibratory roller 2D, for example, whether or not the trajectory of the vibratory roller 2D moving on the surface of the embankment material, which is obtained on the basis of the detection value of the position acquisition unit 42, has reached the target trajectory (for example, the rolling compaction: six times); and in a case of the backhoe (not shown) that performs the edge shaping of the slope

face, for example, whether or not the angle of a compaction attachment has reached the target angle (for example, 45 degrees).

[0077] In Step S13, when it is determined that the configuration work in any of the work areas has been completed, the process proceeds to Step S14, and the determination unit 11D of the control unit 11 determines whether or not all of the configuration works planned in the work scheduled area A have been completed.

[0078] On the other hand, in Step S13, when it is determined that the configuration work has not been completed in any of the work areas, the process returns to Step S12, and monitoring of the work by each of the construction machines 2 is continued.

[0079] In Step S14, when it is determined that all of the configuration works planned in the work scheduled area A have been completed, the control is temporarily terminated because there is no more work area to be newly set by the work area setting unit 11A.

[0080] On the other hand, when it is determined that all of the configuration works planned in the work scheduled area A have not been completed, the process returns to Step S10, and the work area in which next configuration work is to be performed is set by the work area setting unit 11A.

[0081] Through the steps described above, respective work areas (the preceding work area, the subsequent work area) are set sequentially in the work scheduled area A in each of the work sites 1A, 1B, and 1C (the work regions), and the bank body is gradually constructed as the construction machines 2 respectively perform a predetermined configuration work in each work area.

[0082] According to the embodiment mentioned above, the advantages

described below are afforded.

[0083] As described above, the work management method according to this embodiment is the work management method executed by the work management system 100 that manages, in a predetermined work sites 1A, 1B, and 1C (the work regions), N number of configuration works that are performed by the plurality of construction machines 2 including the construction machine 2 capable of being automatically operated in an ordered manner by performing the Nth-step configuration work after (N-1)th (wherein N is a natural number of two or more) configuration work has been performed. The work management method includes: a work area setting step of sequentially setting, in the work region, N number of work areas from the first work area A1, where the first-step configuration work is to be performed, to the Nth work area, where the Nth-step configuration work is to be performed; and the work completion determination step of determining whether or not (N-1) number of configuration works from the first-step configuration work, which is performed in the first work area A1, to the (N-1)th-step configuration work, which is performed in the (N-1)th work area, have been completed. The (N-1)th-step configuration work or the Nth-step configuration work is performed by the automatically operated construction machine 2, and in the work area setting step, the Nth work area is set within the range of the region of the (N-1)th work area, where the (N-1)th-step configuration work has been determined to be completed in the work completion determination step, preferably within the range that does not extend beyond the region of the (N-1)th work area, and a new (N-1)th work area is set so as to be adjacent to the (N-1)th work area, where the (N-1)th-step configuration work has been determined to be completed in the work completion determination step, and so as not to overlap

with this region.

[0084] As described above, according to the work management method according to this embodiment, because the preceding work area, where the preceding configuration work is to be performed, and the subsequent work area, where the subsequent configuration work, which is performed after the preceding configuration work has been performed, is to be performed, are set completely separately, it is possible to avoid the construction machine 2 that performs the preceding configuration work and the construction machine 2 that performs the subsequent configuration work from performing the work in the same area. Therefore, even in a case in which either of the preceding configuration work and the subsequent configuration work is performed by the automatically operated construction machine 2, because there is no risk of hindering the progress of each other's configuration work, it becomes possible to perform the configuration work efficiently. Therefore, it is possible to improve the construction efficiency when the plurality of construction machines including the automatically operatable construction machines perform the works in a predetermined work region. In addition, because the automatically operated construction machine 2 and the manually operated construction machine 2 will not coexist in the same work area, collision between the construction machines 2 can be avoided, and therefore, it is possible to ensure safety.

[0085] Following modifications are also within the scope of the present invention, and it is also possible to combine the configurations shown in the modification with the configurations described in the above-described embodiment, and to combine the configurations described in the following different modifications.

[0086] The work management method according to the above-mentioned embodiment manages the works performed by the construction machines 2 that are involved in the civil engineering work for constructing the bank body. Instead, the work management method for the construction machine 2 that is executed by the work management system 100 may manage the works performed by the construction machines 2G, 2H, and 2J involved in an excavation, as shown in FIGs. 7A, 7B, and 7C, and in addition, the civil engineering construction projects respectively performed in the work sites 1A, 1B, and 1C managed by the work management system 100 may be different types of construction projects such as the embankment and the excavation.

[0087] In this modification, by repeating a plurality of configuration works shown in FIGs. 7A, 7B, and 7C, the formation level having a predetermined width is formed in the ground. The configuration work shown in FIG. 7A is the first configuration work, in which the ground is excavated and an excavation floor is formed by an automatically operated bulldozer 2G (an excavation machine), the configuration work shown in FIG. 7B is the second configuration work, in which a manually operated bulldozer 2H (the excavation machine) accurately excavates a vicinity of a slope toe, and is the configuration work that is performed after the first configuration work has been performed. In addition, the configuration work shown in FIG. 7C is the third configuration work, in which the slope face is compacted by an automatically operated or manually operated backhoe 2J (a slope face shaping machine) and is the configuration work that is performed after the second configuration work has been performed.

[0088] In other words, the excavation floor in one work location is formed by the following procedure:

- the ground is excavated by a predetermined depth by the bulldozer 2G (the excavation machine);

- any location where the excavation is insufficient, such as a vicinity of the slope toe, for example, is excavated by the bulldozer 2H (the excavation machine); and

- the slope face formed by the excavation is compacted by the backhoe 2J (the slope face shaping machine).

[0089] As described above, an excavation work, which is a single overall work, is completed by performing the plurality of configuration works for the work area, which is a predetermined region, in order, and thereby, the height of the excavation floor is lowered.

[0090] Also in this modification, by performing the second configuration work by the manual operation after completion of the first configuration work performed by the automatic operation, it is possible to correct, by the manual operation, the excavation work location (for example, the vicinity of the slope toe and/or a partially formed roughness) that has been insufficiently finished by the automatic operation. In addition, the first configuration work, which is performed by the automatic operation, is performed by a large construction machine or by a plurality of construction machine, while, in the second configuration work, which is performed by the manual operation, the work requiring a higher precision is performed by a small construction machine or the work is performed by fewer construction machines, and thereby, it is possible to enabling labor reduction and improvement in the construction quality.

[0091] Specifically, for example, in the first configuration work, the work may be performed by the automatic operation by three large bulldozers 2G,

while in the second configuration work, the work may be performed by the manual operation by one small bulldozer 2H.

[0092] In the example shown in FIGs. 7A, 7B, and 7C, the target object is the ground, and the ground is gradually excavated by the bulldozers 2G and 2H such that the height of the excavation floor becomes a predetermined height (the target shape), and subsequently, the slope face is compacted by the backhoe 2J to a predetermined shape that is the target shape. Note that, the excavated earth generated by the excavation is transported out by a dump truck (not shown) as needed.

[0093] In this example, the work content planned in the work planning unit 11B includes: in a case of the bulldozer 2G, the excavation such that the height of the excavation floor is lowered by a predetermined height within a predetermined range; and in a case of the backhoe 2J, the compaction of the slope face within a predetermined range so as to achieve the target shape (a predetermined angle (for example 45 degrees)).

[0094] Next, with reference to FIGs. 8A to 8C, a specific description will be given for the work areas set by the work area setting unit 11A in a case in which three configuration works described above are respectively performed in order.

[0095] FIG. 8A shows a state in which the first work area A1 where the first configuration work by the automatically operated bulldozer 2G, which is the first-step configuration work, is performed is set in an unconstructed area in the work scheduled area A in any one of the work sites 1A, 1B, and 1C (the work regions).

[0096] When the first configuration work performed in the first work area A1 shown in FIG. 8A is completed, as shown in FIG. 8B, a new first work area

A1 is set in the unconstructed area in the work scheduled area A so as to be adjacent to the work-completed first work area DA1 and so as not to overlap with this region. In addition, at the same time, the second work area A2 where the second configuration work by the manually operated bulldozer 2H, which is the second-step configuration work, is performed is set within the range of the region of the work-completed first work area DA1, preferably within the range that does not extend beyond the region of the first work area DA1. Note that, as described above, because the second configuration work is the work of excavating a vicinity of the slope toe, the second work area A2 is set in a part of the work-completed first work area DA1 on the slope toe side.

[0097] In this case, the first configuration work by the automatically operated bulldozer 2G is the preceding configuration work that is performed before the second configuration work by the manually operated bulldozer 2H, the second configuration work by the manually operated bulldozer 2H is the subsequent configuration work that is performed after the first configuration work by the automatically operated bulldozer 2G, the first work area A1 is the preceding work area, and the second work area A2 is the subsequent work area.

[0098] When the first configuration work performed in the first work area A1 shown in FIG. 8B is completed, as shown in FIG. 8C, a new first work area A1 is set in the unconstructed area in the work scheduled area A so as to be adjacent to the work-completed first work area DA1 and so as not to overlap with this region. In addition, when the second configuration work in the second work area A2 shown in FIG. 8B is completed, as shown in FIG. 8C, a new second work area A2 is set within the range of the region of the work-completed first work area DA1 so as to be adjacent to the work-completed

second work area DA2 and so as not to overlap with this region, preferably within the range that does not extend beyond the region of the first work area DA1. In addition, at the same time, the third work area A3 where the third configuration work by the automatically operated or manually operated backhoe 2J, which is the third-step configuration work, is performed is set within the range of the region of the work-completed second work area DA2, preferably within the range that does not extend beyond the second work area DA2. Note that, as described above, because the third configuration work is the work of compacting the slope face, the third work area A3 is set in a part of the work-completed second work area DA2 on the slope face side (on the slope toe side).

[0099] In this case, the second configuration work by the manually operated bulldozer 2H is the preceding configuration work that is performed before the third configuration work by the automatically operated or manually operated backhoe 2J, the third configuration work by the automatically operated or manually operated backhoe 2J is the subsequent configuration work that is performed after the second configuration work by the manually operated bulldozer 2H, the second work area A2 is the preceding work area, and the third work area A3 is the subsequent work area. In other words, while the second configuration work is the subsequent configuration work with respect to the first configuration work, the second configuration work becomes the preceding configuration work with respect to the third configuration work.

[0100] When each configuration work in each work area A1, A2, A3 shown in FIG. 8C is completed, similarly to the above description, new work areas A1, A2, and A3 are respectively set. In this example, because the third configuration work is the final configuration work, the work-completed third

work area DA3 becomes the work-completed area.

[0101] In this manner, in the work scheduled area A, the height of the excavation floor is lowered in order from the areas where all of the configuration works are completed, and these configuration works are repeated until the height of the excavation floor reaches the formation level.

[0102] As described above, in order to improve the construction efficiency also in the excavation that is performed by the plurality of construction machines 2 including the automatically operated construction machine 2, it is required to prevent the work by the construction machines 2 that perform the preceding configuration work from being hindered by the construction machines 2 that perform the subsequent configuration work.

[0103] Therefore, even for the works of each of the construction machines 2 involved in the excavation shown in FIGs. 7A, 7B, and 7C, by managing such works by the work management method for the construction machine 2 executed by the above-described work management system 100, similarly to the above-mentioned embodiment, even in a case in which the preceding configuration work or the subsequent configuration work is performed by the automatically operated construction machine 2, it is possible to efficiently perform the configuration works because there is no risk of hindering the progress of each other's configuration work, and it is possible to ensure the safety because the collision between the construction machines 2 can be avoided.

[0104] Embodiments of the present invention were described above, but the above embodiments are merely examples of applications of the present invention, and the technical scope of the present invention is not limited to the specific constitutions of the above embodiments.

[0105] This application claims priority based on Japanese Patent Application No. 2022-183648 filed with the Japan Patent Office on November 16, 2022, the entire contents of which are incorporated into this specification by reference.

SCOPE OF CLAIMS

Claim 1. A work management method executed by a work management system for managing, in a predetermined work region, a plurality of configuration works respectively performed in order by a plurality of construction machines including an automatically operatable construction machine, the work management method comprising:

a work area setting step of sequentially setting, in the work region, a preceding work area, where a preceding configuration work is to be performed, and a subsequent work area where a subsequent configuration work, which is performed after the preceding configuration work has been performed, is to be performed; and

a work completion determination step of determining whether or not the preceding configuration work performed in the preceding work area has been completed, wherein

the preceding configuration work or the subsequent configuration work is performed by the automatically operated construction machine, and wherein

in the work area setting step,

the subsequent work area is set within a range of a region of the preceding work area where the preceding configuration work has been determined to be completed in the work completion determination step, and

a new preceding work area is set so as not to overlap with the region of the preceding work area where the preceding configuration work has been determined to be completed in the work completion determination step.

Claim 2. The work management method according to claim 1, further

comprising:

a display step of displaying a range of the preceding work area and a range of the subsequent work area set in the work area setting step.

Claim 3. The work management method according to claim 1, further comprising:

a monitoring step of issuing an alarm: when it is determined that the construction machine performing the preceding configuration work in the preceding work area moved out from the preceding work area; or when the construction machine performing the subsequent configuration work in the subsequent work area moved out from the subsequent work area.

Claim 4. The work management method according to claim 1, wherein when the work management system received a work completion signal from the construction machine performing the preceding configuration work, it is determined that the preceding configuration work performed in the preceding work area is completed in the work completion determination step, and

the preceding work area becomes an area where the subsequent work area can be set in the work area setting step.

Claim 5. The work management method according to claim 1, wherein when the construction machine performing the preceding configuration work reached a work completion position set in the preceding work area, it is determined that the preceding configuration work performed in the preceding work area is completed in the work completion determination step, and

the preceding work area becomes an area where the subsequent work area can be set in the work area setting step.

Claim 6. The work management method according to any one of Claims 1 to 5, further comprising:

a work content transmission step of transmitting, to the construction machine, a work content including information related to an area range of a work area, in which the construction machine performs the configuration work, wherein

the construction machine received the work content performs work based on the work content.

Claim 7. A work management method executed by a work management system for managing, in a predetermined work region, N number (wherein N is a natural number of two or more) of configuration works performed by a plurality of construction machines including an automatically operatable construction machine, the configuration works being performed in order by performing a Nth-step configuration work after a (N-1)th configuration work has been performed, the work management method comprising:

a work area setting step of sequentially setting, in the work region, the N number of work areas from a first work area where a first-step configuration work is performed to an Nth work area where the Nth-step configuration work is performed; and

a work completion determination step of determining whether or not (N-1) number of configuration works from the first-step configuration work performed in the first work area to the (N-1)th-step configuration work

performed in an (N-1)th work area have been completed, wherein

the (N-1)th-step configuration work or the Nth-step configuration work is performed by the automatically operated construction machine, and wherein

in the work area setting step,

the Nth work area is set in within a range of region of the (N-1)th work area where the (N-1)th-step configuration work has been determined to be completed in the work completion determination step, and

a new (N-1)th work area is set so as not to overlap with the region of the (N-1)th work area where the (N-1)th-step configuration work has been determined to be completed in the work completion determination step.

Claim 8. The work management method according to claim 7, wherein

in the work area setting step, when there is an (N-2)th configuration work, the new (N-1)th work area is set, within a range of a region of the (N-2)th work area where the (N-2)th configuration work has been determined to be completed in the work completion determination step, so as not to overlap with the region of the (N-1)th work area where the (N-1)th-step configuration work has been determined to be completed in the work completion determination step.