

Description

Large Visual Direct Shear Experiment Platform for Solid Filling Materials

Technical Field

The present invention relates to a physical mechanical property simulation test experiment platform and experiment method for solid filling materials of solid filling coal mining, and more particularly relates to a large visual direct shear experiment platform for solid filling materials.

Background Art

In recent years, a comprehensive mechanized solid filling coal mining technology has become one of the most effective technical path for liberating coal under buildings, water bodies and railways due to its remarkable effects in aspects of controlling overburden rock movement, reducing earth surface subsidence, protecting earth surface buildings, etc. Solid filling materials used in solid filling coal mining mainly include non-viscous bulk materials such as gangue, fly ash and aeolian sand. After being filled into a goaf, the solid filling materials are tamped by a tamping mechanism to become a main body for bearing an overburden rock load and reducing the earth surface subsidence, and physical mechanical properties of the tamped solid filling materials, such as shear strength and deformation-resistant capability are important factors for determining the bearing performance of the tamped solid filling materials and ensuring the filling quality.

At present, the studies on the physical mechanical properties of the solid filling materials are mainly focused on the test of the compression deformation resistant capability of the solid filling materials through a steel tube confined compression experiment while there are few studies on the shear strength of the solid filling materials through a direct shear experiment. Although there are various large direct shear experiment apparatuses in the field of geotechnical engineering at present, a tamping process of the solid filling materials in the goaf cannot be simulated, and therefore the shear resistance characteristics of the tamped solid filling materials cannot be studied.

The patent of invention with the application No.: 201210527053.X discloses a simulation

experiment platform of a solid material compaction system for solid filling coal mining. Although a filling and tamping process of the solid materials in a solid filling mining technology can be simulated in a laboratory to study stress-strain characteristics of different solid filling materials under a confined compression condition and creep characteristics at a continuous constant pressure, direct shear experiment studies cannot be performed on the compacted solid filling materials. At the same time, the material particle movement and crushing conditions and the shear zone development process in the experiment process cannot be observed in the whole process. Therefore, there is an urgent need to develop a large visual experiment platform which can achieve the effects of simulating the tamping process of the solid filling materials in the goaf, performing direct shear experiment studies on the tamped solid filling materials and observing the material particle movement and crushing conditions and the shear zone development process in the experiment process at the same time.

Summary of the Invention

By aiming at the above problems, the present invention provides a direct shear experiment platform and experiment method for solid filling materials for solid filling coal mining. The experiment platform can simulate a tamping process of the solid filling materials in a goaf, and can perform a large direct shear experiment and a confined compression experiment on the tamped solid filling materials. And the material particle movement and crushing conditions and the shear zone development process in the experiment process can be observed in the whole process.

The present invention is achieved by the following technical solution:

A large visual direct shear experiment platform for solid filling materials includes a reaction frame, a tamping machine, a vertical loading system, a shear system and a data monitoring system.

The reaction frame consists of a reaction plate and a platform base, and the reaction plate is supported above the platform base through four upright posts.

The tamping machine consists of two tamping machine oil cylinders, a tamping machine base, a horizontal pushing oil cylinder, a slideway and a tamping plate; the slideway is disposed on the platform base, and the tamping machine base is assembled onto the slideway in a rolling or sliding manner; the two tamping machine oil cylinders are parallelly disposed on the tamping machine base, a rear end portion of a cylinder body of each of the tamping machine oil cylinders is hinged

onto the tamping machine base, and the tamping plate is fixed to the front end of a cylinder rod of each of the tamping machine oil cylinders; the horizontal pushing oil cylinder is disposed between the two tamping machine oil cylinders, a cylinder body of the horizontal pushing oil cylinder is fixed onto the platform base, and a front end of a lever of the horizontal pushing oil cylinder is connected with the tamping machine base; and each of the two tamping machine oil cylinders is provided with a height adjusting oil cylinder, one end of the height adjusting oil cylinder is hinged to the tamping machine base, the other end of the height adjusting oil cylinder is hinged onto the cylinder body of the corresponding tamping machine oil cylinder, and the tamping machine base, the height adjusting oil cylinder and the tamping machine oil cylinder form triangular support.

The vertical loading system consists of a first-stage loading oil cylinder, second-stage loading oil cylinders, a second-stage loading oil cylinder base, a loading plate, charging port oil cylinders and a charging plate; the first-stage loading oil cylinder is vertically disposed under the reaction plate, and a cylinder body of the first-stage loading oil cylinder is disposed on the reaction plate; the second-stage loading oil cylinder base is disposed at an end portion of a cylinder rod of the first-stage loading oil cylinder; cylinder bodies of the second-stage loading oil cylinders are disposed on the second-stage loading oil cylinder base and are vertically downward; the second-stage loading oil cylinders are preferably four and are disposed in a square shape; the loading plate is hinged to end portions of the cylinder rods of the second-stage loading oil cylinders; cylinder bodies of the charging port oil cylinders are disposed on the second-stage loading oil cylinder base, and are located at one side of the second-stage loading oil cylinders near the tamping machine, and the charging plate is hinged to end portions of cylinder rods of the charging port oil cylinders; and the charging port oil cylinders are preferably two.

The shear system consists of an upper shear box and a lower shear box, and both the upper shear box and the lower shear box use transparent materials.

The upper shear box consists of a square top ring and a plurality of square laminating rings. Three edges of the square top ring are of an integral structure, the other edge is a dismountable top ring long strip baffle plate, and the top ring long strip baffle plate is located at one side of the tamping machine; sleeves are disposed at four corners of the square top ring, and the four sleeves are respectively sleeved on the four upright posts. Three edges of each of the square laminating rings are of an integral structure, and the other edge is a dismountable tailing baffle plate. The

square top ring and each of the square laminating rings are sequentially laminated to form the upper shear box, the tailing baffle plates are located at one side of the tamping machine, upper surfaces of two edges (shear direction) of each of the square laminating rings parallel to the slideway are provided with a rolling ball slideway, and rolling balls are disposed in the rolling ball slideway.

The lower shear box is a box body with a bottom and no top cover, three side surfaces of the lower shear box are of a whole, the other surface is formed by laminating a plurality of dismountable lower shear box long strip baffle plates, and the lower shear box long strip baffle plates are located at one side of the tamping machine. Tops of two surfaces of the lower shear box parallel to the slideway are provided with a rolling ball slideway, and rolling balls are disposed in the rolling ball slideway. Rolling wheels are disposed at the bottom of the lower shear box in a direction along the slideway.

The data monitoring system includes pressure sensors disposed on each of the tamping machine oil cylinders, the second-stage loading oil cylinders and the charging port oil cylinders, vertical displacement sensors disposed between the second-stage loading oil cylinder base and the loading plate, vertical displacement sensors disposed between the second-stage loading oil cylinder base and the charging plate, horizontal displacement sensors disposed in a middle portion of one surface of the lower shear box opposite to the tamping machine, and horizontal displacement sensors disposed at one surface of each of the square laminating rings of the upper shear box opposite to the tamping machine.

Convenient fasteners are respectively disposed among the square top ring, the square laminating rings and the lower shear box. By releasing all of the convenient fasteners, the mutual restriction can be relieved. By increasing or decreasing the quantity of the laminating rings, a large direct shear experiment can be performed on the solid filling materials of different heights. By closing all of the convenient fasteners, the mutual restriction can be started, and a large confined compression experiment can be performed on the solid filling materials of different heights.

A large visual direct shear experiment method for solid filling materials for solid filling coal mining includes the following steps:

preparing the large visual direct shear experiment platform for solid filling materials of the present invention.

Step 1: Starting the first-stage loading oil cylinder to enable the second-stage loading oil cylinder base to descend, stopping descending when the rolling ball slideway of the lowermost square laminating ring is in contact with the rolling balls on a top surface of the lower shear box, opening a limiting safety bolt of the first-stage loading oil cylinder, and closing the convenient fastener between the lower shear box and the adjacent square laminating rings to enable the upper shear box and the lower shear box to be connected into a stable integral structure.

Step 2: Starting the second-stage loading oil cylinders to enable the loading plate to descend to a specify height.

Step 3: Performing 1st round charging according to a design requirement, then, moving the tamping machine to be close to the lower shear box, limiting the tamping machine base, and performing 1st round tamping on the solid filling materials according to a designed tamping angle and tamping force until the top of the materials is in contact with the loading plate.

Step 4: Repeating Step 3, performing 2nd, 3rd, 4th, ... round charging and 2nd, 3rd, 4th, ... round tamping, and gradually retreating the tamping machine along with the proceeding of charging, at the same time, installing the lower shear box long strip baffle plate, the tailing baffle plate and the top ring long strip baffle plate at a proper moment from bottom to top to prevent the materials from flowing out and ensuring a tamping effect, starting the charging port oil cylinders after the materials are fully charged and flatly filled and the installation of all of the baffle plates is completed, enabling the charging plate to descend, and stopping descending when a bottom surface of the charging plate and a bottom surface of the loading plate reach the same level.

Step 5: Starting all of the pressure sensors and the vertical displacement sensors, then, starting and cooperatively controlling the charging port oil cylinders and the second-stage loading oil cylinders, enabling the charging plate and the loading plate to synchronously descend in a displacement control manner to load the solid filling materials, and stopping loading when a vertical stress reaches a set value.

Step 6: Adjusting the tamping machine oil cylinder to reach a horizontal state, moving the tamping machine base to enable the tamping machine to be in an optimum loading position, opening a limiting device, connecting the tamping machine tamping plate and the lower shear box through a connector, releasing the convenient fasteners among the lower shear box, each of the square laminating rings and the square top ring, canceling the mutual restriction, and preparing to

perform a large direct shear experiment on the solid filling materials.

Step 7: Starting the horizontal displacement sensor, then, starting the tamping machine, pushing the lower shear box to shear the solid filling materials in a displacement control loading manner so that the solid filling materials at a boundary portion of the upper shear box and the lower shear box sequentially drive materials in the upper portion laminating rings to move while moving by receiving shear force, and stopping loading when the displacement of the lower shear box reaches 20 cm.

Step 8: Switching off all of the sensors, contracting the tamping machine oil cylinder to pull back the lower shear box to an original position, aligning each of the square laminating rings in an artificially assisting manner, at the same time, contracting the second-stage loading oil cylinders and the charging port oil cylinders to pull back the loading plates and the charging plates to original positions, closing the convenient fasteners among the lower shear box, each of the laminating rings and the top ring, starting the mutual restriction again, sequentially dismounting the top ring long strip baffle plate, the tailing baffle plate and the lower shear box long strip baffle plate from top to bottom, performing discharging at a side surface, and starting the second-stage loading oil cylinders to apply impact force to loosen the materials when the materials are tightly compacted and are not easy to discharge.

Step 9: After the discharging is completed, returning all of the oil cylinders and components to original positions for a next experiment.

Step 10: Processing data acquired by and stored in the data monitoring system to obtain a shear intensity parameter of the tamped solid filling materials.

The present invention has the following beneficial effects:

The experiment platform can not only simulate a tamping process of the solid filling materials in a goaf through mutual cooperation of the systems, but also perform a large direct shear experiment and a confined compression experiment on the tamped solid filling materials to obtain results such as a shear strength parameter, stress-strain characteristics and creep characteristics of the tamped solid filling materials. At the same time, the material movement and crushing conditions and the shear zone development process in the experiment process can be observed in the whole process. The platform has a simple structure and multifunction, and is an important experiment platform for deep studying mechanical properties of the tamped solid filling

materials and the influence of the tamping process on the mechanical properties of the filling materials. Study results have important significance on guiding selection of the solid filling materials and optimization of a solid filling coal mining process. The platform can be widely popularized and applied to the technical fields of mining engineering and geotechnical engineering.

Brief Description of the Drawings

FIG. 1 is a schematic diagram of an integral structure of a large visual direct shear experiment platform for solid filling materials of the present invention in an initial state.

FIG. 2 is a schematic diagram of a feeding and tamping process of the large visual direct shear experiment platform for solid filling materials of the present invention.

FIG. 3 is a schematic diagram of a direct shear experiment process of the large visual direct shear experiment platform for solid filling materials of the present invention.

FIG. 4 is a schematic diagram of an integral structure of a large visual direct shear experiment platform shear system for solid filling materials of the present invention.

FIG. 5 is a top view of a tamping machine of the large visual direct shear experiment platform for solid filling materials of the present invention.

FIG. 6 is a bottom view of distribution of second-stage loading oil cylinders and charging port oil cylinders of the large visual direct shear experiment platform for solid filling materials of the present invention.

FIG. 7 is a plane diagram of a rolling ball slideway of the large visual direct shear experiment platform for solid filling materials of the present invention.

FIG. 8 is a plane diagram of a rolling ball groove of the large visual direct shear experiment platform for solid filling materials of the present invention.

FIG. 9 is a schematic structure diagram of a tailing baffle plate of the large visual direct shear experiment platform for solid filling materials of the present invention.

FIG. 10 is a schematic structure diagram of a convenient fastener of the large visual direct shear experiment platform for solid filling materials of the present invention. Among them: FIG. 10(a) is a front view, and FIG. 10(b) is a side view.

In the figures, 1 denotes an upright post; 2 denotes a reaction plate; 3 denotes a platform base;

4 denotes a tamping machine; 5 denotes a tamping machine base; 6 denotes a height adjusting oil cylinder; 7 denotes a horizontal pushing oil cylinder; 8 denotes a slideway; 9 denotes a first-stage loading oil cylinder; 10 denotes a second-stage loading oil cylinder; 11 denotes a second-stage loading oil cylinder base; 12 denotes a loading plate; 13 denotes a charging port oil cylinder; 14 denotes a charging plate; 15 denotes an upper shear box; 16 denotes a lower shear box; 17 denotes a pressure sensor; 18 denotes a vertical displacement sensor; 19 denotes a square laminating ring; 20 denotes a horizontal displacement sensor; 21 denotes a square top ring; 22 denotes a rolling ball; 23 denotes a rolling ball groove; 24 denotes a rolling ball slideway; 25 denotes a lower shear box long strip baffle plate; 26 denotes a tailing baffle plate; 27 denotes a top ring long strip baffle plate; 28 denotes a sleeve; 29 denotes a convenient fastener; 30 denotes a solid filling material; 31 denotes a connector; 32 denotes a tamping plate; 33 denotes a tamping machine oil cylinder; 34 denotes a data transmission line; 35 denotes a signal converter; and 36 denotes a computer.

Detailed Description of the Invention

The present invention will be illustrated in detail in conjunction with drawings and implementations hereafter.

A large visual direct shear experiment platform for solid filling materials mainly consists of six major systems of a reaction frame, a tamping machine, a vertical loading system, a shear system and a data monitoring system. The reaction frame includes 4 upright posts 1 distributed at four corners of the platform, a reaction plate 2 at the top and a platform base 3, which are in high-strength rigid connection with each other. The tamping machine 4 includes a tamping machine base 5, height adjusting oil cylinders 6, a horizontal pushing oil cylinder 7 and a slideway 8. The vertical loading system includes a first-stage loading oil cylinder 9, second-stage loading oil cylinders 10, a second-stage loading oil cylinder base 11, a loading plate 12, a charging port oil cylinder 13 and a charging plate 14. The shear system mainly includes an upper shear box 15 and a lower shear box 16. The data monitoring system includes pressure sensors 17, vertical displacement sensors 18, horizontal displacement sensors 20, a data transmission line 34, a signal converter 35 and a computer 36. The hydraulic system provides power for each of the oil cylinders.

2 tamping machine oil cylinders 33 of the tamping machine are parallelly fixed onto the tamping machine base 5, the tamping machine base 5 is placed on the slideway 8, the slideway 8 and the horizontal pushing oil cylinder 7 are fixed at the platform base 3, the horizontal pushing oil cylinder 7 is located between the 2 tamping machine oil cylinders, an end portion of a cylinder rod is connected with the tamping machine base 5 through a pin shaft, and the tamping machine base 5 can be pushed to move on the slideway 8. The tamping machine base 5 is provided with a limiting device, and before the loading of the tamping machine oil cylinder, the limiting device is switched on to fix the tamping machine base 5 onto the platform base 3. One end of the height adjusting oil cylinder 6 is hinged to the tamping machine base 5, one end is hinged to a cylinder body of the tamping machine oil cylinder 33, swinging of the tamping machine oil cylinder 33 can be controlled, and full-height tamping on solid filling materials 30 can be realized through a swinging angle range. The tamping machine 4 is used as a loading mechanism of a horizontal thrust of the lower shear box 16 when a direct shear experiment is started.

One end of the first-stage loading oil cylinder 9 of the vertical loading system is fixed to the reaction plate 2 through a screw bolt, and one end is connected with the second-stage loading oil cylinder base 11 through a screw bolt. The loading oil cylinders 10 are totally four, one end of each of the loading oil cylinders is fixed to the second-stage loading oil cylinder base 11 through a screw bolt, one end is hinged to the loading plate 12 through a pin shaft. The four second-stage loading oil cylinders 10 are symmetrically distributed in a square shape relative to the loading plate 12, and the actions are completely synchronous during working. The charging port oil cylinders 13 are totally two and are parallelly disposed, one end of each of the charging port oil cylinders is fixed to the second-stage loading oil cylinder base 11 through a screw bolt, one end is hinged to the charging plate 14 through a pin shaft, and the actions of the two charging port oil cylinders 13 are completely synchronous during working. Each of the loading plate 12 and the charging plate 14 is processed by a high-strength steel plate with a thickness of 5 cm, length×width of the loading plate 12 is 150 cm× 200 cm, length×width of the charging plate 14 is 49.5 cm× 200 cm, and a gap being 0.5 cm is reserved between the loading plate and the charging plate in a shear direction.

The upper shear box 15 and the lower shear box 16 of the shear system are processed by a high-strength transparent tempered glass panel with a thickness of 5 cm. The lower shear box 16 is

a box body with a bottom and no cover, and an inner dimension of length× width×height is 200 cm× 200 cm× 150 cm. The upper shear box 15 is a square frame body, with an inner integral dimension of length×width×height is 200 cm× 200 cm× 155.5 cm, which consists of a square top ring 21 with a height of 50 cm and 10 square laminating rings 19 with a height of 10 cm.

Rolling balls 22 are respectively disposed at two sides among the square top ring 21, the square laminating rings 19 and the lower shear box 16 in the shear direction, so as to reduce the mutual friction in the shear process. Rolling ball grooves 23 for installing the rolling balls 22 are formed in upper surfaces of the lower shear box 16 and each of the square laminating rings 19, rolling ball slideways 24 are formed in lower surfaces of each of the square laminating rings 19 and the square top ring 21, the dimensions of the rolling ball grooves 23 and the rolling ball slideways 24 are matched with the dimensions of the rolling balls 22, and an unsealing distance between all components is 0.5 cm.

At one side of the upper shear box 15 and the lower shear box 16 near the tamping machine 4, the side surface of the lower shear box 16 is decomposed into four dismountable lower shear box long strip baffle plates 25 with a height of 30 cm and 1 L-shaped dismountable tailing baffle plate 26 with a height of 30 cm at the top in the vertical direction, threaded holes are formed in two ends of each of the lower shear box long strip baffle plates 25 fixed to two sides of the box body through screw bolts. The side surface of each of the square laminating rings 19 is an L-shaped tailing baffle plate 26 with a height of 10 cm, two ends of the tailing baffle plate 26 (fixed to the laminating rings 19 through screw bolts) are provided with threaded holes. A side surface of the square top ring 21 is decomposed into 2 dismountable top ring long strip baffle plates 27 with a height of 25 cm in a vertical direction, two ends of each of the top ring long strip baffle plates 27 (fixed to the square top ring through screw bolts) are provided with threaded holes, and the square top ring 21 is fixed to the second-stage loading oil cylinder base 11 through screw bolts by sleeving the four upright posts 1 with sleeves 28 at four corners, so that the square top ring 21 can only move in the vertical direction by using the upright posts 1 as tracks.

Convenient fasteners 29 are respectively disposed among the square top ring 21, the square laminating rings 19 and the lower shear box 16. By releasing all of the convenient fasteners 29, the mutual restriction can be relieved. By increasing or decreasing the quantity of the laminating rings 19, a large direct shear experiment can be performed on the solid filling materials 30 of

different heights. By closing all of the convenient fasteners 29, the mutual restriction can be started, and a large confined compression experiment can be performed on the solid filling materials 30 of different heights.

For the data monitoring system, pressure sensors 17 are disposed at each of the tamping machine oil cylinders 33, the second-stage loading oil cylinders 10 and the charging port oil cylinders 13, 4 vertical displacement sensors 18 are disposed between the second-stage loading oil cylinder base 11 and the loading plate 12, 2 vertical displacement sensors 18 are disposed between the second-stage loading oil cylinder base 11 and the charging plate 14, 1 horizontal displacement sensor 20 is disposed between the middle portion of the lower shear box 16 opposite to the tamping machine 4 and the platform base 3, 10 horizontal displacement sensors 20 are disposed between the middle portion of each of the square laminating rings 19 opposite to the tamping machine 4 and the second-stage loading oil cylinder base 11, each of the sensors is connected with a computer 36 through a signal converter 35 via a data transmission line 34, and the computer 36 can perform real-time display and storage on the data of each of the sensors.

Performing a large visual direct shear experiment for solid filling materials by using the experiment platform of the present invention includes the following steps:

a: The first-stage loading oil cylinder 9 is started to enable the second-stage loading oil cylinder base 11 to descend, descending is stopped when the rolling ball slideway 24 of the lowermost square laminating ring 19 is in contact with the rolling balls 22 of the lower shear box 16, a limiting safety bolt of the first-stage loading oil cylinder 9 is opened, and the convenient fastener 29 between the lower shear box 16 and the adjacent square laminating rings 19 are closed to enable the upper shear box 15 and the lower shear box 16 to be connected into a stable integral structure.

b: The second-stage loading oil cylinders 10 are started to enable the loading plate 12 to descend to a specify height.

c: 1st round charging is performed according to a design requirement, then, the tamping machine 4 is moved to be close to the lower shear box 16, the limiting device of the tamping machine base is started, and 1st round tamping is performed on the solid filling materials 30 according to a designed tamping angle and tamping force until the top of the materials is in contact with the loading plate 12.

d: Step c is repeated, 2nd, 3rd, 4th, ... round charging and 2nd, 3rd, 4th, ... round tamping are performed, and the tamping machine 4 gradually retreats along with the proceeding of charging, at the same time, the lower shear box long strip baffle plate 25, the tailing baffle plate 26 and the top ring long strip baffle plate 27 are installed at a proper moment from bottom to top to prevent the materials from flowing out and ensuring a tamping effect, the charging port oil cylinders 13 are started after the materials are fully charged and flatly filled and the installation of all of the baffle plates is completed, the charging plate 14 descends, and descending is stopped when a bottom surface of the charging plate 14 and a bottom surface of the loading plate 12 reach the same level.

e: All of the pressure sensors 17 and the vertical displacement sensors 18 are started, then, the charging port oil cylinders 13 and the second-stage loading oil cylinders 10 are started and are cooperatively controlled, the charging plate 14 and the loading plate 12 synchronously descend in a displacement control manner to load the solid filling materials 30, and the loading is stopped when a vertical stress reaches a set value.

f: The tamping machine oil cylinder 33 is adjusted to reach a horizontal state, the tamping machine base 5 is moved to enable the tamping machine 4 to be located in an optimum loading position, the limiting device is opened, the tamping machine tamping plate 32 and the lower shear box 16 are connected through a connector 31, the convenient fasteners 29 among the lower shear box 16, each of the square laminating rings 19 and the square top ring 21 are released to cancel the mutual restriction, and preparation is made for a large direct shear experiment on the solid filling materials 30.

g: A horizontal displacement sensor 20 is started, then, the tamping machine 33 is started, the lower shear box 16 is pushed to shear the solid filling materials 30 in a displacement control loading manner so that the solid filling materials 30 at a boundary portion of the upper shear box 15 and the lower shear box 16 sequentially drive materials in the upper portion square laminating rings 19 to move while moving by receiving shear force, and the loading is stopped when the displacement of the lower shear box 16 reaches 20 cm.

h: All of the sensors are switched off, the tamping machine oil cylinder 33 contracts to pull back the lower shear box 16 to an original position, each of the square laminating rings 19 is aligned in an artificially assisting manner, at the same time, the second-stage loading oil cylinders 10 and the charging port oil cylinders 13 are contracted to pull back the loading plates 12 and the

charging plates 14 to original positions, the convenient fasteners 29 among the lower shear box16, each of the square laminating rings 19 and the square top ring 21 are closed to start the mutual restriction again, the top ring long strip baffle plate 27, the tailing baffle plate 26 and the lower shear box long strip baffle plate 25 are sequentially dismantled from top to bottom, discharging is performed at a side surface, and the second-stage loading oil cylinders 10 can be started to apply impact force to loosen the materials when the materials are tightly compacted and are not easy to discharge.

i: After the discharging is completed, all of the oil cylinders and components return to original positions for a next experiment.

j: Data acquired by and stored in the data monitoring system is processed to obtain a shear intensity parameter of the tamped solid filling materials 30.

Claims

1. A large visual direct shear experiment platform for solid filling materials, comprising a reaction frame, a tamping machine, a vertical loading system, a shear system and a data monitoring system, wherein

the reaction frame consists of a reaction plate and a platform base, and the reaction plate is supported above the platform base through four upright posts;

the tamping machine consists of two tamping machine oil cylinders, a tamping machine base, a horizontal pushing oil cylinder, a slideway and a tamping plate; the slideway is disposed on the platform base, and the tamping machine base is assembled onto the slideway in a rolling or sliding manner; the two tamping machine oil cylinders are parallelly disposed on the tamping machine base, a rear end portion of a cylinder body of each of the tamping machine oil cylinders is hinged onto the tamping machine base, and the tamping plate is fixed to the front end of a cylinder rod of each of the tamping machine oil cylinders; the horizontal pushing oil cylinder is disposed between the two tamping machine oil cylinders, a cylinder body of the horizontal pushing oil cylinder is fixed onto the platform base, and a front end of a lever of the horizontal pushing oil cylinder is connected with the tamping machine base; and each of the two tamping machine oil cylinders is provided with a height adjusting oil cylinder, one end of the height adjusting oil cylinder is hinged to the tamping machine base, the other end of the height adjusting oil cylinder is hinged onto the cylinder body of the corresponding tamping machine oil cylinder, and the tamping machine base, the height adjusting oil cylinder and the tamping machine oil cylinder form triangular support;

the vertical loading system consists of a first-stage loading oil cylinder, second-stage loading oil cylinders, a second-stage loading oil cylinder base, a loading plate, charging port oil cylinders and a charging plate; the first-stage loading oil cylinder is vertically disposed under the reaction plate, and a cylinder body of the first-stage loading oil cylinder is disposed on the reaction plate; the second-stage loading oil cylinder base is disposed at an end portion of a cylinder rod of the first-stage loading oil cylinder; cylinder bodies of the second-stage loading oil cylinders are disposed on the second-stage loading oil cylinder base and are vertically downward; the loading

plate is hinged to end portions of the cylinder rods of the second-stage loading oil cylinders; cylinder bodies of the charging port oil cylinders are disposed on the second-stage loading oil cylinder base, and are located at one side near the tamping machine, of the second-stage loading oil cylinders, and the charging plate is hinged to end portions of cylinder rods of the charging port oil cylinders;

the shear system consists of an upper shear box and a lower shear box;

the upper shear box consists of a square top ring and a plurality of square laminating rings; three edges of the square top ring are of an integral structure, the other edge is a dismountable top ring long strip baffle plate, and the top ring long strip baffle plate is located at one side of the tamping machine; sleeves are disposed at four corners of the square top ring, and the four sleeves are respectively sleeved on the four upright posts; three edges of each of the square laminating rings are of an integral structure, and the other edge is a dismountable tailing baffle plate; the square top ring and each of the square laminating rings are sequentially laminated to form the upper shear box; the tailing baffle plates are located at one side of the tamping machine, upper surfaces of two edges of each of the square laminating rings parallel to the slideway are provided with a rolling ball slideway, and rolling balls are disposed in the rolling ball slideway;

the lower shear box is a box body with a bottom and no top cover, three side surfaces of the lower shear box are of a whole, the other surface is formed by laminating a plurality of dismountable lower shear box long strip baffle plates, and the lower shear box long strip baffle plates are located at one side of the tamping machine; tops of two surfaces of the lower shear box parallel to the slideway are provided with a rolling ball slideway, and rolling balls are disposed in the rolling ball slideway; and rolling wheels are disposed at the bottom of the lower shear box in a direction along the slideway; and

the data monitoring system comprises pressure sensors disposed on each of the tamping machine oil cylinders, the second-stage loading oil cylinders and the charging port oil cylinders, vertical displacement sensors disposed between the second-stage loading oil cylinder base and the loading plate, vertical displacement sensors disposed between the second-stage loading oil cylinder base and the charging plate, horizontal displacement sensors disposed in a middle portion of one surface of the lower shear box opposite to the tamping machine, and horizontal displacement sensors disposed at one surface of each of the square laminating rings of the upper

shear box opposite to the tamping machine.

2. The large visual direct shear experiment platform for solid filling materials according to claim 1, wherein the second-stage loading oil cylinders are preferably four and are distributed in a square shape.

3. The large visual direct shear experiment platform for solid filling materials according to claim 1, wherein the charging port oil cylinders are preferably two.

4. The large visual direct shear experiment platform for solid filling materials according to claim 1, wherein convenient fasteners are respectively disposed between the square top ring and the adjacent square laminating rings, between the adjacent square laminating rings and between the lowermost square laminating ring and the lower shear box.

5. The large visual direct shear experiment platform for solid filling materials according to claim 1, wherein both the upper shear box and the lower shear box use transparent materials.

6. A method for performing a large visual direct shear experiment on solid filling materials by using the large visual direct shear experiment platform for solid filling materials according to one of claims 1 to 5, comprising the following steps:

Step 1: starting the first-stage loading oil cylinder to enable the second-stage loading oil cylinder base to descend, stopping descending when the rolling ball slideway of the lowermost square laminating ring is in contact with the rolling balls on a top surface of the lower shear box, closing the convenient fastener between the lower shear box and the adjacent square laminating rings to enable the upper shear box and the lower shear box to be connected into an integral structure;

Step 2: starting the second-stage loading oil cylinders to enable the loading plate to descend to a specify height;

Step 3: performing 1st round charging according to a design requirement, then, moving the tamping machine to be close to the lower shear box, limiting the tamping machine base, and performing 1st round tamping on the solid filling materials according to a designed tamping angle and tamping force until the top of the materials is in contact with the loading plate;

Step 4: repeating Step 3, performing 2nd, 3rd, 4th, ...round charging and 2nd, 3rd, 4th, ... round tamping, and gradually retreating the tamping machine along with the proceeding of charging, at the same time, installing the lower shear box long strip baffle plate, the tailing baffle plate and the

top ring long strip baffle plate at a proper moment from bottom to top, starting the charging port oil cylinders after the materials are fully charged and flatly filled and the installation of all of the baffle plates is completed, enabling the charging plate to descend, and stopping descending when a bottom surface of the charging plate and a bottom surface of the loading plate reach the same level;

Step 5: starting all of the pressure sensors and the vertical displacement sensors, then, starting and cooperatively controlling the charging port oil cylinders and the second-stage loading oil cylinders, enabling the charging plate and the loading plate to synchronously descend in a displacement control manner to load the solid filling materials, and stopping loading when a vertical stress reaches a set value;

Step 6: adjusting the tamping machine oil cylinder to reach a horizontal state, connecting the tamping machine tamping plate and the lower shear box through a connector, releasing the convenient fasteners among the lower shear box, each of the square laminating rings and the square top ring, canceling the mutual restriction, and preparing to perform a large direct shear experiment on the solid filling materials;

Step 7: starting the horizontal displacement sensor, then, starting the tamping machine, pushing the lower shear box to shear the solid filling materials in a displacement control loading manner so that the solid filling materials at a boundary portion of the upper shear box and the lower shear box sequentially drive materials in the upper portion laminating rings to move while moving by receiving shear force, and stopping loading when the displacement of the lower shear box reaches 20 cm;

Step 8: switching off all of the sensors, contracting the tamping machine oil cylinder to pull back the lower shear box to an original position, aligning each of the square laminating rings, at the same time, contracting the second-stage loading oil cylinders and the charging port oil cylinders to pull back the loading plates and the charging plates to original positions, closing the convenient fasteners among the lower shear box, each of the square laminating rings and the square top ring, starting the mutual restriction again, sequentially dismounting the top ring long strip baffle plate, the tailing baffle plate and the lower shear box long strip baffle plate from top to bottom, and performing discharging at a side surface;

Step 9: after the discharging is completed, returning all of the oil cylinders and components

to original positions for a next experiment; and

Step 10: processing data acquired by and stored in the data monitoring system to obtain a shear intensity parameter of the tamped solid filling materials.