TESTING DEVICE OF DUAL-CHANNEL DEBRIS FLOW PHYSICAL MODEL UNDER EARTHQUAKE ACTION AND METHOD

Field of the Invention

[0001] This disclosure relates to the technical field of indoor simulation tests, in particular to a testing device of a dual-channel debris flow physical model under an earthquake action and a method.

Background to the Invention

[0002] Debris flows are a type of natural disaster caused by heavy rain, melting snow, reservoir bursting and other reasons, and have such features as sudden occurrence, great destructions and prediction difficulties. With the intensification of global climate change and the continuous expansion of human activities, the occurrence frequency and influence scope of debris flow disasters tend to be increased, seriously threatening people's life and property safety as well as social and economic development. However, a disaster mechanism of debris flows is currently researched mostly from a single perspective, which is not suitable for complicated situations in reality. Therefore, it has great practical significance and far-reaching social influence to carry out relevant research on the disaster mechanism of debris flows and improve the prediction, prevention and control capabilities of debris flow disasters.

[0003] Many large-scale landslides, debris flows and ice avalanches, which are originally in critical stable states, are formed and generate blockage under the action of multi-power internal and external power, and then superpose and converge with main-stream and tributary-stream floods to form a larger-scale disaster chain with a wider influence scope. Their mechanisms have also become a major scientific issue in current research.

[0004] At present, earthquake-debris flow simulation devices are rarely researched, and existing physical models are mainly used for simulating from a single inducing factor, which is significantly different from actual situations. The simulated experimental data is greatly different from the actual debris flow data, leading to low authenticity.

[0005] Therefore, in view of the above-mentioned technical solution, it is necessary to provide a testing device of a dual-channel debris flow physical model under an earthquake action and a method.

Statement of Invention

[0006] In order to compensate for the shortcomings in the prior art, a testing device of a dual-channel debris flow physical model under an earthquake action and a method are proposed in this disclosure to solve the technical problems put forward in the above-mentioned background art.

[0007] The technical solution adopted by the disclosure to solve the technical problems is:

[0008] A testing device of a dual-channel debris flow physical model under an earthquake action, comprising a model platform and a vibration table, wherein

[0009] a tabletop of the vibration table is connected with the model platform, and the vibration table is used for driving the model platform to vibrate;

[0010] an upper end of the model platform is connected to a material box, and a lower end is connected to a sliding system;

[0011] the sliding system is movably connected with the vibration table and a rainfall system;

[0012] a monitoring system is used for test monitoring.

[0013] The model platform comprises a main-stream model platform and a tributary-stream model platform, the main-stream model platform comprises a first bottom plate, a first baffle plate, a rotating shaft, a connecting plate, a third bottom plate, a third baffle plate, a load-bearing column, and a first telescopic column, the first baffle plate is vertically connected to the first bottom plate, the first bottom plate is connected to the connecting plate through the rotating shaft, the other end of the connecting plate is connected to the third bottom plate, the third baffle plate is vertically connected to the third bottom plate, the third bottom plate is connected to a slide-rail platform body through the load-bearing column, the load-bearing column is located at a geometric center of the third bottom plate, the first bottom plate is connected to a contact tabletop through the first telescopic column, and an included angle between the first bottom plate and a horizontal plane is changed by changing a height of the first telescopic column for simulating debris flow effects under different slopes.

[0014] The tributary-stream model platform comprises a second bottom plate, a second baffle plate, and a second telescopic column, the second baffle plate is vertically connected to the second bottom plate, the second bottom plate is connected to the contact tabletop through the second telescopic column, an included angle between a second bottom plate and the horizontal plane is changed by changing a height of the second telescopic column, the second bottom plate and the second baffle plate are made of plastic materials, and an angle between the first bottom plate and the second bottom plate can be changed for simulating superposition and convergence effects of river channels at different angles.

[0015] The material box comprises a material box body, a gravity sensing system and a water amount detector, the material box body has a hollow top and is connected to the first bottom plate in the same direction, the water amount detector is located inside the material box body, shares a vertex with the material box body and has three surfaces connected to the material box body, the water amount detector is used for detecting a water amount inside the material box and simulating debris flow effects under different water amounts, the gravity sensing system comprises a sensing baffle plate and a gravity sensor, the sensing baffle plate is vertically connected to the bottom of the material box body and connected to the first bottom plate, the gravity sensor is embedded inside the sensing baffle plate for detecting gravity, a critical value can be set, and the baffle plate is automatically opened when a set value is reached.

[0016] The vibration table comprises a contact table, a load-bearing table, compressible pulley blocks, a contact tabletop and a shift lever, the contact table comprises a contact tabletop, the shift lever is connected to the contact tabletop and located at a geometric center below the contact tabletop, the load-bearing table comprises a load-bearing tabletop and support columns, four support columns are connected to the load-bearing tabletop and located at four vertexes below the load-bearing tabletop, a cavity with a width equal to a diameter of a cross-sectional circle of the shift lever is provided along a width direction at the geometric center of the load-bearing tabletop, allowing the shift lever to move therein, the compressible pulley blocks comprise first pulleys, first bearings and spring tubes, the first bearings are located at circle centers of the first pulleys, four first pulleys are below slidably connected to the load-bearing tabletop and above connected to the contact tabletop through the spring tubes, and influences of earthquakes on debris flows are simulated by horizontally and vertically moving the model platform through the vibration table.

[0017] The rainfall system comprises a support frame, a rainfall device and a water storage tank, the support frame comprises load-bearing rods and an upper bracket, four load-bearing rods are vertically connected to the upper bracket and are located at four vertexes below the upper bracket, the rainfall device comprises a water passage plate, a spray nozzle, a water inlet pipe, a water pressure detector, a switch, and a water pump, the water passage plate is fixed to the upper bracket and is located above the upper bracket, the water passage plate is connected to a multi-purpose box body through the water inlet pipe, the water pressure detector and the switch are located at one end of the water inlet pipe close to the water passage plate, the water pump is located at one end of the water inlet pipe close to the multi-purpose box body, and the spray nozzle is vertically connected below the water passage plate and arranged in a rectangular array; the water storage tank comprises the multi-purpose box body, a partition plate, and a filter net, the multi-purpose box body is above connected to the water inlet pipe and below connected to sliding rails, protrusions at a bottom of the multi-purpose box body fit depressions at tops of the sliding rails to achieve sliding, the partition plate is located at a geometric center of the multi-purpose box body along the width direction, the filter net is located inside the partition plate, the partition plate divides the multi-purpose box body into two parts, with a left half part used for receiving a solid-liquid mixture flowing out of the third bottom plate and a right half part used for storing water to provide a water source for the rainfall device, and the filter net is used for filtering impurities to achieve water circulation.

[0018] The monitoring system comprises vidicon devices and a monitoring device; the vidicon devices comprise camera holders and high-speed vidicons, the camera holders are located on two load-bearing rods close to the multi-purpose box body, the high-speed vidicons are fixed above the camera holders, two vidicon devices are respectively located on the load-bearing rods at a trisection point close to a top end and a trisection point close to a lower end, and are respectively used for photographing material changes on the first bottom plate and the second bottom plate as well as superposition and convergence effects and an accumulation effect of the debris flows on the third bottom plate, the monitoring device comprises an operating table, table columns and a computer, four table columns are vertically connected to four vertexes below the operating table, the computer is placed on the operating table in a contact manner, and the high-speed vidicons achieve real-time monitoring on testing effects by photographing real-time images and transmitting them to the computer.

[0019] The sliding system comprises a slide-rail platform body and lockable pulley blocks, the slide-rail platform body comprises a base and sliding rails, two sliding rails are located on the base and are recessed toward a bottom, the lockable pulley blocks comprise second pulleys, second bearings, and buckles, the second bearings are located at circle centers of the second pulleys, the buckles are located above the second pulleys, the second pulleys can be moved and locked by opening and closing the buckles, and eight second pulleys are located inside the sliding rails and have upper parts connected to four load-bearing rods and four support columns, which can achieve movements of the vibration table and the rainfall system.

[0020] Provided is a method for the testing device of a dual-channel debris flow physical model under an earthquake action, wherein the method is an experimental method for debris flow disasters induced by rainfall and an experimental method for debris flow disasters induced by earthquake superposed rainfall; the experimental method for debris flow disasters induced by rainfall comprises the following steps:

[0021] S1: according to a simulation experiment scheme, preparing the model platform and detrital materials in the material box, wherein the detrital materials are mainly composed of gravels and sand grains, assembling the model platform according to experimental requirements, adjusting an angle of the model platform and an angle between the main-stream model and the tributary-stream model, and mounting the water amount detector and the gravity sensing system;

[0022] S2: according to rainfall characteristics (water amount, duration and rainfall area), debugging experimental equipment and moving the rainfall system to a designated position;

[0023] S3: starting the rainfall system and the monitoring system, performing rainfall as designed, recording data of various sensors, monitoring data, and change processes of the materials on the model platform in a rainfall process;

[0024] S4: observing and recording superposition and convergence effects of materials on the main-stream model and the tributary-stream model on the third bottom plate by the high-speed vidicons;

[0025] S5: observing and recording accumulation processes of the materials on the main-stream model and the tributary-stream model on the third bottom plate by the high-speed vidicons;

[0026] S6: completing test operation steps and analyzing a disaster mechanism of debris flows caused by rainfall and process parameters thereof.

[0027] Therein, the experimental method for debris flow disasters induced by earthquake superposed rainfall comprises the following steps:

[0028] S11: according to a simulation experiment scheme, preparing the model platform and detrital materials in the material box, wherein the detrital materials are mainly composed of gravels and sand grains, assembling the model platform according to experimental requirements, adjusting an angle of the model platform and an angle between the main-stream model and the tributary-stream model, and mounting the water amount detector and the gravity sensing system;

[0029] S12: according to simulated earthquake characteristics and rainfall characteristics (water amount, duration and rainfall area), debugging experimental equipment and moving the vibration table and the rainfall system to designated positions;

[0030] S13: starting the vibration table, the rainfall system and the monitoring system, performing vibration and rainfall as designed, recording data of various sensors, monitoring data, and change processes of materials on the model platform in vibration and rainfall processes;

[0031] S14: observing and recording superposition and convergence effects of materials on the main-stream model and the tributary-stream model on the third bottom plate by the high-speed vidicons;

[0032] S15: observing and recording accumulation processes of the materials on the main-stream model and the tributary-stream model on the third bottom plate by the high-speed vidicons;

[0033] S16: completing test operation steps and analyzing a disaster mechanism of debris flows caused under earthquake and rainfall dual-factor conditions and process parameters thereof.

[0034] This disclosure has the following beneficial effects: three factors, namely superposition and convergence of main and tributary streams, earthquakes and rainfall, as well as their combinations are taken as the inducing factors of geological disasters in this disclosure, which can be used in the laboratory to simulate the initiation and influencing factors of debris flow disasters under complex conditions such as rainfall with different intensities, superpositions and convergences at different angles and multiple types of earthquakes, thereby simulating the complicated conditions when disasters are formed. The model platform can be used for simulating the process in which main-stream and tributary-stream debris flows superpose and converge to form a larger-scale debris flow under the action of multi-power internal and external power; the material box contains detrital materials for simulating the debris flow, and influences of water on the detrital materials are simulated by the rainfall system; the rainfall system can be used for providing a water source, and a water amount is detected by a water amount detector in the material box to simulate influences of different water amounts on the formation of the debris flows; the sliding system can achieve movements of the rainfall system and the vibration table by sliding rails and lockable pulley blocks; furthermore, this disclosure can also simulate influences of earthquakes on the debris flows by horizontally and vertically moving the model through the vibration table. Compared with the prior art, this disclosure achieves the simulation of multiple inducing factors such as superposition and convergence of main and tributary streams, precipitation actions, and earthquakes, making simulation results more realistic.

Brief Description of the Drawings

[0035] In order to explain the technical solutions in implementations of this disclosure or in the prior art more clearly, drawings required to be used in description of the implementations or the prior art are briefly introduced below. Obviously, the drawings described below are merely some implementations of this disclosure, and for those of ordinary skill in the art, other drawings can also be obtained without exerting creative efforts according to these drawings.

[0036] FIG. 1 is a structural schematic diagram of an implementation provided by this disclosure;

[0037] FIG. 2 is a schematic diagram in an implementation provided by this disclosure after combination;

[0038] FIG. 3 is a structural schematic diagram of an implementation of part I of a material box in an implementation provided by this disclosure;

[0039] FIG. 4 is a structural schematic diagram of an implementation of part I of telescopic pulley blocks in an implementation provided by this disclosure;

[0040] FIG. 5 is a bottom cross-sectional view of an implementation of part I of a load-bearing tabletop in an implementation provided by this disclosure;

[0041] FIG. 6 is a structural schematic diagram of an implementation of part I of lockable pulley blocks in an implementation provided by this disclosure;

[0042] FIG. 7 is a schematic diagram of a formation phenomenon of debris flows under a slope of 8° to 12.5° in this disclosure;

[0043] FIG. 8 is a schematic diagram of a formation phenomenon of debris flows under a slope of 12.5° to 17.5° in this disclosure;

[0044] FIG. 9 is a schematic diagram of a formation phenomenon of debris flows under a slope of 17.5° to 25° in this disclosure;

[0045] FIG. 10 is a diagram of this disclosure, showing four debris flows with different basin areas at different elevations.

[0046] Reference signs in the figures: 1. model platform; 11. Main stream model platform; 111. First bottom plate; 112. First baffle plate; 113. Rotating shaft; 114. Connecting plate; 115. Third bottom plate; 116. Third baffle plate; 117. Load-bearing column; 118. First telescopic column; 12. Tributary-stream model platform; 121. Second bottom plate; 122. Second baffle plate; 123. Second telescopic column; 2. Material box; 21. Material box body; 22. Gravity sensing system; 221. Sensing baffle plate; 222. Gravity sensor; 23. Water amount detector; 3. Vibration table; 31. Contact table; 311. Contact tabletop; 312. Shift lever; 32. Load-bearing table; 321. Load-bearing tabletop; 322. Support column; 33. Compressible pulley block; 331. First pulley; 332. First bearing; 333. Spring tube; 4. Rainfall system; 41. Support frame; 411. Load-bearing rod; 412. Upper bracket; 42. Rainfall device; 421. Water passage plate; 422. Spray nozzle; 423. Water inlet pipe; 424. Water pressure detector; 425. Switch; 426. Water pump; 43. Water storage tank; 431. Multi-purpose box body; 432. Partition plate; 433. Filter net; 5. Monitoring system; 51. Vidicon device; 511. Camera holder; 512. High-speed vidicon; 52. Monitoring device; 521. Operating table; 522. Table columns; 523. Computer; 6. Sliding system; 61. Slide-rail platform body; 611. Base; 612. Sliding rail; 62. Lockable pulley block; 621. Second pulley; 622. Second bearing; 623. Buckle.

Detailed Description

[0047] It should be noted that the implementations and features of the implementations of this disclosure may be combined with each other without conflict.

[0048] In the description of this disclosure, it should be understood that terms of "central", "longitudinal", "transverse", "up", "down", "front", "rear", "left", "right", "vertical", "horizontal", "top", "bottom", "inner" and "outer" indicate direction or position relationships shown on the basis of the drawings, and are only intended to facilitate the description of this disclosure and the simplification of the description rather than to indicate or imply that the indicated device or element must have a specific direction or be constructed and operated in a specific direction, and therefore, shall not be understood as a limitation to this disclosure. In addition, the terms of "first" and "second", etc. are only used for the purpose of description, rather than being understood to indicate or imply relative importance or implicitly specify the number of indicated technical features. Thus, the feature limited by "first" and "second", etc. can explicitly or impliedly include one or more of such features. In the description of this disclosure, unless otherwise stated, the meaning of "a plurality of" is two or more.

[0049] In the description of this disclosure, it should be noted that, unless otherwise clearly specified and limited, the terms of "installation", "connected" and "connecting" should be understood in a broad sense, and for example, may be fixed connection, detachable connection, or integral connection; may be mechanical connection or electrical connection; and may be direct connection or indirect connection through an intermediate medium, or inner communication between two elements. For those of ordinary skill in the art, the specific meanings of the above terms in this disclosure may be understood according to specific conditions.

[0050] The implementations of this disclosure are described in detail below in conjunction with the accompanying drawings, but this disclosure can be implemented in many different ways as defined and covered by the claims.

[0051] This disclosure is further described in detail below in conjunction with FIGs. 1–10,

[0052] A testing device of a dual-channel debris flow physical model under an earthquake action comprises a model platform 1 and a vibration table 3, wherein

[0053] a tabletop of the vibration table 3 is connected with the model platform 1, and the vibration table 3 is used for driving the model platform 1 to vibrate;

[0054] an upper end of the model platform 1 is connected to a material box 2, and a lower end is connected to a sliding system 6;

[0055] the sliding system 6 is movably connected with the vibration table 3 and a rainfall system 4;

[0056] a monitoring system 5 is used for test monitoring.

[0057] The model platform 1 comprises a main-stream model platform 11 and a tributary-stream model platform 12, the main-stream model platform 11 comprises a first bottom plate 111, a first baffle plate 112, a rotating shaft 113, a connecting plate 114, a third bottom plate 115, a third baffle plate 116, a load-bearing column 117, and a first telescopic column 118, the first baffle plate 112 is vertically connected to the first bottom plate 111, the first bottom plate 111 is connected to the connecting plate 114 through the rotating shaft 113, the other end of the connecting plate 114 is connected to the third bottom plate 115, the third baffle plate 116 is vertically connected to the third bottom plate 115, the third bottom plate 115 is connected to a slide-rail platform body 611 through the load-bearing column 117, the load-bearing column 117 is located at a geometric center of the third bottom plate 115, the first bottom plate 111 is connected to a contact tabletop 311 through the first telescopic column 118, and an included angle between the first bottom plate 111 and a horizontal plane is changed by changing a height of the first telescopic column 118 for simulating debris flow effects under different slopes.

[0058] The tributary-stream model platform 12 comprises a second bottom plate 121, a second baffle plate 122, and a second telescopic column 123, the second baffle plate 122 is vertically connected to the second bottom plate 121, the second bottom plate 121 is connected to the contact tabletop 311 through the second telescopic column 123, an included angle between a second bottom plate 121 and the horizontal plane is changed by changing a height of the second telescopic column 123, the second bottom plate 121 and the second baffle plate 122 are made of plastic materials, and an angle between the first bottom plate 111 and the second bottom plate 121 can be changed for simulating superposition and convergence effects of river channels at different angles.

[0059] The material box 2 comprises a material box body 21, a gravity sensing system 22, and a water amount detector 23, the material box body 21 has a hollow top and is connected to the first bottom plate 111 in the same direction, the water amount detector 23 is located inside the material box body 21, shares a vertex with the material box body 21, and has three surfaces connected to the material box body 21, the water amount detector 23 is used for detecting a water amount inside the material box 2 and simulating debris flow effects under different water amounts, the gravity sensing system 22 comprises a sensing baffle plate 221 and a gravity sensor 222, the sensing baffle plate 221 is vertically connected to the bottom of the material box body 21 and connected to the first bottom plate 111, the gravity sensor 222 is embedded inside the sensing baffle plate 221 for detecting gravity, a critical value can be set, and the baffle plate is automatically opened when a set value is reached.

[0060] The vibration table 3 comprises a contact table 31, a load-bearing table 32, compressible pulley blocks 33, a contact tabletop 311, and a shift lever 312, the contact table 31 comprises a contact tabletop 311, the shift lever 312 is connected to the contact tabletop 311 and located at a geometric center below the contact tabletop 311, the load-bearing table 32 comprises a load-bearing tabletop 321 and support columns 322, four support columns 322 are connected to the load-bearing tabletop 321 and located at four vertexes below the load-bearing tabletop 321, a cavity with a width equal to a diameter of a cross-sectional circle of the shift lever 312 is provided along a width direction at a geometric center of the load-bearing tabletop 321, allowing the shift lever 312 to move therein, the compressible pulley blocks 33 comprise first pulleys 331, first bearings 332, and spring tubes 333, the first bearings 332 are located at circle centers of the first pulleys 331, four first pulleys 331 are below slidably connected to the load-bearing tabletop 321 and above connected to the contact tabletop 311 through the spring tubes 333, and influences of earthquakes on debris flows are simulated by horizontally and vertically moving the model platform 1 through the vibration table 3.

[0061] The rainfall system 4 comprises a support frame 41, a rainfall device 42, and a water storage tank 43, the support frame 41 comprises load-bearing rods 411 and an upper bracket 412, four load-bearing rods 411 are vertically connected to the upper bracket 412 and are located at four vertexes below the upper bracket 412, the rainfall device 42 comprises a water passage plate 421, a spray nozzle 422, a water inlet pipe 423, a water pressure detector 424, a switch 425, and a water pump 426, the water passage plate 421 is fixed to the upper bracket 412 and is located above the upper bracket 412, the water passage plate 421 is connected to a multi-purpose box body 431 through the water inlet pipe 423, the water pressure detector 424 and the switch 425 are located at one end of the water inlet pipe 423 close to the water passage plate 421, the water pump 426 is located at one end of the water inlet pipe 423 close to the multi-purpose box body 431, and the spray nozzle 422 is vertically connected below the water passage plate 421 and arranged in a rectangular array; the water storage tank 43 comprises the multi-purpose box body 431, a partition plate 432, and a filter net 433, the multi-purpose box body 431 is above connected to the water inlet pipe and below connected to sliding rails 612, protrusions at a bottom of the multi-purpose box body 431 fit depressions at tops of the sliding rails 612 to achieve sliding, the partition plate 432 is located at a geometric center of the multi-purpose box body 431 along the width direction, the filter net 433 is located inside the partition plate 432, the partition plate 432 divides the multi-purpose box body 431 into two parts, with a left half part used for receiving a solid-liquid mixture flowing out of the third bottom plate 115 and a right half part used for storing water to provide a water source for the rainfall device 42, and the filter net 433 is used for filtering impurities to achieve water circulation.

[0062] The monitoring system 5 comprises vidicon devices 51 and a monitoring device 52; the vidicon devices 51 comprise camera holders 511 and high-speed vidicons 512, the camera holders 511 are located on two load-bearing rods 411 close to the multi-purpose box body 431, the high-speed vidicons 512 are fixed above the camera holders 511, two vidicon devices 51 are respectively located on the load-bearing rods 411 at a trisection point close to a top end and a trisection point close to a lower end, and are respectively used for photographing material changes on the first bottom plate 111 and the second bottom plate 121 as well as superposition and convergence effects and an accumulation effect of the debris flows on the third bottom plate 115, the monitoring device 52 comprises an operating table 521, table columns 522, and a computer 523, four table columns 522 are vertically connected to four vertexes below the operating table 521, the computer 523 is placed on the operating table 521 in a contact manner, and the high-speed vidicons 512 achieve real-time monitoring of testing effects by photographing real-time images and transmitting them to the computer 523.

[0063] The sliding system 6 comprises a slide-rail platform body 61 and lockable pulley blocks 62, the slide-rail platform body 61 comprises a base 611 and sliding rails 612, two sliding rails 612 are located on the base 611 and are recessed toward a bottom, the lockable pulley blocks 62 comprise second pulleys 621, second bearings 622, and buckles 623, the second bearings 622 are located at circle centers of the second pulleys 621, the buckles 623 are located above the second pulleys 621, the second pulleys 621 can be moved and locked by opening and closing the buckles 623, and eight second pulleys 621 are located inside the sliding rails 612 and have upper parts connected to four load-bearing rods 411 and four support columns 322, which can achieve movements of the vibration table 3 and the rainfall system 4.

[0064] Provided is a method for the testing device of a dual-channel debris flow physical model under an earthquake action, wherein the method is an experimental method for debris flow disasters induced by rainfall and an experimental method for debris flow disasters induced by earthquake superposed rainfall; the experimental method for debris flow disasters induced by rainfall comprises the following steps:

[0065] S1: according to a simulation experiment scheme, preparing the model platform 1 and detrital materials in the material box 2, wherein the detrital materials are mainly composed of gravels and sand grains, assembling the model platform 1 according to experimental requirements, adjusting an angle of the model platform 1 and an angle between the main-stream model 11 and the tributary-stream model 12, and mounting the water amount detector 23 and the gravity sensing system 22;

[0066] S2: according to rainfall characteristics (water amount, duration and rainfall area), debugging experimental equipment and moving the rainfall system 4 to a designated position;

[0067] S3: starting the rainfall system 4 and the monitoring system 5, performing rainfall as designed, recording data of various sensors, monitoring data, and change processes of materials on the model platform 1 in a rainfall process;

[0068] S4: observing and recording superposition and convergence effects of materials on the main-stream model 11 and the tributary-stream model 12 on the third bottom plate 115 by the high-speed vidicons 512;

[0069] S5: observing and recording accumulation processes of the materials on the main-stream model 11 and the tributary-stream model 12 on the third bottom plate 115 by the high-speed vidicons 512;

[0070] S6: completing test operation steps and analyzing a disaster mechanism of debris flows caused by rainfall and process parameters thereof.

[0071] Therein, the experimental method for debris flow disasters induced by earthquake superposed rainfall comprises the following steps:

[0072] S1: according to a simulation experiment scheme, preparing the model platform 1 and detrital materials in the material box 2, wherein the detrital materials are mainly composed of gravels and sand grains, assembling the model platform 1 according to experimental requirements, adjusting an angle of the model platform 1 and an angle between the main-stream model 11 and the tributary-stream model 12, and mounting the water amount detector 23 and the gravity sensing system 22;

[0073] S2: according to simulated earthquake characteristics and rainfall characteristics (water amount, duration and rainfall area), debugging experimental equipment and moving the vibration table 3 and the rainfall system 4 to designated positions;

[0074] S3: starting the vibration table 3, the rainfall system 4 and the monitoring system 5, performing vibration and rainfall as designed, recording data of various sensors, monitoring data, and change processes of materials on the model platform 1 in vibration and rainfall processes;

[0075] S4: observing and recording superposition and convergence effects of materials on the main-stream model 11 and the tributary-stream model 12 on the third bottom plate 115 by the high-speed vidicons 512;

[0076] S5: observing and recording accumulation processes of the materials on the main-stream model 11 and the tributary-stream model 12 on the third bottom plate 115 by the high-speed vidicons 512;

[0077] S6: completing test operation steps and analyzing a disaster mechanism of debris flows caused under earthquake and rainfall dual-factor conditions and process parameters thereof.

[0078] This disclosure has the following beneficial effects: three factors, namely superposition and convergence of main and tributary streams, earthquakes and rainfall, as well as their combinations are taken as the inducing factors of geological disasters in this disclosure, which can be used in the laboratory to simulate the initiation and influencing factors of debris flow disasters under complex conditions such as rainfall with different intensities, superpositions and convergences at different angles and multiple types of earthquakes, thereby simulating the complicated conditions when disasters are formed. The model platform can be used for simulating the process in which main-stream and tributary-stream debris flows superpose and converge to form a larger-scale debris flow under the action of multi-power internal and external power; the material box contains detrital materials for simulating the debris flow, and influences of water on the detrital materials are simulated by the rainfall system; the rainfall system can be used for providing a water source, and a water amount is detected by a water amount detector in the material box to simulate influences of different water amounts on the formation of the debris flows; the sliding system can achieve movements of the rainfall system and the vibration table by sliding rails and lockable pulley blocks; This disclosure also simulates influences of earthquakes on the debris flow by horizontally and vertically moving the model through the vibration table. Compared with the prior art, this disclosure achieves the simulation of multiple inducing factors such as superposition and convergence of main and tributary streams, precipitation actions, and earthquakes, making simulation results more realistic.

[0079] Case presentation: collecting historical seismic activities in debris flow prediction areas and their surrounding areas, including epicenter locations and magnitude M; determining the distance D between the debris flow prediction area and the epicenter and the sensible radius R of the earthquake, wherein if $R \geq D$, it is determined that the seismic activity is related to the development of debris flows in the debris flow prediction area; if $R < D$, it is determined that the seismic activity has nothing to do with the development of debris flows in the debris flow prediction area; calculating the standardized precipitation index SPI value of the debris flow prediction area according to the collected historical long-sequence rainfall data, wherein if SPI ≤ -0.5, it is determined that drought is related to the development of debris flows in the debris flow prediction area; if SPI>-0.5, it is determined that drought has nothing to do with the development of debris flows in the debris flow prediction area. Calculation is performed according to the following formula.

$$R=\begin{cases}10^{-2.803+0.974M} & M\le 5\\ 10^{0.6110+0.289M} & M>5\end{cases}, \quad f(x)=\frac{1}{\beta^{\gamma}\Gamma(\gamma)}x^{\gamma-1}e^{-x/\beta},$$

$$\Gamma(\gamma)=\int_0^{\infty}x^{\gamma-1}e^{-x}dx, \quad \hat{\gamma}=\frac{1+\sqrt{1+4A/3}}{4A};\hat{\beta}=\bar{x}/\hat{\gamma}, \quad A=\lg\bar{x}-\frac{1}{n}\sum_{i=1}^{n}\lg x_i,$$

$$P(x<x_0)=\int_0^{\infty}f(x)dx, \quad Z=S\frac{t-(c_2t+c_1)t+c_0}{((d_3t+d_2)t+d_1)t+1.0}, \quad t=\sqrt{\ln\frac{1}{P^2}},$$

[0080] In case of P>0.5, S=1; In case of P≤0.5, S=-1 and c0=2.515517; c1=0.802853; c2=0.010328; d1=1.432788; d2=0.189269; d3=0.001308; The Z value obtained according to the above values is a standardized precipitation index SPI. Under a single rainfall condition, taking Linxiang County in Hunan Province as an example, there have been no recorded earthquakes occurring in Linxiang County and its surrounding areas in the past 50 years; by the calculation of SPI=-1.1≤-0.5, it is inferred that rainfall is prone to causing debris flows. D is 434.3 km, an earthquake magnitude is 8, R is 837.5 km, and according to D being smaller than R, it is inferred that earthquakes are prone to causing debris flows; according to SPI=-0.94≤-0.5, it is inferred that rainfall is prone to causing debris flows. Case data can prove that there are differences in the effects of induced debris flows under the single rainfall condition and under earthquake superposed rainfall multi-factor conditions.

[0081] Case presentation: according to a large number of debris flow initiation phenomena and processes, 25 groups of tests at different slopes (8° to 25°) are carried out. According to the testing data, it is found that the formation of debris flows by loose materials greatly varies under different slopes. According to the testing phenomena, the debris flow initiation mode under the runoff action can be roughly divided into three situations. The specific operation process of an experiment is as follows: obtaining a slope of a hillside; determining a debris flow formation mode according to the slope, wherein the debris flow initiation modes comprise a blocked mode, an erosion mode, and a sliding mode; recording experimental data according to experimental phenomena.

[0082] 1. As shown in FIG. 7, under the slope of 8° to 12.5°, the formation phenomenon of the debris flow can be summarized as a debris flow in the blocked mode.

[0083] 2. As shown in FIG. 8, under the slope of 12.5° to 17.5°, the formation phenomenon of the debris flow can be summarized as a debris flow in the erosion mode.

[0084] 3. As shown in FIG. 9, under the slope of 17.5° to 25°, the formation phenomenon of the debris flow can be summarized as a debris flow in the sliding mode.

[0085] As shown in FIG. 10, when experiments are carried out under multiple factors such as different slopes and different rainfall capacities, the occurrence of debris flows varies. The figure shows outbreak situations of four debris flows with different basin areas at different elevations and under different rainfall conditions. Case data can also prove that there are differences in the effects of induced debris flows under a single condition and under multi-factor conditions.

[0086] The above shows and describes the basic principles, main features and advantages of this disclosure. The technicians in this industry should understand that this disclosure is not limited by the above implementation. The above implementation and descriptions in the specification only illustrate the principles of this disclosure. Without departing from the spirit and scope of this disclosure, this disclosure will have various changes and improvements, and these changes and improvements all fall within the scope of this disclosure claimed for protection.