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Analysis of New Materials Application in Municipal Road Construction

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Abstract: In order to promote the development of road traffic in our country, it is necessary to strengthen the research on municipal road construction technology, constantly innovate construction technology and construction technique, and then effectively ensure the rapid development of urban traffic. This paper mainly elaborates on asphalt road surface regeneration technology, modified asphalt concrete, concrete road surface anti-cracking technology, three-dimensional printing technology, composite material road surface, polymer composite materials, etc., to ensure the development of urban transportation and the quality of municipal road projects.

Keywords: Road construction; Asphalt; Material

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1. Introduction

With the rapid urbanization of our country, the scale and amount of road engineering construction has increased. In order to promote the development of road traffic in our country, it is necessary to strengthen the research on municipal road construction technology, constantly innovate construction technology and construction technique, and then effectively ensure the rapid development of urban traffic. With the application of new materials in municipal road construction, the construction quality has been effectively improved. Urbanization has promoted the development of urban road engineering construction. But in the process, many problems have been discovered in municipal road projects. For example, with the acceleration of urbanization, road projects have gradually increased. However, due to lack of attention, the quality of municipal road projects is poor, and their service life is relatively short. Therefore, in order to ensure the development of urban traffic and the quality of municipal road engineering, it is necessary to strengthen the research and application of new materials for municipal road construction.

2. Application value of new materials for municipal road construction

2.1. Reducing urban road maintenance costs

The urban road construction project is a major project that requires a lot of manpower and material resources. At the same time, in order to ensure the quality of urban road construction, higher standards have been put forward for construction operations, making the construction of the entire project more difficult [1]. Moreover, when building roads, if building materials are not selected properly, it is likely to cause various problems on urban roads, which will in turn lead to an increase in maintenance costs in the later period. In the construction of urban roads, increasing the intensity of new use can ensure the quality of road construction from the root, reduce various accidents caused by material problems, and thus reduce

maintenance costs in the later period.

2.2. Reducing the impact on the surrounding environment

In the construction of urban road projects, due to its construction characteristics, it is bound to cause great disturbance to the surrounding natural environment. In particular, conventional building materials such as conventional asphalt concrete have caused great damage to the surrounding natural environment. At the same time, the process of paving the road is very noisy. Increasing the use of various new asphalt building materials can effectively solve the problems above, reduce the impact on the surrounding natural environment and the consumption of heavy polluting energy such as oil and gasoline, and improve the natural environment around the city, so that the environmental benefits of the city can be reflected to the greatest extent.

2.3. Increasing the benefits of urban road construction

The use of new building materials with excellent characteristics can solve various construction problems in the construction of urban roads, and it can greatly alleviate the workload of urban road engineering, ensure the quality of engineering work, and achieve better results. In the past, the low efficiency of engineering construction had a lot to do with the quality of building materials. Therefore, the use of new building materials can not only solve the problem of urban construction fundamentally, but also carry out technological innovation in urban construction, thereby improving the comprehensive benefits of urban construction.

3. Applying new materials and technologies in municipal road construction

In order to ensure the construction quality of municipal road projects, new materials should be actively applied. For example, new materials such as high-performance asphalt mixture, plastic-stabilized gravel, and foam concrete have been widely used in municipal road construction. However, due to the late start of municipal road construction in our country and the immaturity of related technologies, there are still some problems in the application of new materials. Therefore, relevant enterprises should intensify research on municipal road construction technology to improve the application efficiency of new materials in municipal road construction [2-4].

3.1. Asphalt road surface regeneration technology

Asphalt road surface regeneration technology refers to adding a new surface layer on the asphalt road surface to make it into a road again. However, in the process of asphalt road surface regeneration, it is important to pay attention to the following issues: (1) The old asphalt road surface needs to be crushed, screened, heated, etc. before being paved on the new asphalt mixture to form new asphalt; (2) the control of regeneration temperature and time is very important, because it directly affects the quality of the regenerated road surface; (3) in order to avoid secondary pollution during the regeneration of the old asphalt road surface, it is necessary to protect the original environment and try to use environmentally friendly materials to process recycled asphalt mixture; (4) when overlaying old asphalt road surface, regenerant must be added to the original road surface according to a certain proportion, so that its quality be guaranteed; (5) if the original asphalt road surface needs to be resurfaced, the milling thickness and the amount of old asphalt mixture after milling should be determined according to the actual situation when milling the road surface; (6) when heating the original road surface, in order to improve the temperature and quality of the mixture, a high-temperature heating vehicle or heating furnace can be used. In addition, the equipment and raw materials required in the regeneration technology is costly. Therefore, it is necessary to strengthen the research and application of regeneration technology, and constantly innovate its technological level and

construction technology, so as to effectively ensure the quality of municipal road construction.

3.2. Performance of modified asphalt mixture

Modified asphalt is a commonly used mixed material in road engineering, which can meet the requirements of road engineering and has been widely used in construction sites [5]. The anti-rutting performance of the road has also been significantly improved, and its main features are as follows:

(1) It improves the surface characteristics of asphalt
Modified asphalt mainly consists of natural stone and colloidal polymers, which contain a large amount of nitrogen, sulfur, and oxygen elements, which can improve the viscosity and stickiness of asphalt, thereby ensuring the stability of asphalt and achieving better results. In addition, asphaltene has a greater adsorption effect on colloids, which makes it easier to form colloids, thereby significantly improving the bonding strength with aggregates. In short, modified asphalt improves the anti-rutting performance of asphalt concrete.

(2) It has a grid structure and has a restrictive effect on strengthening the road surface
In the preparation of the asphalt mixture, the composition of asphalt mixture preparation can be adjusted accordingly. In addition, under the action of stirring, shearing, etc., the mixture of asphalt and aggregate will be more homogenized in the modified asphalt. After adding modified asphalt into the aggregate, the final form would be in filaments or flats, thus constituting the fiber-reinforced composite material of the composite material. The deformed body of the asphalt road surface additive has the effect of restraining and strengthening when compound is formed. Besides, this mixture has high anti-rutting properties, which is of great significance to road construction and use.

(3) It is stable, durable, and has high anti-rutting ability
High-performance asphalt mixture is a new type of asphalt mixture, which has good stability, durability, anti-rutting ability and is able to withstand high temperatures. In addition, high-performance asphalt mixture has good noise reduction ability and durability, and at the same time, it has good application value in municipal road construction. Some measures need to be taken to further improve the application of high-performance asphalt mixture in municipal road construction. (i) The quality of the raw materials should be improved, and the storage of raw materials should be scientifically managed. Besides, the mixing process of asphalt mixture should also be improved. (ii) The time of asphalt mixture mixing should be properly selected. (iii) Road compaction should be done well to improve the quality of road rolling.

3.3. Anti-crack technology of concrete road surfaces

If the construction of concrete road surface is not up to standard, it will lead to cracks on the road surface, which seriously affects the performance of the road surface. Therefore, it is necessary to strengthen the research on anti-cracking technology of concrete road surface in the construction of municipal roads. Anti-cracking technology for concrete road surfaces mainly include two aspects. Firstly, before the concrete road surface is constructed, it must be thoroughly inspected to ensure that all parameters of the concrete road surface meet the standard requirements. Secondly in order to further improve the construction quality and efficiency of municipal roads, new materials should be applied, especially the comprehensive definition of the application range of new materials. The most commonly used new materials include high-performance rubber asphalt, cement fly ash cementitious material, mineral fiber and carbon fiber. The quality of concrete road surface and crack resistance of concrete road surface can be improved by applying new materials in municipal road engineering. When selecting new materials, various factors must be considered. The impact and ratio of raw materials, the impact of the ratio of raw materials and structure of road on the performance of the road should be fully considered. Secondly, the ratio of materials should be done well-designed in this

process. At the same time, the research and application of municipal road engineering construction technology and construction technique should also be strengthened [6].

3.4. 3D printing technology

Three-dimensional printing technology is a new technology that can realize the free combination and change of materials, making the design of engineering structures more flexible, and has a wide range of applications in municipal road engineering. Different from traditional design methods, 3D printing technology mainly involves creating models through software, optimizing them, and turning them into solid models, and completing the designs according to design drawings. Calculation and analysis are performed using computer software, and the data is processed and corrected accordingly. The model is printed using a 3D printer. The application of 3D printing technology can improve the construction quality and efficiency of the construction of municipal road projects [7,8]. In addition, the application of this technology in municipal road construction can also effectively save raw materials, thereby reducing costs.

3.5. Composite road surface

There are big problems with traditional road surface of urban roads. For example: when the traffic volume is large, the road surface tends to crack, which will not only affect the performance of the road surface, but also cause great traffic safety hazards. In this case, composite road surface can be used. The material belongs to a new type of composite material, which is mainly composed of high-strength fiber and low-modulus cement concrete. Compared to traditional materials, this material not only has better toughness, but also has strong flexural and impact resistance [9]. In addition, this material also has good elasticity. This is mainly because it has good deformation ability and is less prone to cracks. Compared to traditional road surfaces, composite road surface has better performance in terms of structural strength, impact resistance, deformation capacity, and earthquake resistance. This material is also highly feasible in construction. However, since this material is a new type of material, there are still many problems in the actual construction process that need to be further solved. Therefore, to maximize the advantages of composite materials in municipal road construction, it is necessary to further strengthen the research and application of this material.

3.6. Polymer composites

Polymer composites are a new type of composite material made of polymer compound as the matrix with several other compounds added. Polymer composites have many advantages compared to traditional materials. For example, polymer composite materials are not easily affected by external factors during construction; the material loss during construction is small, and the environmental pollution is minor. Polymer composites also have a certain degree of flexibility and can be processed many times. Therefore, the application of polymer composites in municipal road construction helps to improve the quality of the project [10]. With the rapid development of the economy and the advancement of science and technology, the construction of municipal roads is also developing rapidly. In the process of municipal road construction, new materials can effectively improve the quality of roads, thereby providing people with a better, safer, and more comfortable living environment. Municipal road engineering is one of the important infrastructures of urban construction. Through the rational application and innovation of new materials, the quality of municipal road engineering can be effectively improved, thereby effectively improving the level and quality of urban construction.

3.7. Plastic-stabilized gravel

Plastic-stabilized gravel is a new type of composite material, which is formed by adding polymer particles

to the gravel and extruded to form a road surface base with strong bearing capacity, deformation resistance, and aging resistance. Plastic-stabilized gravel is a low-density, high-strength material that can be used in constructions such as urban roads and airport runways. Some enterprises in our country have begun to research and explore related technologies of plastic-stabilized gravel and have achieved great results. The application of plastic-stabilized gravel can improve the strength and stiffness of the road surface and prevent reflective cracks on the road surface. However, since plastic-stabilized gravel is a new type of material, its performance is still lacking compared to traditional materials, so there are some problems in its application. For example: the quality inspection technology of plastic-stabilized gravel is not well-established, and the relevant standards are not uniform enough. Hence, relevant enterprises should continue to explore the construction technology of plastic-stabilized gravel to improve the quality of the project.

3.8. Foam concrete

Foam concrete is a type of lightweight porous concrete with low density, which is made of cement or Portland cement as the main cementitious material, and it is directly foamed by a foaming machine. Compared with ordinary concrete. It is less dense, and has good thermal insulation performance, good frost resistance, and is highly impermeable, so it has been widely used in municipal road construction. However, foam concrete structure itself comes with a few disadvantages such as insufficient pores and it is easily eroded by rainwater. The process of manufacturing foam concrete is simple, it can be easily applied in construction, and it is strong, durable, and can resist corrosion. However, due to the high density of foam concrete, it may affect traffic safety when it is applied in municipal road construction. For this reason, construction personnel should optimize the density of foam concrete according to the actual situation. In addition, it is necessary to do a good job in drainage design to ensure that the drainage system is functional.

4. Conclusion

In conclusion, with the continuous development of social economy, people's living standards continue to improve. In the process of urban construction, municipal road projects are gradually increasing, which can not only make travelling more convenient, but also enhance the image of the city. This means that the construction of municipal road projects is closely related to people's quality of life. Therefore, new materials can be used based on the project to ensure that its quality meets the relevant standards and technical requirements. In addition, new materials must be fully understood, and construction technologies and construction techniques must be constantly innovated.

Disclosure statement

The authors declare no conflict of interest.

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Application of Long-Span Continuous Bridge Technology in Bridge Construction

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Abstract: In order to promote the rapid development of urbanization in our country, it is necessary to improve the construction level and technology of bridge engineering. For long-span continuous bridge technology, it has the characteristics of wide application range, various applicable conditions, and short construction period. Therefore, it is necessary to pay attention to the application of long-span continuous bridge technology. This article mainly analyzes its application in bridge construction, hoping to provide some reference for future use.

Keywords: Bridge; Long-span continuous bridge technology; Construction quality

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1. Introduction

Our country's economy has been developing along with urbanization. Bridge engineering, which is an important part of urbanization construction, is closely related to people's lives and socioeconomic development, and it plays an important role in urban transportation. The key link in the bridge construction process is highly difficult and has many influencing factors. As a prestressed structure, the long-span continuous bridge has a continuous structural form and is integrated with the pier, which allows uniform bearing capacity and high rigidity of the long-span continuous bridge, therefore meeting the requirements of road and railway transportation. In recent years, due to the increasing number of bridge projects in China, the technology of long-span continuous bridges has entered a relatively complete development period. Long-span continuous bridges has good quality, are highly adaptable and easily maintained, and have a long service life. Moreover, the long-span continuous bridge is made of steel, which can effectively reduce negative bending moments on the structure, so that it is more stable, durable, and has good seismic performance. In the construction of a bridge, technicians should utilize technology according to the conditions of the region, to reduce the unfavorable factors for bridge construction and ensure the construction and service life of the entire bridge [1-5].

2. Project overview

With a bridge project in a city as an example, it is a prestressed concrete continuous bridge spanning four major rivers with a total length of 939.44 m. The construction site of the bridge is located near the river, and according to the relevant design documents, the span layout of the bridge is 35 + 72 + 70 + 72 + 50 m. Both the main span and side span were constructed by cantilever concreting with form-traveler, the beam section of the cantilever concreting with form-traveler adopts box section, and there are three forms of box girders: single box with three chambers, single box with two chambers, and two boxes with two chambers.

The side and middle spans are made of C40 concrete. The main girder is in the form of a single-box with three-chambers, and the height of the box girder is about 11 m. The superstructure of the bridge consists of prefabricated and assembled prestressed concrete T-beams. The main structures of the bridge are as follows: the main bridge is a 7–40 m prestressed concrete continuous box girder bridge; the approach is a 20–80 m prestressed concrete cast-in-place continuous box girder bridge; the abutments and anchorages are bored cast-in-place pile foundations; pier 0# and pier 1# are pier bodies; the pile foundations at pier 2#–6# are bored pile foundations with a diameter of 1.5 m. The main girder of the bridge project adopts the form of single box with single chamber, the bridge is 38 m wide, and the structure is horizontally symmetrically arranged. Among them, the two ends of the beam section are round-ended beam section, and the length of the beam section is 11.12–13.30 m. The bridge is a long-span continuous bridge, and the designed load is of a first-level highway.

The geological conditions of the bridge site of the bridge project are as follows: the upper structure and the middle and lower structure. The upper part acts as a temporary support for the main beam during the construction stage and the pouring stage of form-traveler cantilever; the middle and lower structure part is the caps, pier columns, bridge abutments of the substructure, and bored pile foundations in the foundation construction stage.

3. The key to the construction control of long-span continuous bridges in bridge construction

3.1. Difficulties in construction

The scope of the bridge construction is relatively large, and the process comes with many difficulties. The first difficulty is in scaffolding for cantilever concreting on the main girder. Besides, the large deformation in the hanging basket casting process affects the stability of the main beam and the structural safety. Thirdly, during cantilever concreting with form-traveler, it is necessary to control the concrete slump, the width of the crack, and the elevation of the beam section. Therefore, we must pay attention to the application of long-span continuous bridge technology in bridge engineering.

3.2. Construction with cantilever concreting method

In the process of bridge construction, it is necessary to select the most suitable construction method while considering the construction environments in order to ensure the quality of the project. In the construction of long-span continuous bridges, the cantilever concreting method is used for bridge construction, which has the several advantages.

(1) The construction will not be affected by the weather. Construction can proceed on windy or rainy days, which not only helps shorten the overall construction period, but also effectively reduces pollution of the surrounding environment [6].

(2) The structure of cantilever method is simple and adaptable. During cantilever concreting, it is necessary to reasonably select the appropriate type of form-traveler according to the construction environment. Among them, for the T-structure cantilever, steel truss beams, or steel plate trusses are generally used as form-traveler. In order to make the bridge structure stable and safe, it is necessary to select the appropriate type of form-traveler.

(3) The construction method of bridge cantilever concreting can be affected by many factors. Therefore, when carrying out bridge cantilever concreting, it is necessary to select a suitable concrete proportioning method.

(4) Since the balanced cantilever method will be affected by many factors during the application process, it is necessary to strictly control the temperature and humidity of the concrete during the pouring process. Besides, it is necessary to protect the concrete with proper measures.

(5) There are a few points to pay attention to when using the form-traveler to travel: (i) when the form-traveler travels to the position of the vertical formwork, it needs to be leveled; (ii) the connection between the bridge cantilever section and the vertical formwork scaffold must be grouted; (iii) before the form-traveler moves, it is necessary to clean the inside of the form-traveler and between the beams, as well as areas between the beam and the vertical formwork scaffold; (iv) After the bridge cantilever concreting is completed, the cantilever end needs to be dismantled. In order to avoid the affecting the beam alignment, it is necessary to strictly control the alignment of the cantilever concreting section of the bridge; (v) in order to reduce creeping caused by the temperature difference of concrete at the cantilever end of the bridge while pouring, it is necessary to optimize the construction process, specifically setting up thermal insulation measures; (vi) the maintenance work must be done well, for example, if the concrete cracks or the surface temperature is too high, etc., it is necessary to deal with them in time.

3.3. Stress control

Due to the unique structural characteristics of bridges, in the construction of long-span continuous bridges, the stress-influencing factors include temperature stress, load, creep, structural stress, and many other factors. When calculating the pre-load, the influencing factors of the pre-load must be fully considered, and its load and real expansion under load should be considered theoretically. In most cases, the local displacement must be analyzed, and the stress caused by it must be closely monitored. In order to accurately predict the stress of the section, a special stress tester must be used [7]. After the load condition on the bridge is understood, a suitable method of controlling the stress should be adopted. When there are obvious differences or errors between the actual load and the estimated load, structural inspection should be carried out immediately, so as to understand the location and cause of the problem. Subsequently, corresponding measures should be taken to solve the problem, so as to ensure the deviation between the designed stress and the actual stress is within an acceptable range.

3.4. The stability of the control structure

Due to the improvement of the technical level, many new bridge span construction techniques have emerged in the construction of long-span continuous bridges. However, during the long-term operation of many bridges, traffic accidents have been caused due to insufficient bearing capacity, resulting in the instability of the bridge. The overall stability of highway bridges is related to its actual construction and safety in future use, so it must be stabilized and reinforced, which is an important part of safety maintenance [8].

3.5. Control bridge alignment

Bending and deformation are the most common problems of bridges. In fact, many factors are responsible for the bending and deformation of bridges. Therefore, the structure of the bridge has changed, resulting in different positioning deviations in the original design parts. To ensure that the bridge construction are not affected by the bridge structure, it must be strictly controlled, so as to prevent deformations of the bridge [9].

3.6. Construction safety issues

There are often various unavoidable risk factors in the construction of bridges, which will affect the safe operation of bridge projects. In addition, the current domestic construction management system and labor laws are not perfect, leading to potential safety hazards in bridge construction. Therefore, construction enterprises should try their best to ensure the safety of the construction process and the overall construction quality to avoid safety accidents. Proper safety measures should be taken during the construction of a bridge,

and it is important to follow the relevant laws and regulations. Besides, the managers of the construction site must strictly control all aspects of the construction, so as to better improve the safety of the entire construction [10] and reduce the probability of safety accidents on the passer-by. Safety management on construction sites can not only effectively manage the work of construction workers, but also reduce potential safety hazards during construction and ensure the health of construction workers.

4. Long-span continuous bridge technology in bridge construction

4.1. Construction plan

The actual situation should be considered during bridge structure design, and the construction plan should be divided into multiple stages. The main aspects of a construction plan include scaffolding, scaffold pre-loading, system conversion, and closure. The scaffolding should be consistent with the designed height of the bridge, and a flat sand layer should be laid underneath, so as to ensure the stability and safety of the construction. Before the concrete is poured, the sundries on the scaffold should be cleaned up, and the bridge should be inspected. At the same time, the concrete should be proportioned and tested to ensure that its quality is satisfactory.

4.2. Scaffold pre-load

Before the construction of the bridge, sufficient materials must be prepared first, and then the pre-load height of the scaffold should be calculated. It is necessary to consider the number of materials such as concrete and steel bars according to the local conditions before designing, and then prepare the correct volumes of material according to relevant regulations. In addition, it is necessary to strictly control the scaffold and concrete pre-loading process.

4.3. System conversion

The balanced cantilever method is usually chosen in bridge construction. Before construction, it is necessary to ensure that the length of the cantilever is sufficient, and then stabilize it by setting temporary support. The balanced cantilever method is mainly based constructing the cantilever after the installation of a form-traveler. It should be noted that the balanced cantilever method has certain limitations, and there will usually be problems such as formwork deformation and concrete cracking.

4.4. Closure

During the construction of the bridge, the closing work is generally carried out after the end of the No. 0 beam section. Because there is some concrete in the No. 0 beam section, cracking will occur if the closing work is not properly carried out. In addition, attention should be paid to the installation and removal of the temporary scaffold during closing to avoid damaging the scaffold.

4.5. Monitoring technology

In the construction of long-span continuous bridges, the monitoring work mainly consists of monitoring the stress and the temperature. These two parameters should be well-controlled before construction. The methods of monitoring can be derived from similar projects, and the temperature and stress during the construction period of the long-span continuous bridge should be carried out in real time. In addition, when carrying out stress monitoring, it is necessary to use Building Information Modeling (BIM) technology to carry out 3D simulation of the bridge and compare the simulation with the preset simulation model to find the difference between the two. A reasonable design, optimization and improvement can then be carried out to ensure the optimal stress of the project. Through real-time monitoring of the temperature of bridges, box girders, and bridges, it was found that the bridges will have different degrees of cracking in different

environments, and the bridges should be modified to ensure the overall performance of the bridges.

4.6. Scaffolding

When scaffolding, the use of bowl scaffolding was emphasized, and the force and stability of the beam body was calculated. Before formal assembly, its actual bearing capacity should be checked first. Usually, scaffold is placed at the place without gaps, and its bearing capacity must comply with the construction regulations. C20 grade cement mortar can be used to improve the stability of the foundation. Drainage pipes were added on both sides of the reinforcement surface to avoid blockage and improve drainage efficiency. During the construction process, scaffolding was carried out along the horizontal direction of the bridge, and the distance between each scaffold should be 60 cm. In the horizontal direction of the scaffold, a scaffold device was set up at every 3 rows. A 15 cm square of material was placed above or below the stand, which can be adjusted. The square wood was covered with bamboo rubber, and its thickness was 15 mm.

5. Conclusion

In conclusion, with the progress of society, our country's economy is also developing rapidly. Therefore, the people's demands are also increasing, which leads to the continuous development of our country's urban traffic construction, and the pressure on urban traffic is also increasing. As an important part of urban construction, bridge engineering is of great significance to the development of modern transportation. At present, there are still some deficiencies in our country's bridge construction technology, and it is necessary to further improve the level and quality of its construction technology. In order to solve the problems in the bridge construction process, we must pay attention to the application of long-span continuous bridges, which is of great significance to the urbanization of our country. The application of long-span continuous bridge technology is analyzed in this paper. The application of this technology not only improves the quality and level of bridge construction, but also promotes urbanization in our country. Long-span continuous bridge technology is an emerging technology, and many details need to be emphasized during the construction process. Only by doing a good job in all segments before, during, and after construction can the healthy development of bridge engineering be driven.

Disclosure statement

The authors declare no conflict of interest.

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Construction of Teaching Case Base of *Anti-Seismic Design of Building Structure*

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Abstract: *Anti-Seismic Design of Building Structures* is an important course in civil engineering majors, and it is also a course that pays equal attention to theory and practice. Therefore, by establishing a case base for *Anti-Seismic Design of Building Structures*, the obscure theoretical knowledge can be taught to students in the form of examples, and the knowledge becomes intuitive. In this way, the students' understanding of anti-seismic design theory and the efficiency of teaching can be improved, and the students' interest in learning can be stimulated.

Keywords: Building structure; Anti-seismic design; Case base

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1. Introduction

According to statistics, there are about 5 million earthquakes every year around the world, and some earthquakes can only be detected by seismographs because they are too far away or that their shock waves are too small. Earthquakes that caused serious harm to people occurred only a dozen to twenty times in history, but once an earthquake occurs, it will cause serious damage to people's lives and property safety. Therefore, it is important to do a good job in the anti-seismic design of a building. Therefore, the construction of a case base for *Anti-Seismic Design of Building Structure* can provide more educational resources for students majoring in civil engineering. This online and offline (hybrid) teaching method can not only make classes more interesting and allow students to have a better understanding of the subject, but also enhance students' ability to discover and solve problems.

2. Overview of case base construction

Different from the traditional teaching method, case-based teaching pays more attention to the understanding of cases. It is a new interactive and open teaching method. Case teaching requires careful planning and preparation. It is important to make sure that the case matches the actual teaching content and plays a role in guiding students.

Case-based teaching has been welcomed by most teachers and students and has been popularized in colleges and universities in many countries. Students are able to think from different perspectives through case studies in combination with theories, and they can discuss about the cases and analyze them. In this way, students can gain a better understanding of the subject and explain it to others. Besides, the traditional educational concept that only focuses on imparting knowledge can be transformed, and theoretical teaching can be integrated with practical lessons, so that students can be more interested in learning while grasping the cases, and improve their comprehensive quality. The construction of a case base is necessary for case-

based teaching. Large and small cases at home and abroad are collected in a case base, so that students can have a deeper and more thorough understanding of the theories learned. Case-based teaching can make up for the shortcomings of traditional teaching, in which students can understand the theories and improve their practical skills while studying the case.

3. Significance of case base construction

The construction of a case base is helpful for students to understand theoretical knowledge. *Anti-Seismic Design of Building Structure* is course in civil engineering major that involves many theories, which focuses on the development of thinking skills. Therefore, it is impossible to achieve this goal through traditional teaching methods alone. Therefore, with the help of the case base, the teacher can turn obscure theoretical knowledge in the textbook into vivid, intuitive, and figurative examples through case studies, so that students can master theoretical knowledge and improve their comprehensive quality in the discussion of cases. The case base contains pictures, videos, building information modeling (BIM) models, animations, etc., which are visually intuitive [1]. Teachers can use the cases in the case base to make the lessons immersive, so that students can understand the case more intuitively and the theories behind it.

Secondly, the case base can enhance students' ability in designing anti-seismic buildings. The purpose of *Anti-seismic Design of Building Structures* is not only to master theoretical knowledge, but more importantly, to put the theoretical knowledge into practice. *Anti-Seismic Design of Building Structures* is a complex course. From model selection to construction measures, every part of it cannot be taught using traditional teaching methods alone. However, the construction of a case base of *Anti-Seismic Design of Building Structures* can integrate real engineering with the design plan, where the teacher leads the students in analyzing the design drawings of the real case, reproduce the whole process of design drawing. Teachers can even let the students analyze the design draft and propose optimization measures to improve students' designing skills, so that students can applied the theoretical knowledge they have learned.

Finally, the construction of the case base can better allow students to be the main body of the classroom. In traditional teaching, the role of the teacher is emphasized, in which the teacher is the main body of teaching, and students passively accept knowledge. This one-way process of imparting knowledge is not ideal and cannot grab the attention of students. When constructing the case base and adopting the method of case-based teaching, students can have a preview of the core content of the lessons before class, thereby making it easier for teachers to explain theoretical knowledge in class, thus leaving more time for students to discuss, communicate, and analyze the cases. In this way, autonomous learning can be encouraged, and students will gain self-confidence and a sense of accomplishment in the process of discussing, researching, and solving problems.

4. The overall concept case base construction of *Anti-Seismic Design of Building Structures*

Firstly, a professional team should be created to build a case base according to the syllabus, learning objectives, and course requirements. Teachers can then collect and write cases according to the content of the course, edit materials, sort out cases, and discuss the use of cases together. For example, when the topic is about earthquake and earthquake resistance, the core content of the lesson will be the causes and hazards of earthquakes, the transmission and characteristics of anti-seismic waves, the terminology of earthquakes, and the classification standards for anti-seismic fortification. Materials like domestic and foreign news reports on earthquakes, cause analysis, and the direction of anti-seismic waves in the form of animation and video can then be collected. Teachers can then select and play videos from the case base during their lessons, and extract terms related to earthquakes, causes and hazards of earthquakes, transmission and characteristics of anti-seismic waves, etc. from the videos or materials, so as to cultivate their students' sensitivity to information.

Secondly, the case base can be diversified. In addition to videos, animations, pictures, etc., the case base can also include BIM models, virtual simulation technology, and other technologies, so that the form and content of case-based teaching is more vivid. For example, when teaching anti-seismic design of concrete structures, the core content of the course will be the anti-seismic level, frame structure damage due to earthquakes, frame structure design, anti-seismic shear wall structure damage, and shear wall anti-seismic performance evaluation. In this case, teachers can use pictures to show students the damage of strong columns and weak beams and columns and strong beams of multi-storey frame structures caused by earthquakes. At the same time, they can also use BIM models to show students the damage of concrete frame structures and deformation and construction of reinforcement. Teachers can teach their students how to evaluate the anti-seismic performance of shear walls through virtual simulation experiments.

Finally, teachers should fully utilize the case base. The ultimate purpose of building a case base is to improve classroom teaching. Therefore, teachers should think about how to make good use of the case base. For example, when the chapter is about conceptual design of structures, its core content would be irregular planes, vertical irregular surfaces, the setting of anti-seismic joints, and multiple lines of anti-seismic defense. Teachers can choose different types of irregular schemes from the cases for students to understand them. However, in the teaching of the setting of anti-seismic joints and multiple anti-seismic defense lines, teachers should not just show pictures, but also analyze the cases, from the layout to the setting of multiple anti-seismic defense lines. In other words, teachers should select the cases according to the teaching objectives, guide students to discover the pros and cons of the cases, and strengthen the teacher-student interactions. Teachers should guide students to think in a directional way, so that they can grasp the course content in the process of participating in case analysis.

5. Teaching with the *Anti-Seismic Design of Building Structures* case base

The purpose of constructing the teaching case base of *Anti-Seismic Design of Building Structures* is to maximize the advantages of case-based teaching, stimulate students' interest in learning, deepen the mastery of theoretical knowledge of *Anti-Seismic Design of Building Structures*, improve anti-seismic designing skills, and stimulate students' potential in anti-seismic building design. The main contents of *Anti-Seismic Design of Building Structure* case base include three aspects: The first one is classic earthquake disasters in ancient and modern China and foreign countries, the second one is anti-seismic design, and the third one is simulation experiments.

In the teaching of this course, teachers can use earthquake disasters that have occurred in the history of ancient and modern China and foreign countries as examples to let students understand the hazards of earthquakes and the consequences of inadequate earthquake prevention, so that students can learn from past experiences. Students will then be more aware of the importance of earthquake prevention. After students have learned anti-seismic design from the case studies, they can then evaluate the design plan, and teachers can guide students in designing an anti-seismic plan. Students can then improve their designing skills while perfecting the plan. The simulation experiment involves using simulation software to simulate reality, conduct experiments on the anti-seismic design, which can stimulate students' innovation skills, and cultivate students' logical thinking.

The construction of *Anti-Seismic Design of Building Structures* case base can not only realize the sharing of online and offline teaching resources, but also promote teaching reform and innovation, improves students' practical skills, and encourage active learning.

6. Problems in the case-based teaching of *Anti-seismic Design of Building Structures*

The construction of *Anti-seismic Design of Building Structures* case base in China still falls behind its demands. Although it has progressed from borrowing foreign cases to independent collection and

compilation of local cases, it is undeniable that the construction of *Anti-Seismic Design of Building Structures* case bases started relatively late, and there are still some problems.

First of all, the quality of the case bases for *Anti-seismic Design of Building Structures* is low, which is firstly reflected in the quantity. Although many cases from ancient and modern China and foreign countries have been compiled in the case base, most of the cases are similar, and there are not many classic cases. There is a lack original design schemes in the case base. Secondly, most of the earthquake case studies are shallow, and there is not much for students to explore and study. In addition, because there is no unified standard when selecting cases, the quality of cases in the case base is uneven. For example, some cases are completely reproduced from newspapers or the Internet, and some cases have incomplete information, so it is difficult to apply them in teaching.

Secondly, the sources of cases are limited. There are two main sources of cases in the current case base, one is real cases collected and edited from the Internet, newspapers, and other channels; and the other type consist of new cases modified by relevant personnel based on information such as the syllabus, teaching objectives, and theoretical knowledge combined with relevant materials. Therefore, it is difficult to collect comprehensive and systematic cases for teachers to use in their lessons. At the same time, because the construction of the case base lacks the necessary incentives, the staff do not realize the significance of case bases when collecting the cases. Besides, not enough attention is given to the construction of case bases, so the staff lack enthusiasm, which in turn makes the construction of the case base difficult.

Furthermore, the case base is not well-utilized. One of the reasons for the construction of the case base is to enable teachers to find cases that meet the course content and improve the teaching quality through case studies. However, although teachers are aware of the importance of case-based teaching, and are also willing to use some cases in their lessons, the cases used are often directly obtained from newspapers or the Internet, which are in the form of pictures and texts, making it difficult to achieve the purpose of case-based teaching. In addition, under the background of big data, the sources of cases are very confusing. Teachers often get slightly biased information based on the sources of cases, which leads to inefficient use of case bases.

Finally, the use of case base is not promoted enough. Most colleges and universities build case bases only to meet the needs of their own schools, so the scope of coverage is small, and there is no unified editing and management mechanism. Therefore, teachers often have no idea where to start when organizing case resources. With the rapid development of informatization, the staff can quickly edit the related cases. However, the use of the case base is only limited to the scope of the colleges and universities, and the lack of promotion cannot reflect the significance of case bases.

In short, the problem in case base construction is the lack of motivation and foundation for development, and the construction of the case base is a huge and systematic process, so there is still a long way to go.

7. Solutions for the problems in the construction of *Anti-Seismic Design of Building Structure* case base

Based on the problems in the construction of case bases described earlier, the problem of insufficient development motivation and poor foundation of case bases can be solved from several aspects.

First of all, a sound system and mechanism should be established to improve the the utilization of case bases and insufficient promotion of the case base. In the process of building the case base, there must be a certain procedure and specification for the selection standards, selection process, review of cases, and the incentive mechanism for the case editors. In his way, the operation of the case base can be more organized, the rights and responsibilities of relevant departments can be clarified, and the construction of case bases can be well-managed. Considering the syllabus of the subject, the important and difficult points of teaching,

as well as the teaching objectives and content, it is necessary to build a case base that not only covers one college or university, but also major primary and secondary colleges of the whole country as a collaborative platform for case bases that is open to all users can promote the development of case bases.

Secondly, the capital for case bases should be increased. The construction case bases is a systematic and huge project. Therefore, it requires a large amount of financial support. The operation of the case base cannot be supported only by the investment of the college or university. Therefore, the country and other social organizations should also provide some financial support for the construction of case bases. The sources of funds for the construction of case bases should be continuously expanded to ensure the smooth operation of the case base.

Thirdly, the sources of cases should be broadened. The construction of a case base requires the formation of a professional team and regular training to improve the comprehensive quality of case collection and editing staff, so that they can be more sensitive to the cases they collect and edit. Secondly, in addition to using pictures and videos about earthquakes published in newspapers and the Internet, the students' design plans can also be included in it, and for some excellent designs, teachers can have them modified by professionals who compile original cases for students. Colleges and universities can also give academic recognition to excellent case designs and provide opportunities to publish periodicals as an encouragement to motivate teachers and students to continue to innovate and forge ahead.

Finally, in the process of constructing case bases, it is necessary to obtain the support of all parties. Not only in terms of financial and cognitive support, but also to instill the concept of earthquake resistance into people, so that more people know that the construction of the case base is not only to improve the efficiency of teaching and promote innovation and reform of teaching, but also to put it into practice ultimately. The earthquakes that occurred in the history of our country not only caused serious damage to people's lives and property, but also left serious psychological trauma to the people. Therefore, the construction of the case base can potentially improve the earthquake resistance of our country's buildings and reduce the safety risks of people's lives and property.

8. Conclusion

The key to the construction of case bases is to integrate the resources of all parties. The theoretical knowledge of the course can be displayed to students intuitively and visually through the construction of the case base, thereby enhancing the students' understanding of the knowledge and improving students' practical skills. Although there are still some problems in the construction of case bases in our country, as long as colleges and universities and related organizations strengthen the construction of related systems and mechanisms and ensure the quality of case base construction, the courses on *Anti-Seismic Design of Building Structures* in civil engineering can then develop smoothly.

Disclosure statement

The authors declare no conflict of interest.

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Study of the Application of Expansive Cement in Building Construction

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Abstract: A China's construction industry continues to develop, the amount of building construction has increased significantly, and construction technology has been continuously advancing. In particular, the application of expansive cement in building construction is becoming more popular. The correct use of construction technologies can not only speed up the progress of the construction project, but also reduce the project cost significantly. In this paper, the application of expansive cement building construction is discussed in detail, and the solutions of related problems are proposed.

Keywords: Building construction; Expansive concrete; Construction technology; Application strategy

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1. Introduction

Concrete cracks and the number of formwork turnover are common problems in traditional concrete construction that will affect construction quality. In this case, expansive concrete can be used to improve the efficiency and quality of building construction, so it is very important to study its application in building construction.

2. Introduction of expansive cement

2.1. Performance of expansive cement in building construction

High-performance concrete expansion agent (ZY type) chemical expansion agent is added to cement, and its amount is adjusted for different projects to achieve the required physical expansion rate. The rate of expansion often depends on the shrinkage parameters and elastic dimensions. The higher the shrinkage parameter or the elasticity, the larger the amount of expansion cement and vice versa. Under suitable conditions, the addition of ZY type chemical expansion agent will lead to different degrees of expansion, thereby preventing the concrete from cracking. However, its effect is susceptible to reinforcement and specific fixed positions. Therefore, in the construction process of expansive cement materials, it is necessary to reduce the amount of cement used. It is necessary to adjust the amount of the chemical expansion agent according to specific conditions and requirements, which not only reduces the construction costs, but also achieves the ideal quality of the concrete, thus effectively ensuring the construction quality. ZY type chemical expansion agent has good performance, and its characteristics are shown in **Table 1**.

Table 1. Performance characteristics of ZY type expansion agent

Performance characterization	Main feature	Effect of application
Good degree of swelling	7% ZY< 13% u-type expansive agent (UEA)	It increases cracking suppression of reinforced concrete frame
Low alkali concentration	B21 ≤ 0–4% (alkali concentration)	Prevents alkali-aggregate reaction
Small amount of material required	7% ZY <13% conventional expansion agent	Reduce material cost
Good quality	It is not affected by cement slump and has a wide range of applications	Compatible with commercial cement and concrete pumps
Easily activated	Complete hydration reaction	It can completely replace concrete
Enhances the performance of cement	Increasing cement strength	It can completely replace concrete
Excellent cement impermeability	P21-P31 (antibiotic penetration label)	Good waterproof effect

2.2. Application principle of expansive cement in construction

The principle of applying expansive cement is that the concrete is mixed with an appropriate amount of expansion agent, and the expansion agent will react with the cement. As a result, the concrete begins to expand outward, and the reinforced concrete generates stress during the process of expansion. Due to various factors, the concrete undergoes internal shrinkage during the curing process, and the expansion agent offsets the stress generated by internal shrinkage, which prevents cracks, which in turn improves the quality of the concrete and prolongs its service life [1].

2.3. Advantages of using expansive cement

2.3.1. Improve the earthquake resistance of the building

An expansive agent is added to the expansive concrete to increase the shrinkage tension of the concrete, and other additives are also added into the cement, thereby improving the integrity of the concrete structure and the earthquake resistance of the structure itself.

2.3.2. Prevents cracking

Concrete cracking is a common problem in building construction, which is due to various reasons such as temperature difference in the working environment and excessive structural stress, which will inevitably affect the overall strength of the structure itself. In the process of using expansive cement, the expansive agent is added to the cement very early on so that the expansion force generated during the concrete setting process prevents early compression of the concrete, thus reducing the possibility of cracking.

2.3.3. The service life of the building structure is effectively prolonged

Expansive cement will generate prestress, improve the internal prestress of the concrete structure and the shrinkage capacity of the concrete itself, and effectively play the compensating role of the expansion agent, so as to extend the life of concrete structures.

3. Application strategy of expansive cement in building construction

3.1. Installation of expansion reinforcement belt

“Jointless structure” refers to the effect of using concrete under ideal conditions. The possibility of this situation happening in actual construction is very small. Therefore, expansive cement is usually used as the main building material, and steel strips are mainly used for seamless construction. Steel strips protective nets can be set at both ends to effectively solve the problem of concrete penetration. At the same time, ZY expansion agent is added reasonably and accurately to ensure that the expansive cement meet the standards

and ensure the construction quality. The specific requirements are shown in **Table 2**.

Table 2. Expansive concrete mix ratio

Parts	Label	Cement	Sand	Pebbles	ZY	Fly ash	Admixture	Water
Roof	C30, P6	284	776	1071	22	76	8.2	180
Reinforcement belt	C35, P6	317	746	1073	33	86	8.9	185

3.2. Installation of compensation reinforcement

Expansive cement will generate internal stress during the maintenance process, and the concrete structure should also be equipped with compensation reinforcement to balance the internal stress and improve the integrity of concrete after molding. There are a few aspects to take note of in the installation of compensation reinforcement. (1) Concrete solidification is directly related to temperature control. Therefore, we should pay attention to temperature changes, choose the appropriate time for the installation, and reduce the effects of temperature on the solidification of the concrete. (2) To determine the position of the compensation reinforcement, based on previous experiences, the position of the compensation reinforcement should be perpendicular to the steel strips, the insertion depth of the compensation reinforcement concrete should be greater than 50 cm, and its material properties should also match the original structural reinforcement material. (3) It is necessary to control the relevant parameters. The diameter of the reinforcement rod should be shorter than that of the original structural rod, with a difference of 1–2 grades. At the same time, rails should be fixed to improve the effect of compensation reinforcement [2].

3.3. Mixing and transporting expansive cement

In order to improve the quality and efficiency of using expansive concrete, the mixing time of expansive concrete should be optimized, because a suitable mixing time can not only improve the mixing of the concrete, but also the quality of concrete. The formwork should be cleaned before the concrete is poured. To avoid waste and concrete accumulation during construction, the concrete at the discharge port should be vibrated. The depth of the vibrator entering the concrete and the range of motion of the vibrator are key factors affecting the construction quality, so confinement work is required during the actual vibration period and concrete joints should be looked out for. Besides the amount of concrete used in the pouring area should also be calculated in advance [3].

Figure 1. Stirring and transportation of expansive concrete

3.4. Surface maintenance

In order to avoid concrete cracking, the expansive concrete shall be plastered after pouring. Plastering should be done during the maintenance phase when the concrete is just setting, usually within 10 hours after the concrete is placed. After the initial concrete setting stage, in order to ensure the flatness of the building, the secondary mortar should be added. The maintenance effect of expansive cement directly affects the service life of the concrete. Therefore, the staff should pay attention to the maintenance of the concrete. The maintenance usually takes about half a month. The staff should pay attention to the curing process and try to avoid exposure of the expanded concrete to the sun, so as to further improve the quality of the concrete.

Figure 2. Surface maintenance

3.5. Management and control of the reinforcement binding process

The reinforcement connection process also affects the performance of expansive cement, so attention needs to be paid to the management and control of the reinforcement connection process. Reinforcement connection will lead to a significant change in the temperature stress of the expansion zone. Therefore, it is necessary to keep the temperature stress of the expansion steel bar at a high level. The following points should also be noted: Firstly, during the binding process, it is important to ensure that the bars are straight and parallel with each other. Secondly, it is necessary to pay attention to the distance between the steel bars, and appropriately adjust the position of the steel bar according to the actual needs of the project, so that the distance increases with the expansion of the steel bar at both ends of the building structure, so as to ensure the construction quality. It is important to manage the construction process and follow the relevant procedures to create a good construction environment while using expansion cement. If the reinforcement bonding process is not managed well, it will affect the construction of concrete expansion joints [4].

Figure 3. Rebar binding

3.6. Strictly controlling the use standards of technology

In the application of expansive cement, the proportion of expansion agent will directly affect the final effect of concrete molding. According to previous experiences, before determining the proportion of materials, it is necessary to conduct appropriate tests, and determine the optimal proportions based on the test results and apply the technique. Before this, a project manager should be appointed to understand the on-site working environment and determine the material configuration based on the site conditions. In addition, the requirements of site operation and management standards, along with national construction standards and local standards, should be followed. Besides, feasible standards should also be developed to speed up the construction process.

3.7. Application of joint treatment technology

In addition to the aforementioned applications, joint treatment technology is also one of the technologies used for the subsequent treatment of the structure. The techniques of concrete pouring can be divided into continuous pouring and intermittent pouring. Before pouring, the construction personnel should ensure that the area is clean and free of debris. Besides, the wetting process should be carried out properly, and after the project is completed, concrete of the same performance is inserted into the joints to improve the overall structure integrity.

4. Matters needing attention in the application of expansive cement construction technology

4.1. Strictly controlling the construction process

Managers must strictly control the entire construction process to ensure the smooth progress of the project, and the monitoring of the adhesion of expansive concrete can effectively ensure that the quality of the entire construction is up to standard.

4.2. Performing scientific calculations

Before adding the expansion agent, the proportion the expansive cement should be scientifically calculated, taking into account the equipment used, material classification, local climate conditions, etc., so as to correctly determine the amount of expansion agent needed.

4.3. Strictly controlling the selection of concrete

Strict quality control and the use of high-pressure expansive cement are very important to improve

construction quality. Expansive cement is used and handled fundamentally differently compared to normal cement because of the addition of expansive agents and other building components to the material. In some cases, the preparation of reinforced concrete should be carried out in strict accordance with the national technical requirements. Even if no expansion agent is used, it should still be prepared in strict accordance with the specifications, and each procedure should be well-controlled.

4.4. Strictly control the implementation technology of concrete

Strengthening the engineering control of the concrete in the non-expansion area (the area without expansion agent) and its construction equipment will greatly improve their technical performance. Concrete reinforcement welding should be continuously improved after high pressure expansion is attempted to achieve seamless welding in order to understand the compressive stresses of reinforced concrete on the main structure of the building. Secondly, when preparing the expansion agent, the expansive cement should be rationally configured and controlled according to the structures of the main body of the building. The modified concrete significantly improves the production quality and use efficiency.

5. Conclusion

With the development of the construction industry, new technologies are constantly emerging and widely used in the construction industry, which not only contributes to the development of the construction industry, but also the development of the economy. As mentioned above, mastering the correct construction techniques and technologies in building construction, preparing for construction in advance, along with good construction techniques and proper supervision and inspection, building construction can be completed successfully. This new type of expansive cement will be more widely used in building structure construction as it reduces costs, shorten the construction time, and most importantly, prevent concrete cracking, reduce the cost of raw materials, and significantly improve economic and social benefits.

Disclosure statement

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Strategies for Strengthening Highway Construction Testing and Quality Control

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Abstract: In recent years, the scale of China's highway projects have been expanding. However, in real life, road construction projects in some places have not passed professional and rigorous inspections, resulting in various quality problems, and seriously affecting the safety of drivers and pedestrians. This paper analyzes the current situation of highway engineering test and detection, expounds the application of new technologies for highway engineering test and detection. In this paper, a case study was carried out on ground penetrating radar (GPR), which aims to improve highway engineering test and detection and provide reference for reducing highway safety risks.

Keywords: Highway engineering; Test detection; Quality control

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1. Introduction

To ensure that the quality of the highway project is up to standard, the construction unit and relevant departments must conduct a comprehensive inspection of the entire project. There are many materials involved in highway engineering, such as cement, steel bars, etc. To ensure that the materials are of good quality, they must be sampled and tested, so that the project will not be affected. In order to ensure the quality of the project, the inspectors must conduct detailed inspections on the structural dimensions, material consumption, construction standards, etc. in accordance with the standards to make sure that the test results are accurate. In addition, the technology and machinery used in each process should follow a certain order, so that the construction process can be more coordinated. Moreover, we must strengthen the awareness of environmental protection during road construction. During the construction process, the waste of resources should be monitored to ensure that energy-saving and emission-reduction measures are implemented in the construction of the project. Outdated construction methods and equipment should be eliminated so that the speed of construction can be accelerated [1].

2. Analysis of the current situation of road construction test and detection

2.1. Defects in the sampling process

The sampling process should cover all road sections to prevent missing out some areas of the road [2]. However, there are obvious loopholes and deficiencies in the process of sample collection for highway projects, so the final data of the highway test may not be accurate. Sampling operators failed to carefully check the equipment and instruments required for sampling, resulting in incorrect selection of sampling. In addition, the entire process of sample collection is also dangerous, resulting in the loss of road test samples.

2.2. Poor quality of relevant personnel

Inspectors must have a clear understanding of the work they are doing, and make sure that they are capable of performing the required operations. However, there are still some workers of road construction test and detection who cannot guarantee the quality of roads according to the existing systems and rules, and are not willing to proactively learn information-based testing methods. In the process of collecting road samples and analyzing various parameters of the road, test engineers often incur extra expenses and increase the cost of road construction due to their incapabilities.

2.3. Lack of necessary supervision

The process of road test and inspection must be strictly supervised. Or else, the work of road test and inspection will be disorderly. At present, there is a lack of strict supervision on the overall operation process of road test, and road test technicians can only deal with problems based on their own work experience. However, the final test results of highway construction must meet certain standards to be considered qualified. Without third-party supervision in this process, problems such as subjectivity and arbitrariness will appear in the process of highway testing, which makes decision-making difficult.

2.4. Defects in technical means

With the continuous expansion of the scope of highway construction, highway test and inspection work has become more difficult to perform. Therefore, the staff of each department will inevitably encounter difficulties when collecting a large amount of information. For road inspection, most of the inspection methods today requires the use of information technology. If the inspection staff does not have the relevant skills, some key data will be missed out during the inspection process, resulting in wrong inspection results. Therefore, it is of great practical significance for the staff to use and master the means of information technology. Because the data system is yet to be perfected, some important information in the highway test is lost. The operation and execution of highway engineering sample collection will affect the quality of highway construction. Therefore, it must be collected through an automated sampling data system. Relevant technicians should carry out real-time highway safety and quality management. If automation and information technology are not utilized, the highway inspection, supervision and control cannot be optimized

3. Analysis of new technologies for highway engineering quality inspection

Science and technology have promoted the upgrading of road construction quality inspection technology, thereby improving the efficiency and accuracy of road construction test and detection inspection. With the integration of Internet of Things and various fields, the test instruments of highway engineering are connected with the Internet of Things, so the test data can be intelligently processed, thereby improving the scientificity of test results, reducing manpower, and making the process fully automated, showcasing the capabilities of big data technology.

3.1. Optical fiber sensing technology

Optical fiber sensing technology has properties like anti-interference and anti-corrosion. It can achieve long-term transmission without reducing accuracy, and can also adapt to various conditions such as high or low temperature, and can improve the accuracy of detection data of highway engineering. However, in reality, due to the constraints of the working environment, it is difficult to directly obtain a lot of data through optical sensors. During highway construction, the preset of optical cable sensor devices should be done in advance. In the stage of highway construction inspection, optical cable sensors should be used to transmit data in real time accurately. At the same time, presetting optical cable sensors can also facilitate

the follow-up road construction quality inspection work.

3.2. Ground-penetrating radar technology

Ground-penetrating radar technology uses the reflection of electromagnetic waves to detect the structure of the road. This method is widely used because it does not damage the road. Its working principle is as follows: Energy is emitted from an energy transmitting device and the reflected energy goes into the receiving device, then the corresponding signal will be processed and analyzed by a computer. Due to the difference in the material, hole, interlayer, and other factors of the medium, there are differences in the energy propagation speed of the medium [2]. However, the propagation speed of the same medium is more continuous and constant, and its energy amplitude tends to be more balanced. Therefore, the quality of the road can be determined through the analysis of electromagnetic waves, which facilitates the evaluation and rectification of the road.

3.3. Echo detection technology

Echo detection technology is the safest technology in highway construction inspection. This technology will not generate any radioactive substances, and it will not damage the structure of the highway project. When testing, echo waves is sent into the road structure. If there are corrosion lesions or defects on the road, the echo waves will be reflected, resulting in changes in the collision diameter data. The relevant data is then be collected saved in real time, and the frequency of the echo wave is studied. In this way, the defects of the road structure can be identified, and the condition of the highway section can be understood.

3.4. Radiographic testing

Through the use of X-ray inspection technology, the internal structure of highway engineering can be fully understood and evaluated. The basic principle of this technology is that X-rays are used to detect the structure of road construction. High-speed electrons collide with the surface of the road to generate X-rays. The X-rays are then analyzed to determine the condition of the road. The position of the hole and the degree of fracture of the steel bar can be accurately determined using X-ray, thereby helping technicians to make an accurate judgment on the condition of the road and providing a basis for future maintenance [3].

3.5. Non-destructive imaging technology

There are many ways to detect highway projects, and the use of non-destructive imaging technology can understand the quality of the project more intuitively and efficiently. There are two main types of image non-destructive imaging technology: holographic imaging and infrared imaging. The experimental detection of road construction was carried out by using these two methods. These imaging methods can determine the degree of damage or condition of the road through the data collected [4].

4. Application of highway engineering test and detection technology

The working principle of ground penetrating radar (GPR) detection technology is shown in **Figure 1.**

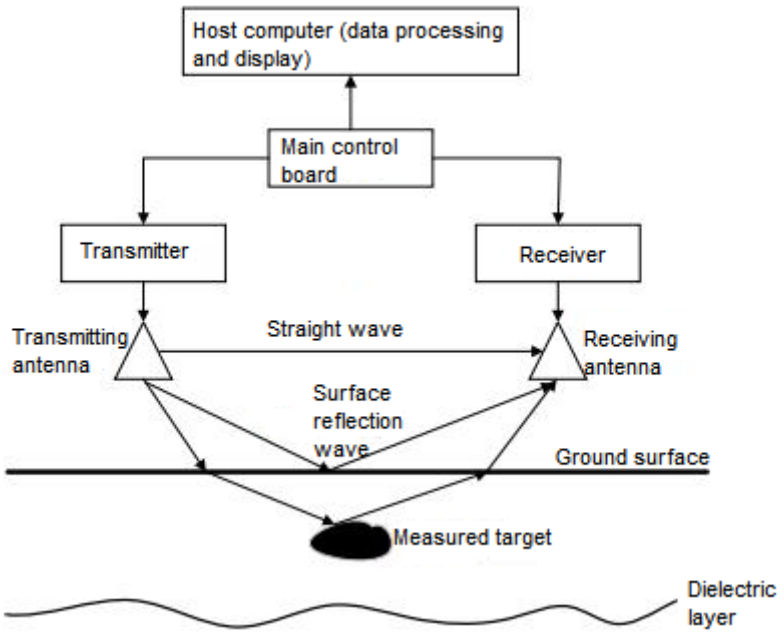

Figure 1. Schematic diagram of road detection by GPR

4.1. Detection of highway pavement surface thickness

At present, the thickness of roads in our country is between 10–20 cm, 20–30 cm, and 40 cm. Therefore, higher requirements are put forward for detection accuracy. Usually, the resolution of the detection signal is only 1/4 of that of the detection wavelet. EP-71011 GPR technology can carry out precise, continuous, non-destructive, and accurate measurements on the road. It can carry out comprehensive, precise, and continuous measurement of more than 100 meters of the road within one day. Besides, it is non-destructive, and compared to other technologies, its detection cost per kilometer is relatively low, with good detection results, and it is highly adaptable, which means it can be used for different road projects or networks.

4.2. Characteristic parameters of the medium

Table 1. Characteristic parameters of medium

Medium	Relative permittivity ε_r	Conductivity (S/m)	Wave speed (m/ns)	Attenuation factor α (dB/m)
Air	1.0	0	0.3	0
Freshwater	81	0.5	0.033	0.1
Seawater	81	30000	0.01	1000
Concrete	4–10	1	0.09–0.15	
Asphalt	3–5	0.12–0.18		
Clay	5–40	2–1000	0.06	1–300
Sandy soil	4–7	0.01–1	0.06–0.15	0.01–0.3
Granite	4–6	0.01–1	0.15	0.01–1

On the ground, low-frequency electromagnetic signals will be absorbed by the ground, while high-frequency electromagnetic signals can be transmitted over long distances. When it is transmitted in a lossy medium, it will cause energy loss, and the conductivity coefficient of the lossy medium is $б = 0$, so that its amplitude continues to decrease [5]. Therefore, in a lossy medium, the electromagnetic wave can be obtained by the following formula:

$$V = \frac{\omega}{\beta} = \frac{c}{\sqrt{\left(\frac{\mu_r \varepsilon_r}{2}\left[1+\left(\frac{\sigma}{\omega\varepsilon}\right)^2+1\right]\right)}}$$

5. Quality control strategy for road construction test and detection and inspection

5.1. Good supervision and management of the testing process

With the continuous development of society, market conditions have become more complex. Some domestic construction companies are still unable to keep up with the construction needs of current highway projects. At the same time, they are also facing internal imperfections in terms of organization and management, and the requirements specific engineering process required are also unclear [6]. Therefore, it will not only cause adverse consequences to highway construction, but also pose a serious threat to the safety of highway construction. Besides, the advantage of testing technology also cannot be fully utilized in highway construction. Therefore, effective supervision and control is necessary to improve the process of highway testing and detection. Highway construction test and inspection work must be strictly regulated to ensure that the whole process is orderly [7].

5.2. Improve the comprehensive quality of testing personnel

The comprehensive ability of testing personnel affects the results of road construction test and detection. Therefore, specific executive personnel are required to have more excellent professional quality [8]. At present, the daily inspection and supervision work of some highway sections is poorly implemented, and there are hidden dangers in highway safety and engineering quality. Therefore, the operators involved must have better knowledge, professional quality, and professional ethics. It is necessary to ensure that testing personnel fully understand the importance of road test and detection. Besides, it is necessary for testing technicians to utilize intelligent testing equipment to perform their tasks, so that they can better deal with large-scale road test and detection work while ensuring the accuracy of test results [9].

5.3. Improving test equipment and working environment

When selecting highway construction test and detection equipment, it is necessary to consider the cost along with the practical benefits, and at the same time pay attention to the requirements for relevant indicators, so as to ensure the accuracy of testing and testing equipment. The results will only be credible if they are accurate [10]. Therefore, it is important to do some research before purchasing instruments to fully understand the characteristics of various instruments, and to select the instruments that best meet the testing requirements and match the testing environment. In addition, the working environment of the instruments and equipment needs to be improved and should be suitable for the surrounding geological conditions and specific requirements. In the detection process, it is very important to ensure that the detection conditions meet the corresponding technical requirements.

6. Conclusion

In highway construction, test and detection of highway construction projects plays a decisive role in its quality and safety. However, there are still some problems in the current highway engineering test and detection process. If the problems are not solved, the quality and service life of highway construction will be affected. Therefore, relevant government departments, management departments, and testing personnel should vigorously promote the specification of highway engineering test and detection to ensure the accuracy of testing data and the standardization of the testing process, thereby ensuring the safety and reliability of highway construction.

Disclosure statement

The author declares no conflict of interest.

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Research of Risk Identification and Prevention of Underground Pressure Pipelines Damage Caused by External Disturbance

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Abstract: External disturbance is an important cause of underground pressure pipeline damage, which leads to accidents, and it is crucial to study the risk of damage caused by external disturbance and come up with proper prevention and control measures. We reviewed literature on risk identification of underground pressure pipelines damage due to external disturbance was conducted, and a list of risk factors was formed. Based on the list of risk factors, fault tree analysis was carried out on underground pressure pipelines damage caused by external disturbances, and risk prevention and control measures were proposed through the calculation of minimum cut sets, minimum path sets, and structural importance, in hopes of providing reference for the normal operation of underground pressure pipelines.

Keywords: Underground pressure pipeline damage; External disturbance; Risk identification; Fault tree; Risk prevention and control

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1. Introduction

Urban population is becoming denser with the acceleration of urbanization, and the construction scale of underground pressure pipelines such as gas, water supply, and heat supply are also increasing. Many pipelines are tightly arranged or even intersected, which can easily lead to secondary and derivative accidents, causing significant casualties, economic losses, and adverse social impacts. Therefore, it is crucial to study the risk prevention and control of underground pressure pipelines.

Extensive research has been conducted on risk identification, prevention, and control of underground pressure pipelines, but there is limited systematic analysis on the specific risk identification and prevention of external disturbances to underground pressure pipelines, and the reasons for the risks have not been fully clarified [1-5]. External disturbance is a major cause of underground pressure pipeline accidents. Therefore, based on the accident-causation theory, research was carried out to carefully identify the risk factors of external disturbance damage and a fault tree was created. Prevention and control measures were proposed through fault tree analysis.

2. Overview of accident-causing theory

The accident-causation theory demonstrates the occurrence, development, and results of accidents through accident mechanisms and models [6]. Among them, the accident-causation theory at home and abroad mainly include the accident proneness theory, and Heinrich's Dominos theory (**Figure 1**), theory on unexpected release of energy, and the 24Model theory (**Figure 2**) [7-9].

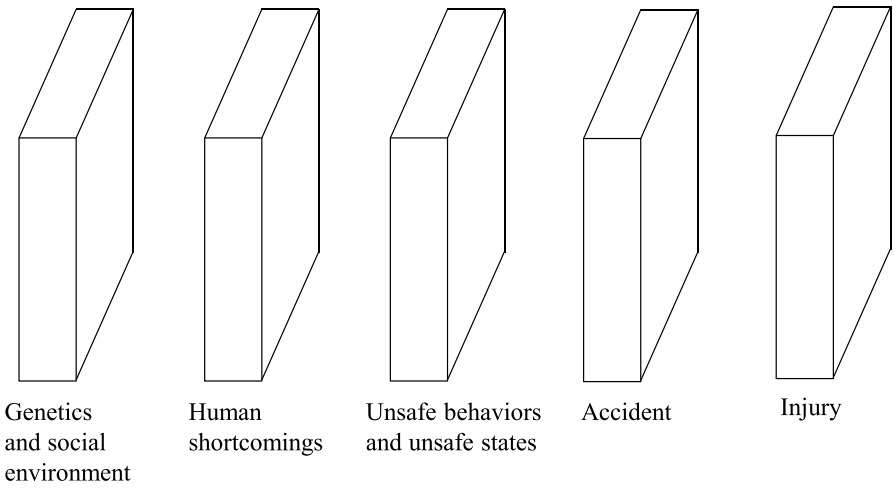

Figure 1. Heinrich's Dominos theory

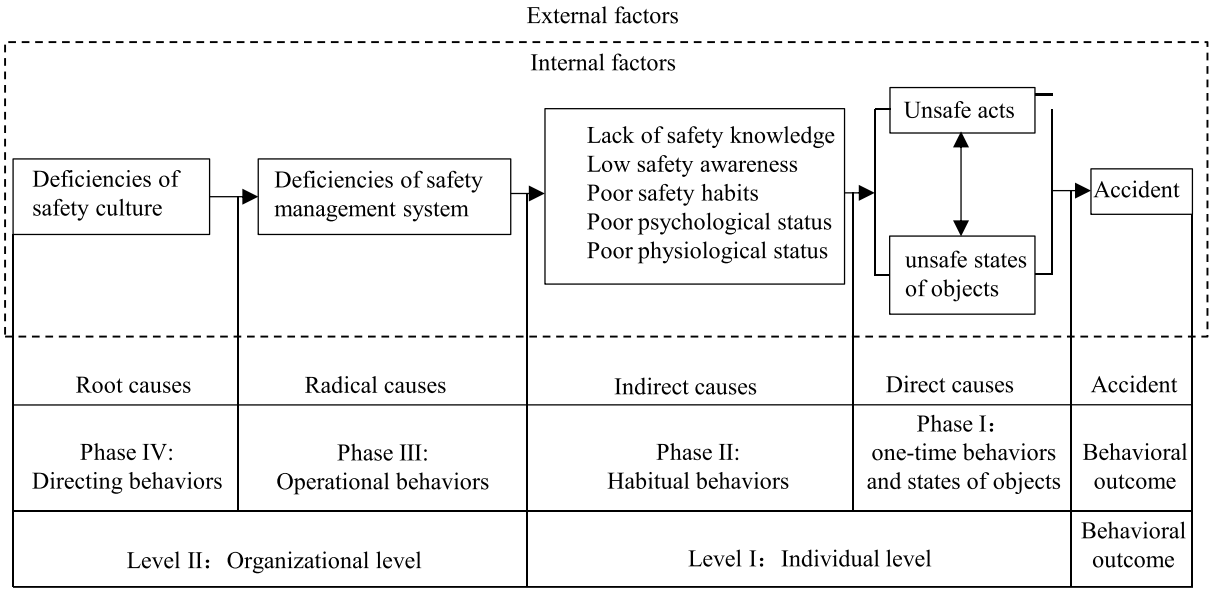

Figure 2. 24Model theory

The accident proneness theory completely attributes the responsibility for accidents to individuals; Heinrich's Dominos theory uses 5 dominoes to represent the mechanism of accidents but does not reflect the complex relationship between accidents; the theory of unexpected release of energy believes that accidents are caused by the accidental release of energy, explaining the physical reasons for accidents; 24Model theory divides the causes of accidents into internal and external factors. The internal factors explained from two levels (organizational level and individual level) and four stages (one-time behaviors and states of objects, habitual behaviors, operational behaviors, and directing behaviors), which better explains the occurrence and development of accidents.

3. Risk identification of external disturbance damage to underground pressure pipelines

Based on Heinrich's Dominos theory and the 24Model theory, the direct cause of accidents is attributed to unsafe behaviors of humans and unsafe states of objects, and then the indirect causes of accidents are explored. However, through research, it was found that risk factors of underground pressure pipelines damage due to external disturbance to not only include the human and "object" factors, but also environmental factors. So, it is necessary to study the causes of risk from three direct risk factors: unsafe behaviors of humans, unsafe states of objects, and unfavorable environmental factors.

3.1. Unsafe behaviors of humans

There are two types of unsafe behaviors of humans: construction/operation damage and vandalism. Construction/operational damage is mainly caused by unstandardized construction, barbaric construction, and operational errors, while vandalism is mainly driven by interests and resentment.

3.2. Unsafe states of objects

The unsafe states of objects can be divided into two types: the impact of the upper load and the unqualified pipeline foundation. The impact of the upper load is mainly caused by insufficient burial depth of pipelines and frequent activities such as rolling and construction. The unqualified pipeline foundation is mainly caused by unstandardized construction and poor construction quality.

3.3. Unfavorable environmental factors

Unfavorable environmental factors mainly include landslides, mud-rock flows, collapses, and earthquakes. Among them, landslides and mud-rock flows are mainly caused by three reasons: geological evolution, deforestation and indiscriminate cultivation, and unreasonable excavation. Collapses are mainly caused by poor protective effects and unreasonable excavation. Earthquakes are mainly caused by crustal movement and large-scale blasting activities.

3.4. List of risk factors

Based on the analysis above, a list of risk factors for underground pressure pipelines damage due to external disturbance is summarized and sorted out in **Table 1**.

Table 1. List of risk factors

Number	First-level risk factors	Second-level risk factors	Third level risk factors	Fourth level risk factors
1	Unsafe behaviors of humans	Construction/operational damage	Unstandardized construction	Lack of professional skills
2				Poor sense of responsibility among construction personnel
3				Lack of supervision and management
4			Barbaric construction	Lack of accurate pipeline location information
5				Poor safety responsibility awareness
6				Lack of supervision and management
7			Operational errors	Lack of professional skills
8				Poor psychological quality
9		Vandalism	Interest driven	–
10			Resentment	Improper handling of social relations
11				Poor economic conditions
12	Unsafe states of objects	Impact of upper load	Insufficient burial depth of pipelines	Pipeline backfilling not in place
13				Rainwater erosion
14			Frequent activities such as rolling and construction	Failure to set warning signs in accordance with regulations for pipelines
15				Lack of supervision and management
16		Unqualified pipeline foundation	Unstandardized construction	Lack of professional skills
17				Poor sense of responsibility among construction personnel
18				Lack of supervision and management
19			Poor construction quality	Lack of professional skills
20				Material defects
21				Poor sense of responsibility among construction personnel
22				Lack of supervision and management

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Number	First-level risk factors	Second-level risk factors	Third level risk factors	Fourth level risk factors
23	Unfavorable environmental factors	Landslides	Geological evolution	–
24			Deforestation and indiscriminate cultivation	Interest driven
25				Weak legal awareness
26				Lack of supervision and management
27			Unreasonable excavation	Poor technical solutions
28				Lack of supervision and management
29		Mud-rock flows	Geological evolution	–
30			Deforestation and indiscriminate cultivation	Interest driven
31				Weak legal awareness
32				Lack of supervision and management
33			Unreasonable excavation	Poor technical solutions
34				Lack of supervision and management
35		Collapses	Poor protective effects	Poor technical solutions
36				Lack of professional skills
37				Material defects
38			Unreasonable excavation	Poor technical solutions
39				Lack of supervision and management
40		Earthquakes	Crustal movement	–
41			Large-scale blasting activities	–

4. Drawing of fault tree for external disturbance damage to underground pressure pipelines

Based on the risk factors listed in **Table 1**, the risk factors were converted into events in the fault tree as shown in **Table 2**. The logical relationships between events were expressed by "AND" and "OR" gates, and a fault tree was drawn, as shown in **Figures 3** and **4**.

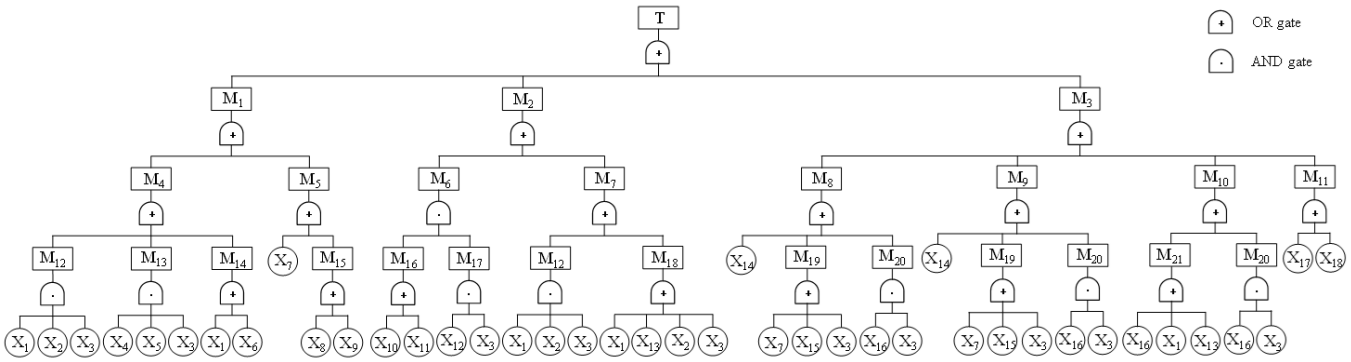

Figure 3. Fault tree of external disturbance damage to underground pressure pipelines

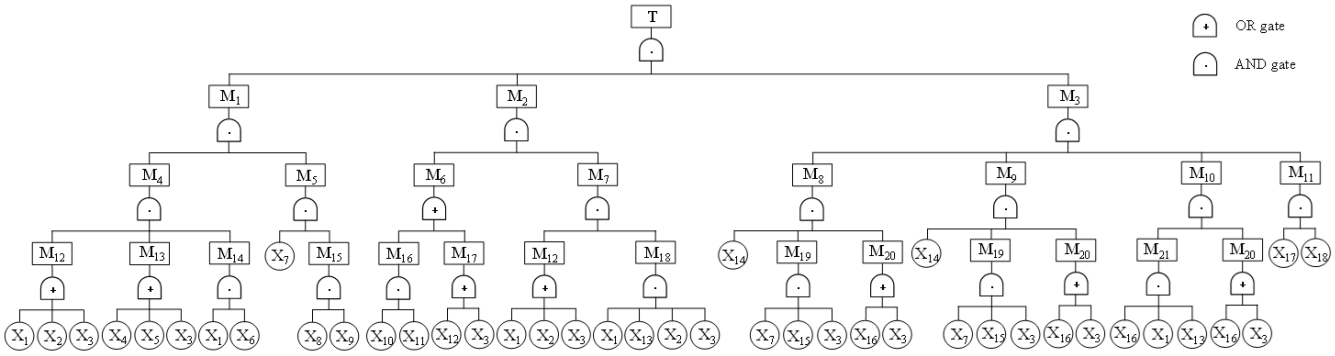

Figure 4. Success tree of external disturbance damage to underground pressure pipelines

Table 2. Event meanings of fault tree

Event symbols	Event meanings	Event symbols	Event meanings
T	Underground pressure pipelines damage due to external disturbance	M_{20}	Unreasonable excavation
M_1	Unsafe behaviors of humans	M_{21}	Poor protective effects
M_2	Unsafe states of objects	X_1	Lack of professional skills
M_3	Unfavorable environmental factors	X_2	Poor sense of responsibility among construction personnel
M_4	Construction/operational damage	X_3	Lack of supervision and management
M_5	Vandalism	X_4	Lack of accurate pipeline location information
M_6	Impact of upper load	X_5	Poor safety responsibility awareness
M_7	Unqualified pipeline foundation	X_6	Poor psychological quality
M_8	Landslides	X_7	Interest driven
M_9	Mud-rock flows	X_8	Improper handling of social relations
M_{10}	Collapses	X_9	Poor economic conditions
M_{11}	Earthquakes	X_{10}	Pipeline backfilling not in place
M_{12}	Unstandardized construction	X_{11}	Rainwater erosion
M_{13}	Barbaric construction	X_{12}	Failure to set warning signs in accordance with regulations for pipelines
M_{14}	Operational errors	X_{13}	Material defects
M_{15}	Resentment	X_{14}	Geological evolution
M_{16}	Insufficient burial depth of pipelines	X_{15}	Weak legal awareness
M_{17}	Frequent activities such as rolling and construction	X_{16}	Poor technical solutions
M_{18}	Poor construction quality	X_{17}	Crustal movement
M_{19}	Deforestation and indiscriminate cultivation	X_{18}	Large-scale blasting activities

5. Risk prevention and control of external disturbance damage to underground pressure pipelines

5.1. Minimum cut sets

The minimum cut sets represent the minimum combination of elementary event that lead to the top event. The Boolean algebra method was used to calculate the fault tree, and 13 minimum cut sets were obtained, as shown in **Table 3**.

Table 3. Minimum cut sets of fault tree

Code	Composition
K_1	X_1
K_2	X_2
K_3	X_3
K_4	X_6
K_5	X_7
K_6	X_8
K_7	X_9
K_8	X_{13}
K_9	X_{14}
K_{10}	X_{15}
K_{11}	X_{16}
K_{12}	X_{17}
K_{13}	X_{18}

It can be seen from **Table 3** that all 13 minimum cut sets are first-order cut sets, and there are 18 "OR" gates and 8 "AND" gates in the fault tree; the OR gates account for 69.23% of the total number of logic gates. Therefore, it is clear that there are many ways external disturbance can cause damage to underground pressure pipelines damage, and the risk is relatively high.

5.2. Minimum path sets

The fault tree was converted into a success tree, and the minimum path sets of the fault tree were obtained by calculating the minimum cut sets of the success tree. The minimum path sets were also calculated by the Boolean algebra method, and the minimum path set is represented by P = {X_1, X_2, X_3, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{12}, X_{13}, X_{14}, X_{15}, X_{16}, X_{17}, X_{18}}.

There is only one minimum path set, indicating that there is only one way to suppress the occurrence of top events in the fault tree analysis. Moreover, this path set is a 13-order path set with a higher order, and it is necessary to simultaneously prevent and control 13 risk factors in order to suppress external disturbance damage to underground pressure pipelines. Even if geological evolution (X_{14}) and crustal movement (X_{17}), which are two natural factors that are difficult to control, are not considered, there are still 11 risk factors that need to be controlled simultaneously, which is difficult.

5.3. Structural importance

Considering that solving the structural importance through the minimum cut sets (path sets) is relatively simple, qualitative analysis was mainly conducted, and precise structural importance coefficients were not required. Therefore, in this study, the structural importance was determined based on the minimum cut sets (path sets). Generally, the structural importance can be determined according to the number of elementary events in the minimum cut sets (path sets) and relevant principles [10]. If the situation is relatively complex, the approximate formula of formula (1) [11-12] was usually used to solve the structural importance.

$$I(i) = \sum_{X_i \in K_j} \frac{1}{2^{n_i - 1}} \tag{1}$$

In Equation (1), $I(i)$ represent the structural importance of elementary event X_i; X_i represents elementary events, K_j represents the minimum cut sets or minimum path sets, n_i represents the number of elementary events contained in the minimum path sets or minimum cut sets where the elementary event X_i is located.

Due to the fact that all 13 minimum cut sets were of the first order and there was only one minimum path set, the judgment results were consistent regardless of the method used, and the order of structural importance was I(1) = I(2) = I(3) = I(6) = I(7) = I(8) = I(9) = I(13) = I(14) = I(15) = I(16) = I(17) = I(18). It can be seen that the structural importance of these elementary events are equal, indicating that they are equally important and comprehensive prevention and control are needed. In addition to force majeure factors, the following measures should be taken as a priority: (1) strengthening of professional skills training; (2) strengthening of education on safety responsibility awareness; (3) strengthening of supervision and management, including using technology to strengthen risk monitoring, warning, and prevention and control; (4) strengthening of psychological quality education; (5) strengthening of value education; (6) strengthening of communication and understanding among all parties, and improvement of economic level; (7) strict control of pipeline material quality; (8) strengthening of legal education; (9) discussions on technical solutions to ensure scientific rationality; (10) For large-scale blasting, pipeline relocation or protection measures should be taken in advance. In short, only by taking multiple measures in parallel can the risk of disturbance damage to underground pressure pipelines be prevented.

6. Conclusions

Through a literature review, the risk factors for underground pressure pipelines damage due to external disturbance were identified from three aspects: unsafe behaviors of humans, unsafe states of objects, and unfavorable environmental factors, and the risk factors were listed.

(1) Based on risk factors for underground pressure pipelines damage due to external disturbance, the risk factors were converted into events in the fault tree. The logical relationships between events were expressed by “AND” gates and “OR” gates, and a fault tree was drawn.

(2) By calculating the minimum cut sets, minimum path sets, and structural importance, targeted prevention and control measures were proposed, including strengthening skill training, legal education, psychological quality education, value education, supervision and management, and material control for comprehensive prevention and control.

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Disclosure statement

The author declares no conflict of interest.

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Results and Application of Soil and Water Conservation Monitoring in the Yellow River Basin

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Abstract: Since water and soil conservation monitoring in the Yellow River Basin entered a new stage at the end of the 20th century, the monitoring scope has been expanding, the monitoring accuracy has been improving, the monitoring content and indicators have been increasing, and the monitoring technology and methods have been improving. This paper mainly analyzes the status of soil and water conservation monitoring in the Yellow River Basin, as well as the construction of the monitoring system and related research, in order to provide a reference for watershed management and development and the scientific research of water and soil conservation.

Keywords: Soil and water conservation; Monitoring results; Application

Online publication: May 31, 2023

1. Introduction

The Yellow River is the "mother river" of China, but it is also the area with the most severe soil erosion in our country. Over the years, our country has continued to emphasize soil and water conservation monitoring in major strategies of ecological protection and high-quality development in the Yellow River Basin. After years of development, the country has accumulatively deployed more than 4,300 soil and water conservation monitoring stations in the Yellow River Basin, forming a soil and water conservation monitoring network covering the upper, middle and lower reaches of the river basin, major tributaries, and key governance areas, and formed a water and soil conservation monitoring system supported by digital technology [1]. At the same time, the country has carried out a series of research and practical works on dynamic monitoring of water and soil erosion in the Yellow River Basin and key areas in China, providing strong technical support for improving the ecological protection and high-quality development and governance capabilities of the Yellow River Basin.

2. Background

The Yellow River Basin is located in northern China, with a length of about 1800 km from east to west and a width of about 900 km from north to south, with a drainage area of 242,000 km^2. Its ecological environment is fragile, and it has the most severe soil erosion in the country. Besides, the Yellow River

Basin is located in the hilly and gully areas of the Loess Plateau and the concentrated and contiguous poverty-stricken areas of the Qinba Mountains, making it a key area for poverty alleviation. For a long time, the state has attached great importance to the work of soil and water conservation in the Yellow River Basin and has carried out a series of research and practical works and have produced certain outputs. In fact, soil and water conservation monitoring has been carried out in our country since 1985. In 1987, the first water and soil conservation monitoring work in the Yellow River Basin was carried out. In 2002, the first large-scale monitoring on the Loess Plateau was carried out. In 2008, a water and soil conservation monitoring network was built on the main stream and tributaries of the Yellow River for water and soil conservation monitoring on the main stream of the Yellow River. In 2013, a dynamic monitoring network for water and soil loss in key national areas has been deployed for dynamic monitoring in key control areas in Shaanxi, Shanxi, Henan and other provinces along the Yellow River Basin. In 2019, a network of national soil and water conservation science and technology demonstration base stations was deployed in the middle reaches of the Loess Plateau and the Qinba Mountains. After years of development, a water and soil conservation monitoring information system supported by digital technology was established, and it allowed the monitoring of water and soil conservation in the upper reaches of the Yellow River Basin in northern Shaanxi, northwestern Shanxi, and western Inner Mongolia, as well as the main tributaries along the basin. Among them, the dynamic monitoring of water and soil loss in key national areas is an important aspect developed on the basis of the dynamic monitoring network of water and soil loss in key areas in our country. On the basis of arranging monitoring points in subregions in the downstream, the dynamic monitoring of water and soil loss in each subregion is carried out using technology like remote sensing and satellites. At present, the state has completed the dynamic monitoring of soil and water loss in key areas of the country, including the Loess Plateau and the Qinba Mountains, and has gradually established an information system supported by digital technology [2-10].

3. Monitoring system

Soil and water conservation monitoring started relatively late in our country. In the mid-1970s, the former Ministry of Water Resources began research and pilot work on soil and water conservation monitoring. In 1986, the Ministry of Water Resources organized the establishment of the National Soil and Water Conservation Monitoring Station to strengthen the management of national soil and water conservation monitoring. So far 5 levels of water and soil conservation monitoring stations have been deployed in the Yellow River Basin, including 5 stations in national key areas, 12 stations in major project areas, and 1,561 in small watersheds with a watershed of 50 km^2 or more. Through continuous improvement and construction of national, provincial, municipal, and county-level soil erosion monitoring networks, a water and soil conservation monitoring information system supported by digital technology was formed. At present, several national and provincial water and soil conservation monitoring data sharing service platforms have been established, such as the central water conservation cloud platform, provincial water conservation cloud platform, and basin-level water conservation cloud platform; an ecological protection system covering the upper, middle and lower reaches of the Yellow River Basin was built. Besides, three comprehensive test bases for soil and water conservation ecological environment protection in the key areas, and the upper and middle reaches of the Yangtze River and the Yellow River was constructed. Moreover, regional positioning observation of typical small watersheds in the Yellow River Basin and experiments on long-term observation the slope of typical small watersheds runoff has been carried out. In addition, soil erosion experiments have also been carried out in typical areas of the Loess Plateau [11-14].

4. Research status

4.1. Research application

The state has carried out soil and water conservation monitoring work in the Yellow River Basin, and then carried out a series of research on key control areas of water and soil conservation, national key areas, national key prevention areas of water and soil loss, and national key counties of water and soil conservation and ecological environment protection, and produced many research outputs. For example, research has been carried out on the law of erosion and sediment yield and its causes in typical areas of the Yellow River Basin, the mechanism and regulation of erosion and sediment yield in the Loess Plateau, the spatial pattern and regulation of soil erosion in the Loess Plateau. As a result, an information technology system for soil and water conservation monitoring has been developed. Besides, methods for dynamic monitoring of water and soil loss in key control areas across the country has been established. Dynamic monitoring of water and soil loss in the Yellow River Basin has been systematically designed and implemented. A soil erosion model for the Loess Plateau, a forecast model for water and soil loss in production and construction projects, and comprehensive management of water and soil conservation in small watersheds has been developed. They have been implemented in the Yellow River Basin and have achieved remarkable results; a soil erosion information management system has been developed in the Loess Plateau, which aids comprehensive management of soil erosion in the Loess Plateau. For example, according to the spatio-temporal differences of soil erosion in different types of typical areas in the Yellow River Basin, a soil erosion model suitable for the Loess Plateau has been developed. Besides, a multi-scale soil erosion model has been developed based on soil erosion intensity zoning and soil erosion change characteristics of different regions. An information technology system for soil and water conservation monitoring has been developed according to the characteristics of ecologically fragile areas in the Yellow River Basin. In view of the characteristics and regional differences of water and soil conservation governance models in different areas, ecological restoration models, governance technologies, and benefit evaluations for different types of areas have been developed. Moreover, in view of the characteristics of soil erosion of different areas, technologies such as the forecasting model of water and soil erosion for production and construction projects and management model of small watersheds have been developed.

4.2. Development strategy

The ecological protection and high-quality development of the Yellow River Basin is a major national strategy personally planned and promoted by the country and it is also the starting point for ecological protection and high-quality development of the Yellow River Basin in the new era. In 2019, the state council approved the “Yellow River Basin Ecological Protection and High-quality Development Plan,” which outlined the major tasks, reforms, and safeguard measures for ecological protection and high-quality development of the Yellow River Basin. As an important aspect in the ecological protection and high-quality development of the Yellow River Basin, the monitoring of water and soil conservation has been highly valued by the Ministry of Water Resources, the Ministry of Finance, and other ministries and commissions. In 2021, the Ministry of Water Resources issued the “Guiding Opinions on Carrying Out Water and Soil Conservation Monitoring in Watersheds,” which contains clear requirements for water and soil conservation monitoring in watersheds. The monitoring of water and soil conservation in the Yellow River Basin is based on the condition of the river basin, is demand-oriented, focuses on improving monitoring capabilities, and aims to improve its service quality. Up to now, a total of 2,166 soil and water conservation monitoring stations of various types (including 811 national level stations) have been deployed in the Yellow River Basin, including 1,026 monitoring stations for soil and water conservation in production and construction projects (776 national level stations). On the basis of continuously strengthening the construction of soil and water conservation monitoring network, the following work has

been mainly carried out:

4.3. Improving the monitoring system

Soil and water conservation monitoring have been incorporated into project management to strengthen supervision and inspection. Watershed soil and water conservation monitoring institutions have been established, and the responsibilities of various departments have been outlined. Besides, watershed soil and water conservation monitoring management systems have been established, watershed monitoring tasks and organizational management requirements have been determined, the monitoring behavior of various departments have been standardized. “Yellow River Basin Water and Soil Conservation Monitoring Work Plan,” “Yellow River Basin Production and Construction Project Water and Soil Conservation Monitoring and Management Measures,” “Yellow River Basin Ecological Protection and High-Quality Development Water and Soil Conservation Monitoring Work System,” “Yellow River Basin Ecological Protection and High-Quality Development Water and Soil Conservation Monitoring Results Reporting System,” and a series of system norms have been formulated and implemented to ensure the ecological protection and high-quality development of the Yellow River Basin.

4.4. Improving monitoring capabilities

The “Yellow River Basin Ecological Protection and High-quality Development of Water and Soil Conservation Monitoring Capability Improvement Plan” has been formulated, which clarified the main tasks, safeguard measures, and overall goals of monitoring capacity improvement. Besides, the construction of monitoring stations has been standardized in accordance with the unified standards of the Ministry of Water Resources and technical requirements, and the monitoring level of water and soil conservation in the watershed have been improved. Moreover, water and soil conservation monitoring in the watershed have also been informatized in accordance with the “unified standards and procedures” to monitor information on water and soil conservation to update the system. In addition, pilot work on the application of soil and water conservation monitoring information have been carried out, and an online monitoring platform for soil and water conservation and a remote sensing monitoring platform have been established to explore the information application of soil and water conservation monitoring.

4.5. Strengthen monitoring services

In combination with the supervision and management of water and soil conservation of production and construction projects, the acceptance and verification of water and soil conservation facilities, and monitoring of water and soil conservation, etc., technical services have also been carried out for water and soil conservation monitoring of production and construction projects, which have effectively solved the difficult problems in the supervision and management of water and soil conservation of production and construction projects, and greatly improved service quality and efficiency. Since 2020, 31 provincial water administrative departments in the basin have been instructed to complete 545 monitoring tasks of water and soil conservation for production and construction projects, and 1,026 monitoring tasks for production and construction projects have been completed. Provincial-level water administrative departments in the Yellow River Basin found 1,236 problems in their daily supervision and inspection, and 1,218 problems were discovered through soil and water conservation monitoring, which effectively promoted the prevention and control of water and soil erosion in production and construction projects.

4.6. Consolidate the foundation of water conservation monitoring

Since 2021, the provinces in the river basin have cooperated with the national water and soil conservation monitoring project to increase capital investment, and strengthen the infrastructure construction of water

and soil conservation monitoring stations through purchasing services and local self-raising. Up to now, the provinces in the Yellow River Basin have transformed more than 5,300 monitoring stations, with an investment of nearly 660 million yuan. Subsequently, various provinces have implemented national soil and water conservation monitoring network construction projects, and carried out construction, renovation, and upgrading of monitoring stations using existing facilities. As a result, full coverage of major production and construction projects in the watershed was gradually realized. Some provinces have also established automatic monitoring networks for soil and water conservation that integrate video surveillance, automatic rain measurement, automatic monitoring, and remote sensing interpretation, which has greatly improved the efficiency of soil and water conservation monitoring. All localities have also improved the informatization level of water and soil conservation monitoring by actively carrying out technological transformation and upgrading of stations, introducing advanced technical means, and carrying out digital pilots.

5. Suggestions and prospects

In the future, the monitoring of water and soil conservation in the Yellow River Basin should be developed based on the national soil and water conservation monitoring plan, so as to provide solid technical support for the realization of ecological protection and high-quality development in the Yellow River Basin.

The first method is to adopt "Internet +" soil and water conservation monitoring to promote the construction of an information system for water and soil conservation monitoring supported by digital technology, give full play to the advantages of smart water conservancy construction, and build a water and soil conservation monitoring business system integrating "data, analysis, and service."

The second step is to maximize the supporting role of the national soil and water conservation planning projects. New modes of combining national soil and water conservation planning projects with key projects such as dynamic monitoring of water and soil erosion and comprehensive management of small watersheds should be explored. The supporting role of national soil and water conservation planning projects should be maximized in the implementation of major strategies for ecological protection and high-quality development in the Yellow River Basin.

Lastly the dynamic monitoring capabilities of the country's key regions and important river basins should be continuously improved. The construction of dynamic monitoring capabilities in typical regions of the Yellow River Basin on the basis of improving the dynamic monitoring capabilities of key national regions. Besides, data support should be provided for a comprehensive understanding of the ecological protection and high-quality development of the Yellow River Basin.

Disclosure statement

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The Construction of *Architectural CAD* Course Competition Integration Teaching Mode

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Abstract: *Architectural Computer-Aided Design (CAD)* is a basic course for architectural engineering majors in vocational colleges. The integration of competition into teaching will not only help stimulate the students' enthusiasm, but also help them improve their professional skills. However, there are still some problems in the teaching of *Architectural CAD*. Therefore, teachers must continuously optimize the integration of competition content into *Architectural CAD* classes through various strategies, so as to give full play to the value of competition content in classes. We explored and analyzed the problems in the integration of competition content into *Architectural CAD* classes, and proposed specific strategies, in hopes of improving the quality of *Architectural CAD* teaching.

Keywords: Architectural CAD course; Integration of courses and competitions; Construction strategy

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1. Introduction

The content of the *Architectural Computer-Aided Design (CAD)* course is relatively complex and dull. If the teacher only explains the content of the course through textbooks, it would be difficult to stimulate students' interest in learning. Therefore, teachers must be more innovative in teaching *Architectural CAD* courses, fully mobilize the subjective initiative of students through the integration of competition content. Through incorporating competition content, students can have a better understanding theoretical knowledge of the course, and their practical skills and creativity can be developed and improved.

2. Problems in the teaching of *Architectural CAD*

2.1. Disconnection between the syllabus and actual applications

In classroom teaching, teachers teach professional knowledge and technology most of the time, and students have less time for actual hands-on operation, which puts students in a passive position. It is difficult to improve the students' comprehensive quality when they can only accept what is taught by their teachers [1]. For example, when teachers explain about drawings in *Architectural CAD*, they usually directly explain the elements of plane layout and facade layout graphics and teach students how to read and analyze these elements. After completing the course, students will undergo internship only when they are about to graduate. However, during the internship program, because students learned from books and do not understand the specific work of related positions in the company, many of them are clueless on their tasks, which makes it difficult for them to adapt to their internship program. In traditional teaching, students are less enthusiastic and the rate of participation are naturally low, and the effect is not very ideal [2].

2.2. Disconnection between lessons

With the continuous deepening of education reform, the teaching of *Architectural CAD* should also be improved, but there are still some teachers who are less innovative in teaching this course. The problem is not only about establishing a teaching model of integrating competition content into lessons, but also the lack of systematic teaching. Usually, each knowledge point is explained independently in classes, which is not conducive to the improvement of students' architectural thinking and problem-solving ability [3]. The "*saike*" (class-competition) integrated teaching mode is a new teaching mode formed by integrating teaching content and related competitions. After the implementation of the education reform, the Ministry of Education has put forward new requirements for the teaching of *Architectural CAD*, requiring them to meet the development needs of the construction industry and improve students' professional skills. Therefore, in the teaching of *Architectural CAD*, the integration of competition content into classes is an inevitable trend. It can not only deepen students' understanding and mastery of professional knowledge, but also cultivate students' teamwork spirit and independence [4].

2.3. Architectural CAD contest

Architectural CAD competitions are sponsored by the Education Management Information Center of the Ministry of Education of China. The purpose of the competitions is to improve students' practical skills and information technology application. All students are allowed participate in the competitions [5]. As Architectural CAD competitions develop, not only can the professional ability of the participating students be showcased, but the competitions also reflect the quality of the schools, and competitions can also be a platform for companies to find talents.

The content of the Architectural CAD competitions mainly includes three modules. The first module is architectural construction drawing understanding and theory. This module focuses on the assessment of the ability to apply theoretical knowledge of architectural projection, drawing skills, and application of architectural theoretical knowledge. The second module is drawing construction drawings, which focuses on the assessment of the ability to use CAD software to draw construction drawings, modify construction drawings, mark construction dimensions, release drawings, and teamwork. The third module is to construct the building model, which focuses on the assessment of the ability to use CAD software to construct architectural models and the ability to understand drawings. The duration and weight of each module in a typical Architectural CAD competition is shown in **Table 1**.

Table 1. Architecture CAD competition time and weight

Architectural CAD competition modules	Duration (minutes)	Weight (%)
Construction drawing knowledge and theory	120	20
Drawing construction drawings	210	55
Building architectural models	120	25

Architectural CAD competition is a team competition where each team consists of 2 people. The content of the competition is completed by computer. The seats for the competition are generally determined by drawing lots. The first module of the competition, that is, the theoretical knowledge assessment module, is completed independently by each participant, while the other two modules are completed by both members of each team. The content of the first module is mainly objective multiple-choice questions, including single-choice questions and multiple-choice questions. The scores of each participant will be calculated automatically on the spot. The other two modules need to be completed using the standard software provided by the competition, and the scores will be given by referees.

3. Strategies for the integration of competition content into the syllabus of *Architectural CAD*

3.1. The syllabus should be modified according to the requirements of Architectural CAD competitions

To cultivate talents with Architectural CAD skills, colleges and universities should focus on the development of practical skills when teaching *Architectural CAD* and reduce the emphasis on theories. Architectural CAD competitions were introduced to improve the learning of this course [6]. The competitions require participants to be able to use CAD software flexibly. In the past, too much attention was given to the systematic explanation of theoretical knowledge, while the relationship between theoretical knowledge and practice was ignored, and the teaching objectives failed to meet the needs of relevant jobs. Therefore, when integrating competition content into *Architectural CAD* lessons, teachers should strengthen their connection with relevant professionals in enterprises, conduct comprehensive market research, reasonably adjust the teaching syllabus according to the requirements of Architectural CAD competitions, and improve their practical lessons. The ratio of post-work tasks should be taken as the basis of practical teaching [7]. Practical lessons can be improved through case-based teaching. Besides, it is necessary to ensure that the teaching objectives are consistent with the job scope of relevant positions, so as to provide high-quality talents for the society.

3.2. Design of teaching content

The teaching activities in *Architectural CAD* courses cannot be limited to software operations alone. Some students do not understand the architectural structure, legends, and dimensions when they are learning to draw construction drawings. Therefore, teachers need to pay attention to the professional knowledge related to architecture, which is also needed in Architectural CAD competitions. Teachers should organically include knowledge of architectural structure and architectural drawing in the syllabus of *Architectural CAD*, and simplify the previous teaching content, so as to improve the practicality of the syllabus [8]. The topics involved in Architectural CAD competitions are usually highly practical, and the topics will change along with the development of the industry. Therefore, teachers should make students pay attention to Architectural CAD competitions and follow the development of the industry to understand the latest updates on the industry. At the same time, teachers should also simulate situations in a real job for students. Some *Architectural CAD* teachers become lecturers right after graduation, thus they lack corresponding practical experience. There are also some teachers who only pay attention to the explanation of the content in the textbooks and pay little attention to the development of the industry. The topics of Architectural CAD competitions are usually based on actual situations in enterprises. Teachers can introduce some cases from Architectural CAD competitions into their lessons, so as to increase the practicality and the students' interest towards *Architectural CAD*. The teacher should also participate in the case studies and discuss with the students. In this way, teachers will better understand the problems encountered by the students when completing their tasks. While carrying out targeted teaching activities, the quality of teachers can also be improved to a certain extent [9].

3.3. Strengthening the reform of teaching methods through introducing competition content

The evaluation criteria in CAD competitions are usually based on the job requirements of certain positions. Therefore, teachers integrated competition content into the syllabus on the basis of cultivating the students' abilities. The reform of the school makes students interested in Architectural CAD. Through the simulation of the competition projects, the students' practical skills and teamwork spirit can be cultivated [10]. Teachers can use the project teaching method to realize the integration of theory and practice. For example, teachers can separate the students into groups according to the rules of Architectural CAD competitions and then assign project tasks. Students in each group can formulate project plans by searching for relevant

information and discussing. Teachers can then guide their students by explaining important and difficult knowledge according to the plans made by the students in each group, and the students can make corresponding improvements. The students can then implement the project plan in a cooperative manner. Finally, each group of students will present their completed works and conduct self-evaluation, and other groups give their comments. Teachers need evaluate the work of each groups based on a rubric. When setting project tasks, teachers need to follow the basic principle of step-by-step, from simple to difficult, and be in line with the students' learning progress to avoid affecting their self-confidence.

3.4. Promote the development of teaching activities through diversified forms of competitions

Competitions are an effective way to improve students' Architectural CAD skills. In addition to encouraging students to participate in Architectural CAD competitions, teachers can also organize competitions [11]. Competitions are naturally dynamic, which can improve the students' application of knowledge, test the students' mastery of knowledge, and their learning ability. To stimulate the students' competitiveness and encourage them to participate in competitions, teachers can also organize Architectural CAD skills competitions with other institutions, so that students can learn from each other through the competitions. To make the competitions more standardized, teachers can learn more about relevant competitions, rules, and evaluation standards of the competitions.

3.5. Promoting the formation of high-quality teachers through the integration of competition content into classes

The construction of a teaching mode that integrates competitions into the syllabus of *Architectural CAD* also puts forward higher requirements for teachers. In addition to professional and theoretical knowledge, teachers also need to have certain practical experience and excellent practical skills and be familiar with the requirements of relevant jobs. Therefore, teachers should take the opportunity to improve themselves in the process of building a teaching model that integrates lessons and competitions. While encouraging students to participate in Architectural CAD competitions and other related competitions, teachers will also need to actively participate in various skill certificate examinations. This will not only set an example for students, but also improve the quality of teachers. Institutions also need to actively encourage teachers to participate in such competitions. In addition, colleges and universities should also strengthen cooperation with related companies. In addition to providing students with more internship opportunities, teachers should also be given opportunities to undergo training in companies. This will not only keep teachers updated on industry developments, but also enrich their practical experience. In this way, when teachers integrate competition content into the lessons, they can ensure that the activities designed are more in line with the current industry development.

4. Conclusion

In conclusion, *Architectural CAD* competitions can not only provide a platform for students to showcase their knowledge and skills, but teachers can also understand the weaknesses of their students through the competitions discover the problems in their teaching methods and the impact on students' learning. Subsequently, more targeted reforms and innovative teaching activities can be made. The integration of competition content into the lessons can also train and develop students' professional ability and their knowledge application ability. In addition, it is also a good opportunity for teachers to improve their own professional abilities. Teachers can also participate in various related skill certificate examinations and competitions, so as to enrich their own practical experience, improve their teaching skills, and their ability to stimulate the students' interest in learning, resulting in a better learning effect of *Architectural CAD*.

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Analysis on Classified Storage and Traceability of Construction Project Archives

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Abstract: With the development and progress of economic construction and market economy, urban construction is also developing rapidly. In the field of construction engineering, a large number of construction engineering files are constantly being produced and accumulated. Therefore, the role of file management is becoming more and more important. The archives are the true records of the whole process of project construction, including the information on the whole process from project design to completion, and are also the main basis for operation management after project delivery. However, there are many aspects to construction project archives, and there are many problems. Nowadays, the classification and preservation of archives are receiving more and more attention. In this article, the origin and development history of construction project archives is first expounded, and its attributes and importance are analyzed. Secondly, the differences between ancient and modern archives management are compared, and at the same time suggestions on improving the archives' traceability system, strengthening the use of archives, and establishing and improving archives management are given. In this paper, we summarize the problems in archives sorting and put forward specific solutions to improve the standardization and systematic management of archives work and enhance the authenticity and integrity of construction project archives.

Keywords: Construction project archives; Archives management; Classification and storage; Traceability

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1. Introduction to construction engineering archives

1.1. The origin and history of development of construction project archives

1.1.1. The origin of construction project archives

Our country has a long history with countless classics, so are the archives, and information resources are abundant. With the continuous development of production practice, commerce, society, and technology, the conversion of texts into archives has become a necessity for future reference. Archives are organized and preserved, and their content, form, and names are continuously enriched.

Archives are not a social phenomenon that has always existed, and the research on its origin is relatively complicated, especially for construction project archives. Archives are created due to various factors such as social needs and technical conditions. Throughout the years, and throughout the world, human experience accumulation and social management are inseparable from the assistance and support of written materials.

In "Historical Records Book of Meditation," it was recorded that a Jinan man named Gongyu Dai presented Emperor Wu of the Han Dynasty with a picture of the Mingtang of the Yellow Emperor, so that he could build the hall according to the picture. According to Sima Qian's record, there were engineering drawings of the building in the Yellow Emperor's time, making it the earliest architectural file in the current

literature records [1].

The oldest surviving architectural archive in China is a copperplate architectural design plan unearthed in the west of Sanji Village, Pingshan County, Hebei Province in 1977 – *Zhaoyu Tu* from the King of Zhongshan's tomb of in the Warring States Period [2]. It is speculated that this copperplate map of the Warring States Period is at least 2,200 years old. It is the earliest scaled drawing and architectural plan found in China, and it is also the earliest copper building discovered in the world. The unearthing of this copperplate mega-field map has very important research value and significance in archaeology, history, linguistics, sociology, architecture, etc.

1.1.2. The history of development of construction engineering archives

In the transition from primitive society to slave society, after classes and countries appeared, documents came into being. Due to various factors such as the production of written records, the development of society, the gradual formation of the country, and the specific social needs after entering the class society, archives gradually emerged and developed.

In the process of development and evolution, construction project archives have also absorbed the essence of archaeology, philology, modern management, informatics, and other disciplines. Construction project archives are the soul of a project, and they are historical records in various forms such as words, diagrams, audios, and videos, etc. of project construction activities, which should be preserved. Project archives has the record of the whole process of a project, from project approval, bidding, survey, design, construction, to completion, which is a true reflection of the project construction process and results [3].

Construction project archives are also a kind of scientific and technological archives, a complex of archives, a product of human engineering construction activities, produced in human engineering construction activities, and serving various engineering construction activities. Logically, engineering construction activities and technology first should come before construction project files. After the appearance of construction project archives in ancient China, with the emergence and continuous development of engineering construction activities, construction project archives were gradually formed, and the main body of the formation and the content of the archives themselves have been constantly changing.

1.2. Attributes and characteristics of construction project archives

1.2.1. Attributes of construction project files

1.2.1.1. Originality

Project archives are directly formed during a project construction, and they are original records of the entire project's preliminary preparation, design, equipment procurement, construction and supervision, commissioning, and production preparation, etc., not made up after the whole process.

1.2.1.2. Authenticity

Archives are the real records of the project construction process, which can truly reflect the real situation of the construction and its various activities. Project files are just a visual record of the entire process of a project construction, and do not decide whether the project construction process is correct.

1.2.1.3. Value

Engineering project archives must have value, and should be able to provide information for verification, reference, and utilization for subsequent operations of the project. Therefore, the documents in project archives should be identified, organized, and then archived, rather than receiving it blindly without any processing.

1.2.2. Characteristics of construction project archives

Most of the construction projects are long-term and large-scale projects, which require a lot of manpower, material resources, and financial resources. Because of this, engineering archives have their own characteristics.

1.2.2.1. Complete and systematic

Due to the technical nature of construction projects, project archives also present comprehensive and systematic features. Construction project archives record all links from the beginning to the end of a project, so that the data of the projects are traceable, making the project more refined. The original data of the project can be found in the files, and the problems in terms of construction and scheme can be simulated, making project management more systematic and comprehensive. At the same time, the maintenance records after project delivery can also be found in the archives, which plays a guiding role.

1.2.2.2. Extensive and fluidity

Construction project archives involve a wide range of specialties, including project proposals, applications, project decisions, project plans, etc. The process involves municipal administration, construction, supervision, material suppliers and other units, and construction technology, etc., requiring strong professional knowledge. Moreover, the relationships involved are complicated, and the corresponding data can be easily affected by many factors, which makes engineering files highly fluid. Therefore, the scope of original materials of engineering archives is wide and fluid, with a huge amount of data.

1.2.2.3. Professionalism and complexity

The quality assurance of engineering projects requires the cooperation and coordination of multiple disciplines. Meteorology, construction, water supply, and drainage, electrical, geology, information, etc. must be integrated and coordinated to promote the completion and delivery of engineering projects on schedule. Therefore, this makes engineering archives highly professional, which is different from ordinary enterprise archives.

1.2.2.4. Complexity and detail

The majors involved in the project archives, the units involved in the completion of the project, the project links, and the scale of the project all make the number of files huge. However, the information for each link needs to be timely, complete, and true, which makes archiving a meticulous job.

1.2.2.5. Lag and perfection

Engineering archives need to be continuously improved and supplemented in order to form a sound engineering archive that explains the quality of the project in detail. Therefore, the engineering archives are perfected and supplemented with delayed data to ensure the integrity and authenticity of the archives.

2. Classification and storage of construction project files

2.1. Ancient and modern

2.1.1. Ancient

Since the Qin dynasty, which more than 2,000 years ago, documents were widely used in the daily activities of the country. Based the content recorded in the *Qin Bamboo Slips of Sleeping Tiger Land*, in the Qin Dynasty, archives already had a special storage place – a "library." The management system of the library was clearly stipulated in the form of laws and regulations and had full-time guards and inspection personnel. A character in *Qin Bamboo Slips of Sleeping Tiger Land* Neishiza said: "Do not use fire to enter Zang

(Tibetan) mansions and libraries." The buildings were connected.

A perfect document filing system is key in archives management, and a relatively complete document filing system was established in the Han dynasty.

During the Tang dynasty, the archives appraisal system had been formed: the storage period of archives was divided into two levels: permanent retention and short-term retention (three years), and appraisal and destruction were carried out every three years. Besides, the specific types of permanent files were also stipulated, and there were also records of the destroyed files.

In the Song dynasty, the earliest and most specific archive classification method known in our country – "Thousand-Character Classic Method" (*Qianziwen Jiagefa*) – appeared in the Song dynasty. This classification method solved the problem of piled up and chaotic archives to a certain extent, and it was also a great leap forward in the development of ancient archives in our country.

The archives of the Ming dynasty were well preserved. The Ming Dynasty paid more attention to the construction of archives institutions than any other feudal dynasty before the Ming dynasty. Xuanwu Lake in Nanjing in the Ming Dynasty was the storage place for the national archives of the Ming dynasty government. It was called "Houhu Yellow Book Library" at that time. It used to be the "national archives" and "big data center" of the Ming Dynasty. Its management was very scientific and was used until the formation of Republic of China. Back then, the "warehouse of yellow books" was placed in an east-west direction to ensure sunlight from morning to night and prevent dampness and mold [3].

2.1.2. Archives management in the information age

The construction of archives informatization is an inevitable trend in the development of engineering archives. The rapid development of the information age has resulted in huge challenges in the traditional archives management model. There are problems in the traditional archives management model [4]. In the traditional archives management, management personnel and archives resources is taken as the center, and archives managers are required to manage the archives manually. The human, financial, and material input by the unit is far from the output of archives management, and archives resources cannot be fully utilized. In the development of the information age, the efficiency, integration, and scientificity of information technology provides an alternative for archives management model [5]. Therefore, under the background of the current information age, it is necessary to transform the traditional archives management. The efficiency and quality of management work is the inevitable requirement of archives management, and it is also the research focus of this paper.

2.2. Significance of classified storage of construction project files

Documents are the predecessor of archives, and archives are the destination of documents; documents are the foundation of archives, and archives are the essence of documents; documents are factors of archives, and archives are the combination of documents [6].

The quality of construction projects is closely related to the quality of construction project files, and file management directly affects the overall economic benefits of the enterprise [7]. Therefore, it is necessary to make real records of the entire construction project to ensure the accuracy and completeness of all documents, which can be used as an important reference for the verification by the audit department, project completion acceptance, daily maintenance, and even future reconstruction. Therefore, it is necessary to focus on the management of construction project files, improve the effectiveness and standardization of file management, and promote the sustainable development of construction project file management.

(1) Archives have the function of evidence and basis. As an important base for documents, archives are a kind of non-renewable resources, which play an irreplaceable role in the collection, management,

utilization, and protection of documents. Project archives play an irreplaceable role in the construction, management, maintenance, and transformation of projects.

(2) Construction project archives are the true records of the labor achievements and historical achievements of builders. To some extent, they can serve as a monument for the builders.

For important documents, it is important to maintain the confidentiality of information to ensure the integrity and availability of information.

It is important to strive towards standardized and scientific management of construction project archives management. The general requirements of a good quality archive are as follows: the rules and characteristics of the formation of files should be followed, the files should be organically connected, the different values of files should be distinguished, and the archives should be organized in a way that facilitates storage and utilization [8].

3. Opportunities and challenges faced by construction project archives

3.1. Challenges

3.1.1. Irregular, incomplete, and inaccurate files

Although archives are managed by different departments, most people do not know enough about archives management, and the standards of each participating unit are different. This results in difficulties in information sorting, making it impossible to collect engineering files in time, and even incomplete and inaccurate files.

3.1.2. Delayed file collection, resulting in the loss of documents

Due to the relatively large scale of construction projects, it is very difficult to manage them. Many projects do not require file management personnel, let alone relevant institutions. Information are usually archived separately by different departments, which results in a scattered archive.

3.1.3. Poor archive conditions

During the construction period, the storage conditions of the archives are poor, and the awareness of protection is weak, resulting in damage and loss of archives. There are many departments in a project, and each department has related files. Because of this, the project files are very large. It can be said that archives start to be generated when a construction project is approved. As people's requirements for construction continue to increase, more departments will be established for construction projects, and the amount of project files will increase accordingly.

3.1.4. The handover of construction project files is not standardized

After the project files are generated, they all need to be handed over to the relevant file management personnel, and handover procedures must be followed when handing over. The increase in projects has brought greater pressure on the transfer of files, which is a huge challenge to the file management of engineering construction. However, there are many deficiencies in the current project file transfer system. For example, after the files are transferred, they are only stored in various functional departments casually. This has brought huge hidden dangers to engineering file management.

3.2. Countermeasures

3.2.1. Improving the management system of engineering archives

When signing a contract, relevant clauses should be set up for project filing, where the filing responsibilities of each unit involved in the construction are clearly stipulated. Besides, it is important to strictly follow the national regulations and normative requirements during the project construction, and collect and sort out

the filing responsibilities of each link in a timely manner.

3.2.2. Strengthening the functions of the archives administrative department

The main person in charge of the archives administrative department should be included as a member of the leading group of key construction projects. Not only that, but the construction unit should also report the construction project to the local archive administrative management department upon approval from the provincial authorities.

3.2.3. Strengthening the allocation and training of project archives management personnel, and improving the professional quality of archivists

Project archiving is a very professional job. Construction units should select personnel who understand both construction business and archives business to engage in archives management and keep the personnel relatively stable. The archives administration department should also select archivists to participate in the training of key project archives management. Besides, the project file management network should be improved, the allocation and training of project file management personnel and instructors should be strengthened, and their professional quality should be continuously improved.

3.2.4. Clarifying the responsibilities and rights of archives management

It is a very cumbersome and complicated task to manage engineering archives. If there is no corresponding management standard, it will be difficult to manage engineering archives well. Therefore, relevant management norms should be created, so as to determine file management responsibilities in accordance with relevant regulations. The construction unit should have more detailed requirements for the records of any project. From special personnel management to fixed-point supervision, from simple records to design changes, from the use of signatures to various systems, all tasks should be included in standardized management.

4. Conclusion

Construction project files play an extremely important role in all aspects of engineering construction. For archives management personnel, it is necessary to strengthen the concept of comprehensive quality management, constantly standardize the quality of archives, and strengthen communication with other departments and personnel, so that the integrity and authenticity of engineering data can effectively guaranteed, so as to ensure the quality of construction projects. File management plays a role in promoting orderly development of project archives.

For construction projects, the management of project files is very necessary. If the archives of the project cannot be managed effectively, the construction quality of the project cannot be improved, and the project will lose its competitiveness. To effectively manage engineering files, it is important to understand its professional and extensive characteristics and formulate corresponding methods. Only in this way can engineering file management be effective.

Disclosure statement

The author declares no conflict of interest.

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Technical Analysis of Highway Bridge Static Load Test

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Abstract: Highway bridges are an important part of the transportation industry and can promote social economic construction and development. In actual operation, highway bridges are often damaged due to overload and natural factors, which tend to affect the safety and shorten the service life of these bridges. Assessing the overall state and performance of highway bridges is therefore a key element. Static load test, which is a type of sustainable detection experiment, has many advantages, including low cost, high efficiency, and high accuracy. In this paper, the bridge structure is analyzed through the application of theoretical calculations and relevant comparisons, so as to judge the operating state of the bridge.

Keywords: Highway bridge; Static load test; Detection technology

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1. Introduction

At present, China's transportation industry is developing rapidly, providing a strong foundation for the development of highway bridges. Bridges are important links between roads and play an extremely important role in the transportation industry. According to relevant data, more than 90% of all bridges in China are concrete bridges. Due to natural disasters or overload, the safety of bridges is affected, which may cause serious economic losses and even pose a threat to people's lives. In order to ensure the safety and stability of the structure, proper health inspection of the bridge structure should be done. The static load test is a common and effective detection method that can fully reflect the overall performance of the bridge, allowing us to effectively grasp the actual operating state of the bridge, timely address the existing problems to improve and optimize the quality of the bridge, and promote the development of the transportation industry.

2. Contents of static load test

The application of static load test mainly includes the following aspects: (i) strengthen vertical detection and lateral detection; in order to effectively improve the accuracy of detection, the layout of the measuring points should be optimized during the detection process to ensure that the location and quantity of the measuring points can meet the actual requirements; at least 3 measuring points should be set in each span; after clarifying the detection content, the deflection value of the bridge bearing can be obtained [1]; (ii) optimize the section stress detection work; through reasonable application of the detection technology, the partial load characteristics and the maximum value of the section stress can be analyzed; (iii) corners, expansion and contraction of the bearing, and displacement of pier tops are structures that are prone to problems in bridge structures; based on the detection results, the accuracy and efficiency of risk judgment

of bridge structures can be improved; (iv) with prolonged use, damages may occur at different positions, including cracks of different sizes at different positions; thus, the safety and stability of the bridge structure are not guaranteed; the crack detection work mainly includes the direction, position, length, and load.

3. Importance of static load test for highway bridges

The main purpose of the static load test is to test the main structure of the bridge. In the process, the actual structural performance and operating state of the bridge can be understood; the deflection and load stress of the bridge can be detected; the structural stiffness and load strength of the bridge can be verified; and whether the overall structural data of the bridge meets the relevant design requirements and design specifications can be determined. In project construction management, proper quality inspection and safety inspection must be carried out on a regular basis, so as to improve the overall quality of the project, ensure the normal operation of highway bridges, and lay a strong foundation for the development of the transportation industry [2]. Although the bridge inspection work in China is highly adept, many problems will arise in the production and construction stage. Therefore, proper inspection of the building structure and building materials must be done, so as to ensure that the materials and quality of construction meet the relevant regulations and requirements.

4. Bridge static load test equipment

For highway construction testing, specialized equipment should be used to strictly control the quality of data in order to ensure the accuracy of the test and prevent problems from arising. In the testing process, there are high requirements for testing capabilities and testing equipment; the testing equipment must be tested and proofread by the relevant personnel to ensure that it meets the data testing requirements. In laboratory testing, the testing equipment, as an extremely important tool, is the basis for carrying out various testing works. The optimization of the testing equipment improves the accuracy and overall quality of the test data. Applying specialized testing equipment can garner better test results and more accurate test data [3]. The detection and calibration of equipment should be strengthened to improve detection capabilities.

The testing equipment should be regularly checked, and the testing equipment should be regularly calibrated to ensure safe and stable operation and reduce the occurrence of aberrant situations. In equipment verification work, it is often necessary to move the testing equipment within a relatively special working environment. After the verification work, the analysis and research of the verification data should be performed. If there are large deviations in the data, the use of the equipment should be suspended, and the equipment should be inspected and repaired to ensure the accuracy of the obtained data.

5. Testing standards and conditions

In the process of highway construction testing, the testing methods and standards promulgated by the state should be applied and used as data assessment standards. All data testing results must be supported by the testing standards. Samples must be stored in accordance with the relevant specifications during the actual testing process. The best sample collection can be achieved through the testing of related equipment, and the environment and related samples can be tested effectively. In highway bridge inspection, there are high requirements for the inspection work. Temperature, humidity, and climate can affect the inspection results. A huge difference between the detection environment and the collection environment can easily affect the inspection equipment and the accuracy of the detection data [4]. Relevant test personnel should carry out comprehensive monitoring and testing of the environment, so as to improve the accuracy of data testing.

6. Preliminary test preparation for static load test

6.1. Select the test hole

In order to improve the accuracy and effectiveness of data detection, it is necessary to arrange the test holes in accordance with the relevant regulations and requirements in the preparatory process as well as the actual state and characteristics of highway bridges. This would help ensure that the number of test holes is adequate and promote the static load test work.

6.2. Select the scaffolding and fixtures

In the detection process, many large-scale devices need to be used, each of which has its own unique functions. However, these devices will affect each other. Therefore, it is necessary to control the distance between equipment when planning and arranging the equipment at the testing site. For example, independent scaffolding and test fixtures should be set up to minimize the impact and interference of the test results [5]. In addition, steel structures are required for scaffolding and test fixtures in order to improve the stability and safety of the bridge structure.

6.3. Select the loading position

A reasonable selection of the loading position can directly affect the detection efficiency and results. A large difference between the actual requirements and the selected loading position will affect the accuracy of the detection results [6]. Therefore, strict adherence to the loading effect and loading principle is mandatory when selecting the position, so as to ensure the safety and accuracy of the test results.

7. Inspection process of highway bridge static load test

7.1. Load test condition

The current bridge structure and operation quality should be inspected in detail. In order to improve the overall quality of the test results, the test conditions must be in line with the following requirements [7]: (i) ensure the quality of the continuous girder bridge; in the actual static load test, the load test plays an extremely important role, and since there are various test conditions, they should be selected according to the test requirements and actual test conditions [8]; due to the particularity of the overall structure of highway bridges, the continuous beam structure is usually a single-box, single-chamber, cross-section structure, with high rigidity in the transverse direction, and symmetrical loads are often applied below; (ii) common positive load conditions and partial load conditions; in equipment selection, two heavy-duty vehicles, each of which weighs about 30 tons, are used in the static load test; they are important equipment in the test and detection; dynamic changes should be recorded, and the indicator data under different conditions should be compared. For comparison of specific indicators, see **Table 1**.

Table 1. Calculation value of loading test and loading efficiency

Loading conditions	Theoretical value (kN·m)	Test value (kN· m)	Loading efficiency (η)
Maximum positive bending moment of the section (working condition 1)	1232	1174	0.951
Maximum positive bending moment of the section (working condition 2)	1232	943	0.76

7.2. Determine the test load

When applying the beam static load test to highway bridges, it must be in line with the following principles:

(i) control the load; during the detection process, it is necessary to analyze and optimize the load area of the bridge; the vehicle load can be divided into two types, 30 tons and 20 tons, respectively; there are certain differences between the load conditions and the construction load in which the deviation is controlled to ascertain the volume of the load and determine the test requirements and time efficiency; (ii) uninstall the program; in the process of carrying out the static loading work, the program should be selected and optimized according to the structural change; in the static load test of highway bridges, it can be divided into three levels, with each level being defined through the control strength and the actual test situation on site [9]; after the loading and unloading work is carried out in accordance with the relevant regulations, it is necessary to take readings after a period of time to control the data deviation.

7.3. Measuring point layout

There are certain particularities to the location and deflection of strain measuring points of highway bridges. In actual detection work, it is necessary to set up as many measuring points as possible, with the number of measuring points controlled to about 3 in special locations and 7–10 in cross-section mid-span positions.

7.4. Test results

In static load test and detection, prestressed, prefabricated hollow slabs of certain specifications should be used as the main reference standard. The application of static load test and detection work strengthens the judgment of the actual situation of the bridge structure and improves the accuracy of data calculation. Through a detailed analysis of this detection link and content, it is known that the concrete thickness of the bridge deck is relatively high. In order to reduce the probability of concrete cracks, the application principles of the steel-joined beam method should be perfected in the prefabricated slab optimization and calculation work. There is a difference between the half-wave sine load and the actual load. In the actual calculation process, the content and data of the elastic modulus of the concrete should be fully considered, and the consideration and research on the vehicle load and the vehicle itself should be strengthened. The coefficient K = K1 • K2 • K3. In the application of static load test, many factors need to be considered. Among them, there are significant differences in the values of K1 and K2; the corresponding calculation work should be carried out according to the actual situation of the construction site. At the same time, the effective value of K3 is obtained by the hinged plate method. The comparison between the calculated results and the experimental values is shown in **Table 2**.

Table 2. Comparison of calculation results and test values

Data	Maximum deflection of side plate (cm)	Maximum strain of side plate (με)
Before correction	5.543	202.4
After correction	4.623	167.9
Test value	3.875	162.4

7.5. Test results and bearing capacity evaluation

The last part in the static load test of highway bridges is to analyze the test results. The specific evaluation methods include the following aspects: (i) the detection coefficient; in the actual application process, the static load test detection technology can effectively reflect the bridge data and provide feedback on the state of the bridge; it is expressed by the ratio between the calculated value and the measured value; a detection coefficient less than 1 indicates that the bridge bearing capacity meets the relevant requirements and the performance of the bridge is relatively good, but a detection coefficient greater than 1 indicates that the bearing capacity of the bridge is weak, which will affect the safety and stability of the structure; in the

actual application process, the data of the detection and verification system should be effectively controlled because if the data is too great or too little, the quality and specifications of the detection cannot be guaranteed, and the results will be greatly affected [10]; (ii) the relationship curve between theoretical value and measured value; when carrying out the load test and detection work, the monitoring of the use of the bridge and its safety should be strengthened; the actual and theoretical value curves provide feedback on the working condition of the bridge; an insignificant deviation between the two curves indicates that the bridge has good performance and is in good operating state, with low safety risk; however, a significant deviation between the two curves indicates that there are certain problems in the operating state and overall performance of the bridge, with high safety risk; hence, it should be dealt as soon as possible.

8. Conclusion

Generally speaking, in the development of highway bridge projects, the safety and performance of bridges are important issues that need to be considered. Therefore, the static load test detection technology has been widely applied to highway bridges. The static load test is a detection method with high accuracy and detection efficiency and low cost. Through the application of this technology, we can have a clearer understanding of the structural health and bearing capacity of highway bridges and objectively evaluate the actual state of highway bridges. In addition, we can also see the shortcomings of these bridges and address them in time, so as to optimize the structure, improve the overall quality, and promote the development of the transportation industry .

Disclosure statement

The author declares no conflict of interest.

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This section can be divided into subheadings. This section focuses on the results of the experiments performed.

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This section should provide the significance of the results and identify the impact of the research in a broader context. It should not be redundant or similar to the content of the results section.

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Appendix

This section is optional and is for all materials (e.g. advanced technical details) that has been excluded from the main text but remain essential to readers in understanding the manuscripts. This section is not for supplementary figures. Authors are advised to refer to the section on ‘Supplementary figures’ for such submissions.

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Journal

Journal article (print) with one to three authors

[1] Yao Y., Xia B. Application of Phase Frequency Feature Group Delay Algorithm in Database Differential Access. Computer Simulation, 2014, 31(12): 238-241.

Journal article (print) with more than three authors

[2] Gamelin F.X., Baquet G., Berthoin S., et al. Effect of high intensity intermittent training on heart rate variability in prepubescent children. European Journal of Applied Physiology, 2009, 105: 731–738.

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[4] Hargreave M., Jensen A., Nielsen T.S.S., et al. Maternal use of fertility drugs and risk of cancer in children—A nationwide population-based cohort study in Denmark. International Journal of Cancer, 2015, 136(8): 1931–1939.

Book

Book with one to three authors

[5] Schneider Z., Whitehead D., Elliott D. Nursing and midwifery research: methods and appraisal for evidence-based practice. 3rd edn. 2009, Elsevier Australia, Marrickville, NSW.

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No author

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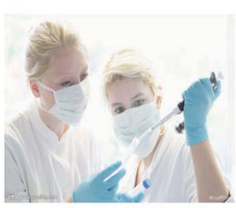
In-service Doctors



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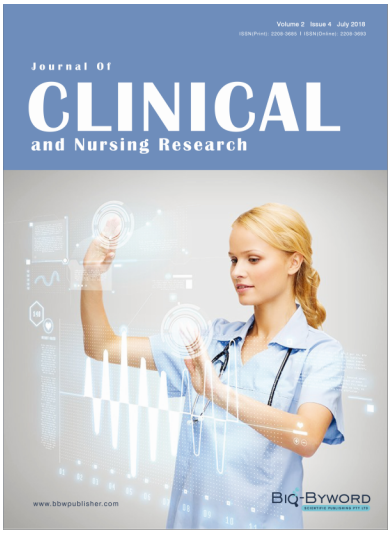

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