2024

BRICS SKILLS COMPETITION

(BRICS FUTURE SKILLS & TECHNOLOGY CHALLENGE)

Digital Application of Highway Construction and Maintenance

BRICS-FS-48

Test Project

(International Final)

August, 2024

DIRECTORY

1 Competition format

Each team has two contestants.

2 Competition content

This competition is based on actual construction projects, targeting the skill requirements of enterprise positions, and further emphasizing innovative application of highway construction and maintenance technology, showcasing the cutting-edge development and widespread application of new technologies. the competition adopts advanced virtual simulation computer competition platform which comprehensively examines the participants' ability in handling practical engineering cases and comprehensive grasp of expertise of skills.

The assessment content of this competition is divided into theoretical knowledge assessment, Construction and maintenance of roadbed and pavement, and bridge construction and maintenance, covering a more diverse range of road and bridge construction scenarios. The competition is based on actual roadbed, pavement, and bridges engineering case,the content mainly covers construction technology, testing and inspection, maintenance operations, etc., while incorporating project entire process of construction and management,which further elevates contestant’s professional ethics and cultivates their innovative thinking.

3 Project Modules And Time Requirements

3.1Project Modules And Time Requirements

The highway construction and maintenance competition consists of three subjects, requiring participants to complete them within 300 minutes. Specific project module name and time requirements are in the table blow.

Competition Subjects, Duration, And Answer Format

No	Subjects	Duration	Formation
1	Theoretical knowledge assessment	30min	Individual answering questions, team scoring
2	Construction and maintenance of roadbed and pavement	150min	Individual answering questions, team scoring
3	Bridge construction and maintenance	120min	Individual answering questions, team scoring

3.2 Task Content

Subject **1**：Theoretical Knowledge Assessment（**30min**）

（1）Task Background

In today's rapidly developing era, highway transportation, as an important infrastructure for national economic and social development, is increasingly demonstrating its indispensable position. With the rapid expansion and increasing frequency of use of the highway network, continuous progress and innovation in highway construction and maintenance technology have become crucial. This not only relates to the safety, smoothness, and comfort of highways, but also directly

affects people's travel experience and the efficiency of goods transportation. To ensure the safety and efficient operation of highways, the assessment of this competition focuses on evaluating the participants' professional knowledge mastery and application ability in the field of highway construction and maintenance.

As a highway construction and maintenance technician, participants are requested to answer the relevant theoretical, legal, regulatory, and professional ability assessment questions based on the competition content to verify their professional theoretical knowledge mastery level.

（2）Key Assessment

Comprehensive knowledge: Assessing the contestants' comprehensive understanding of the field of highway construction and maintenance, including the historical development of highway engineering, different types of highway engineering structures, principles and characteristics, laws, regulations and normative documents.

Construction technology: Assess the familiarity of the contestants with the construction process of roadbed, pavement, and bridges, including construction plans and procedures, selection and operation of construction equipment, quality control during the construction process, project progress management, and strengthening the assessment of advanced construction equipment and construction technology.

Experimental testing: Assessing the importance and methods of experimental testing in roadbed, pavement, and bridge engineering, including the application of various bridge and tunnel engineering experimental testing projects, quality testing standards and methods, the impact of experimental result evaluation on engineering decision-making, and strengthening the assessment of experimental data analysis

ability.

Highway maintenance: Assessing the familiarity of participants with the highway maintenance process, including maintenance projects, maintenance technical measures (methods and processes), selection and operation of maintenance equipment, quality control during the maintenance process, and strengthening the assessment of advanced maintenance equipment and maintenance technical measures.

Professional ethics: Assessing the professional ethics and comprehensive qualities of athletes, including professional ethics and ethical standards, teamwork, career development planning, and personal growth awareness.

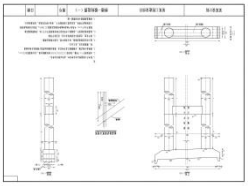
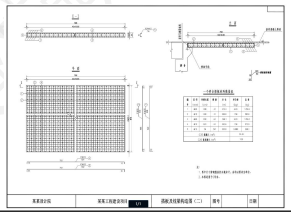
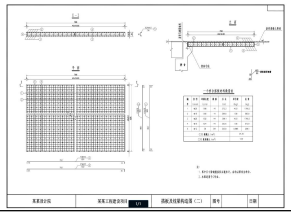
Engineering drawing recognition: Assessing the precise mastery and efficient application of engineering drawing skills by contestants in highway construction technology and maintenance operations, ensuring that every detail in the construction and maintenance process is accurate and error free.

The theoretical knowledge assessment subjects are standardized test papers and are conducted through online assessment methods. Individual independent answering, team scoring, accounting for 20% of the total score.

The sample questions for the theoretical knowledge exam are as follows:

No	Topic type	difficulty	Content	Topic	Choice	Answer
1	Single choice	Easy	Comprehensive knowledge	What materials are mainly used to construct asphalt pavement?	A. Asphalt B. Cement C. Gypsum D. Lime	A
2	Single choice	Difficult	Comprehensive knowledge	What are the main provisions of the "Code for Construction and Acceptance of Highway Engineering"?	A. Construction safety standards B. Environmental requirements C. Construction quality control and acceptance standards D. Engineering cost budget	C

3	Single choice	Hard	Construction technology	If the compaction degree of a certain roadbed is 93%, the measured dry density is 1.7g/cm ³, and the maximum dry density is 1.8g/cm ³, calculate the compaction degree.	A. 90% B. 92.22% C. 93% D. 94.44%	D
4	Single choice	Difficult	Construction technology	What is the main purpose of prestressed tensioning in bridge construction?	A. Improve the load-bearing capacity of the structure B. Enhance the aesthetic appeal of bridges C. Reduce the usage of concrete D. Accelerate construction progress	A
5	Single choice	Hard	Experimental testing	What method is commonly used for testing the compaction degree of asphalt pavement?	A. Excavation and sand filling method B. Visual inspection method C. Sonic detection method D. Infrared detection method	A
6	single choice	Difficult	Highway maintenance	What is the main purpose of preventive maintenance?	A. Extend the service life of highways B. Improve the aesthetics of highways C. Increase highway driving speed D. Reduce traffic flow on highways	A
7	single choice	Easy	Professional ethics	What are the basic requirements of professional ethics?	A. High salary and good working environment B. Dedication to work, honesty and trustworthiness, fairness in handling affairs, serving the masses, and contributing to society C. Flexible working hours and flexible working methods D. Rich social and entertainment activities	B
8	Multiple Choice	Easy	Comprehensive knowledge	Which of the following materials are commonly used for roadbed filling?	A. Sand soil B. Clay C. Crushed stone D. Wood E. Asphalt	A B C

9	Multiple Choice	Difficult	Construction technology	What are the main processes involved in bridge construction?	A. Pile foundation construction B. Template installation and removal C. Concrete pouring and curing D. Bridge deck paving E. Tunnel excavation	A B C D
10	Multiple Choice	Hard	Experimental testing	What are the routine inspection items for asphalt pavement?	A. Compaction degree B. Flatness C. Deflection value D. Permeability coefficient E. Flexural strength	A B C D
11	Image recognition question	Easy	Comprehensive knowledge	The top elevation of the tie beam shown in the following figure is（ ）。 	A. H3 B. H4 C. H5 D. H6	C
12	Image recognition question	Hard	Comprehensive knowledge	The total number of reinforcement bars for the transition slab shown in the following figure（ ）kg。 	A. 1798.2 B. 1768.3 C. 583 D. 4991.5	D
13	Image recognition question	Difficult	Construction technology	According to the drawing requirements, the concrete grade required for the bridge approach slab is（ ）。 	A. C15 B. C20 C. C25 D. C30 E. C35	B E

Subject 2： Construction And Maintenance Of Roadbed And Pavement（**150min**）

（1）Task Background

Under the joint influence of continuous use and changing natural environment, a key highway in a certain region has shown several diseases on the asphalt pavement, such as cracks, potholes, ruts, etc. These diseases not only reduce the smoothness and safety of driving, but also pose a threat to the overall performance and lifespan of highways. In order to ensure the safety of highway traffic and improve driving comfort, there is an urgent need for professional roadbed and pavement construction and maintenance work.

This competition will simulate this actual engineering scenario, requiring participants to use the provided virtual simulation competition platform for roadbed and pavement construction and maintenance to complete a series of operations such as asphalt mixture surface layer construction, identification and technical condition evaluation of asphalt pavement diseases, treatment of asphalt pavement crack diseases, layout of safety facilities in road maintenance work areas, and determination of the length of road maintenance work areas. Assessing contestants' mastery of professional knowledge, testing their professional skills and practical abilities.

The assessment subjects for roadbed and pavement construction and maintenance are conducted through a virtual simulation competition platform. Independently answered by individuals, scored by the team, accounting for 50% of the total score.

（2）Task Content

① Construction Of Roadbed And Pavement

a.Task Description：

On the virtual simulation competition platform, participants will use platform

resources to complete roadbed excavation and protection, as well as asphalt mixture surface layer construction, based on the highway construction plan and requirements, ensuring overall construction quality and efficiency.

b.Task Content：

Participants are required to develop a comprehensive and detailed construction plan, specifying the sequence, time nodes, and completion time of each stage of roadbed excavation, protection, and asphalt mixture surface layer construction. At the same time, it is necessary to accurately select and configure construction equipment and materials on the virtual simulation competition platform based on the construction plan and conditions.

c.Matters Attention:

Contestants need to fully utilize the interactivity of the virtual simulation competition platform, strictly follow the construction plan to simulate construction on the virtual platform, and ensure accurate and compliant operations; When selecting equipment and materials, comprehensive consideration should be given to ensure their reasonable applicability; Quality control is the core of construction, and construction standards should be followed at all times.

② Roadbed And Pavement Inspection

a.Task Description：

On the virtual simulation competition platform, participants will conduct comprehensive roadbed technology testing and evaluation, as well as asphalt pavement disease identification and technical condition evaluation for a given road section.

b.Task Content：

Participants are required to select and operate road surface inspection equipment on the virtual simulation competition platform to test key indicators such as road surface smoothness, skid resistance, and structural strength, and accurately record the inspection data. At the same time, athletes should identify various diseases of asphalt pavement and scientifically evaluate their severity. Finally, based on the detection data and disease assessment results, the technical condition of the road surface is comprehensively evaluated to provide decision-making basis for subsequent maintenance work.

c.Matters Attention:

When operating the virtual simulation competition platform, contestants need to ensure proficiency and accurate operation of various road detection equipment to ensure the accuracy, reliability, completeness, and continuity of detection data; The assessment of road surface technical conditions must be based on scientific testing data analysis and professional judgment to ensure the objectivity and impartiality of the assessment.

③ Roadbed And Pavement Maintenance

a.Task Description：

On the virtual simulation competition platform, participants need to treat asphalt pavement crack diseases on a given road section.

b.Task Content：

Participants are required to use the repair function of the virtual simulation competition platform to accurately locate the location and degree of asphalt pavement crack diseases, design and implement scientific crack treatment plans.

c.Matters Attention:

Contestants should have solid knowledge and practical experience in roadbed and pavement maintenance, in order to accurately diagnose the problem of broken roadbed and pavement, propose effective solutions, and ensure the feasibility and effectiveness of the plan.

④ Determination Of The Length Of The Road Maintenance Work Area

a. Task Description:

On the virtual simulation competition platform, participants need to complete maintenance work theory and determine the length of the work area for a given road section.

b. Task Content:

Participants are required to simulate the dangerous experience of driving a vehicle without setting up a warning zone according to regulations through a virtual simulation competition platform, and determine the length layout of various parameters, warning zones, upstream transition zones, buffer zones, work zones, downstream transition zones, termination zones, and other areas of the maintenance operation control zone based on the project overview and relevant regulations.

c.Matters Attention:

Contestants should be familiar with concepts such as types of highway maintenance operations, division of maintenance operation areas, and setting of highway maintenance operation areas; In order to accurately diagnose and propose effective solutions to the problems with the broken foundation and road surface, and ensure the feasibility and scientificity of the work area setting.

⑤ Layout Of Safety Facilities In Road Maintenance Work Area

a. Task Description:

On the virtual simulation competition platform, participants need to complete the installation and removal of safety facilities in the maintenance work area for designated scenarios.

b. Task Content:

Participants are required to complete the installation of traffic signs, road markings, warning lights, roadblocks, and other facilities in designated work scenarios through a virtual simulation competition platform; Select, place, and rotate traffic safety facilities in warning zones, upstream transition zones, buffer zones, work zones, downstream transition zones, and termination zones in accordance with regulations in each scenario, ultimately completing the layout of the entire maintenance operation area. After the deployment is completed, operations such as dismantling and scene content correction can be carried out in order.

c.Matters Attention:

Contestants should master the basic theories and principles of road traffic safety facility layout, including facility functions, standard requirements, and applicable conditions. Master the layout of traffic safety facilities in the safety maintenance operation area under common scenarios such as expressway and Class I~fourth-class highway.

Subject 3： Bridge Construction and Maintenance（120min）

（1）Task Background

A prefabricated bridge in a certain region, as a key node in the transportation network, has gradually shown significant damage and functional degradation due to multiple pressures such as natural environmental erosion and continuous increase in traffic flow after a long period of service. This degradation not only threatens the

safety and stability of the bridge itself, but also poses a potential threat to the smooth flow of daily traffic. In order to effectively address this challenge and ensure the stability, safety, and smooth traffic of bridges, it is urgent to use advanced prefabricated bridge construction technology and refined maintenance methods for intervention and maintenance.

This competition will simulate this actual engineering scenario, requiring participants to use the provided virtual simulation competition platform for bridge construction and maintenance technology to complete a series of operations including prefabricated box girder bridge construction, bridge load testing, bridge support replacement and maintenance. Assessing contestants' mastery of professional knowledge, testing their professional skills and practical abilities.

Virtual Simulation Competition Platform - Asphalt Pavement Crack Disease Treatment

The assessment subjects for bridge construction and maintenance are answered through a virtual simulation competition platform. Independently answered by individuals, scored by the team, accounting for 30% of the total score.

（2）Task Content

① Prefabrication Construction Of Prefabricated Box Girder

a.Task Description：

On the virtual simulation competition platform, participants will simulate the entire process of prefabricated box girder construction using platform resources based on the bridge construction plan and requirements.

b. Task Content:

Participants are required to develop detailed construction plans in a virtual environment, covering the sequence of each construction stage, expected time nodes, etc. According to the construction plan and conditions, the contestants need to accurately select construction equipment and materials on the virtual platform to simulate the construction process of prefabricated box girders.

c.Matters Attention:

Contestants should fully utilize the interactivity of virtual platforms, strictly follow the construction plan for construction simulation, and ensure the accuracy of operations; When selecting equipment and materials, comprehensive consideration should be given to ensure that the selection is reasonable.

② Transport And Installation Of Prefabricated Box Girders

a.Task Description：

Contestants need to use a virtual simulation platform to simulate the construction scene and standardized operation process of prefabricated box girders using three-dimensional visualization and interactive operation methods.

b. Task Content:

Contestants complete the practical simulation of construction preparation and implementation process according to the software process. This includes the

preparation of construction plans for prefabricated box girders, disclosure of plans and safety technology, construction of box girder pouring pedestals, prefabrication of box girder steel bars, installation of box girder steel bars, construction of prestressed pipelines, installation of formwork, installation of core formwork, construction of negative moment prestressed pipelines, installation of pressure bars, pouring of beam concrete, demoulding and curing, tensioning of prestressed reinforcement, grouting of ducts, sealing head plates, beam storage, quality control testing and other virtual simulation practices.

c.Matters Attention:

Contestants need to master the preparation work before the construction of prefabricated box girders, as well as the materials, equipment, machinery, and tools required for the construction of prefabricated box girders. Master the quality inspection items and methods during the construction process of prefabricated box girders.

③ Transportation And Installation Of Prefabricated Cover Beams

a.Task Description：

Contestants need to use a virtual simulation platform to simulate and complete the transportation and installation of prefabricated cover beams using three-dimensional visualization and interactive operation methods, as well as standardized operation processes.

b. Task Content:

Contestants complete the practical simulation of construction preparation and implementation process according to the software process. This includes the virtual simulation and practical operation of multiple links, including the preparation of

construction plans, plan disclosure and safety technical disclosure, pre site inspection of the cover beam, lifting, fixing, transportation, measurement and layout of the cover beam, treatment of the contact surface between the cover beam and the pier column, cover beam positioning, grouting sleeve connection, grouting, quality control inspection, etc.

c.Matters Attention:

Contestants should master the material, technical, and organizational preparation contents before the transportation and installation of prefabricated cover beams, including the preparation of special construction plans, expert argumentation, technical disclosure, etc. Master the materials, equipment, machinery, and tools required for the transportation and installation of prefabricated cover beams. Master the quality inspection items and methods during the transportation and installation of prefabricated cover beams, such as pre delivery acceptance of cover beams, grouting quality inspection, etc.

④ Bridge Load Test

a.Task Description：

On the virtual simulation competition platform, participants will conduct bridge load tests on a given bridge model to comprehensively evaluate its technical condition.

b. Task Content:

Participants are required to select and operate bridge inspection equipment on the virtual simulation competition platform to inspect key parts of the bridge. Simulate the bridge response under different load conditions using load tests, evaluate the technical condition of the bridge based on detection data, and propose corresponding

maintenance or reinforcement suggestions.

c.Matters Attention:

Contestants should be proficient in operating testing equipment to ensure the accuracy and completeness of testing data; The assessment of the technical condition of bridges should be based on scientific data analysis and professional judgment to ensure the objectivity and accuracy of the evaluation results.

⑤ Bridge bearing replacement

a.Task Description：

On the virtual simulation competition platform, a scientific maintenance plan is proposed and implemented for bridge models that have already been damaged, including bearing replacement and maintenance, as well as maintenance operation construction and safety operation management.

b. Task Content:

Participants are required to use the repair equipment and functional operations of the virtual simulation competition platform to accurately locate the location and degree of damage to the bridge model, and develop a scientific support replacement plan.

c.Matters Attention:

Contestants should possess solid knowledge and practical experience in bridge maintenance in order to accurately diagnose bridge problems and propose solutions; When designing a virtual maintenance plan, the actual situation and maintenance needs of the bridge should be fully considered.

4 Scoring criteria for project modules

This competition is based on the characteristics of vocational education teaching and relevant teaching guidance plans issued by the Ministry of Education. Knowledge points, skill points, and evaluation standards are set for each stage of assessment, with skill assessment as the main focus. Experts are organized to develop competition regulations, implementation plans, and various scoring rules, and to conduct open, fair, and impartial evaluations of hand selection skills. The scoring criteria are completely consistent with the competition content of the event. Only the works submitted by the contestants to the server will be rated during the scoring process.

Competition Score, Total Score, And Weight Explanation

Subject	Team Total Score	Portion
Subject1：Theoretical knowledge assessment	200	Proportion of total score 20%
Subject2：Construction and maintenance of roadbed and pavement	200	Proportion of total score 50%
Subject3：Bridge construction and maintenance	200	Proportion of total score 30%
Total score	200	Subject 1*20%Subject 2*50%+Bridge construction and maintenance*30%

1.All assessment subjects are automatically scored by computer systems.

Ranking is arranged in descending order of total score; If the total score is the same, the ranking will be based on the shorter total time spent; If the total score is the same and the total time is the same, the one with higher scores in roadbed and pavement construction and maintenance will rank first. If the scores in roadbed and pavement construction and maintenance are still the same, the one with higher scores in bridge construction and maintenance will rank first.

2.Subject1：Theoretical Knowledge Assessment

The standard test paper consists of a total of 85 questions, with a total score of 100 points. Among them, there are 70 Single choice question, each of which has 4 options, only one of which is the most consistent with the meaning of the question. 1 point for each question, 1 point for right choice and 0 point for wrong choice; There are 15 multiple-choice questions, each with 5 alternative options. At least 2 of them match the meaning of the question. Each question is worth 2 points, with 1 point given for selecting the wrong option and 0 points given for not selecting or selecting incorrectly.

3.Subject2、3：Skill Operation Assessment

The assessment subjects for roadbed and pavement construction and maintenance, as well as bridge construction and maintenance, each include 5 practical skill application tasks. Each task corresponds to a relevant operation point, and scores can be obtained by correctly operating the tools or equipment in the designated area according to the correct operation sequence and selecting the correct tools or equipment. Otherwise, no points will be awarded.