NATIONAL COUNCIL FOR TECHNICAL EDUCATION

NOVEMBER 2022

PROPOSED OCCUPATIONAL STANDARDS

FOR CIVIL ENGINEERS

LEVEL: NTA 7

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FOREWORD

The National Council for Technical Education (NACTE) is a corporate body established by the National Council for Technical Education Act, Cap.129. The Act provides a legal framework for the Council to coordinate the provision of technical education and training in Tanzania. The mandate of NACTE is three-fold, namely; Regulatory, Quality Assurance and Policy Advisory.

In discharging its mandate, the Council has been charged with the responsibilities, among others, to:

(a) assist technical institutions in the transmission of knowledge, principles and training in the field of technical education and training for the benefit of the people of Tanzania;
(b) assist technical institutions in the overall development of the quality of education they provide and to promote and to maintain approved academic standards;
(c) establish and make awards in technical education which are consistent in standard and comparable to related awards in Tanzania and internationally; and
(d) ensure that the quality of education required for the awards is met and maintained throughout the duration of the delivery of the course.

In the course of execution of these responsibilities, the Council has been instituting various measures aiming at advancing the quality of training provided in technical institutions in respect of the changing demands of the labour market, both local and international.

To achieve the above obligation, NACTE, under the Ministry of Education, Science and Technology implemented the East Africa Skills for Transformation and Regional Integration Project (EASTRIP), a project aiming at promoting regional integration through supporting the regional corridors and sector markets, developing common standards and qualifications, and promoting mobility of students, faculty, and graduates. The project supports the Government of Tanzania to address shortage of skills in five sectors namely:

(a) Energy;
(b) Construction;
(c) Information and Communication Technology (ICT);
(d) Transportation; and
(e) Agribusiness .

To address the skills, miss-match and shortage in the five (5) sectors in the country, the project funded, among others, a component of Development of Occupational Standards for

Technical and Vocational Education and Training (TVET). In this regard, NACTE endeavoured to identify qualified and highly experienced experts in the five sectors from both the industry and training institutions to carry out the development of Occupational Standards. The exercise was carried out at Morogoro Teachers College – Morogoro from 16th July to 10th August, 2021. The output of the exercise is Occupational Standards for 12occupations. Occupational standards for Civil Engineers are among the 12 occupational standards which have been developed.

Since Occupational Standards are statements of work performance reflecting the ability to successfully complete the functions required in an occupation, as well as the application of knowledge, skills, attitudes and understanding in an occupation, it is the Council's expectations that the developed standards will form a robust base for decision making and provide explicit guidance to policy makers, curriculum developers, educators, employers and other stakeholders in matters related to manpower planning as well as execution of Technical and Vocational Education and Training undertakings.

Prof. J. W. Kondoro
Chairman

Dar es Salaam
November 2022

ACKNOWLEDGEMENT

The National Council for Technical Education (NACTE) is charged with the mandate to be the Quality Assurance organ of the Government in matters related to Technical and Vocational Education and Training (TVET) and production of qualified manpower for both local and international labour markets. In order to realize this obligation, NACTE endeavours to institute policies, guidelines and standards and to set the quality benchmarks for training institutions.

However, this is only possible if there is a strong base, linking the training institutions on one hand and the demands of the industry/labour market for relevant manpower on the other hand. Therefore, the Council undertook a step to develop Occupational Standards in sectors considered to be the engine to steer the country's desire to achieve an industrial economy. This exercise would not be a success without the input and support from our stakeholders. I am indebted to acknowledge some of them here.

I wish to acknowledge and appreciate the support from the Ministry of Education, Science and Technology through the East Africa Skills for Transformation and Regional Integration Project (EASTRIP)for the financial support which facilitated the preparation of this document. I wish also to appreciate Mrs Leah Lukindo and Eng. Dr. Simon Baregu for the tireless efforts and commitment in facilitating and guiding the standards development process, Ms. Eileen Tzamburakis and Ms. Chausiku Yakweli Ibrahim for compiling and type setting the final document; and the NACTE Secretariat for coordinating the whole activity.

In a very special way I wish further to extend my sincere gratitude to this team of wonderful experts who tirelessly dedicated their time and availed their invaluable intellect in the preparation of this document. I would like to recognise the colossal inputs of the following experts:

S/N	Name	Designation	Organization
1.	Eng. Emmanuel Taseni	Consulting Engineer	NIMETA Consult (T) Limited
2.	Eng. Josephat Mutembei	Civil Engineer II	Kigamboni Municipal Council
3.	Eng. George M. Chaula	Civil Engineer I	Tanzania Building Agency (TBA)

4.	Eng. Franco Faustine	Civil Engineer I	Tanzania Building Agency (TBA)
5.	Eng. Godfrey Komba	Civil Engineer	The National Council for Technical Education (NACTE)
6.	Eng. Milton J. Nyerere	Managing Director	Aquifer Construction Limited
7.	Eng. Mwivei Msisili	Principal Civil Engineer	Hinly Company Limited
8.	Dr. Jubily Musagasa	Lecturer	Dar es Salaam Institute of Technology
9.	Eng Cheche Mabiki	Principal Registration Officer	Contractors Registration Board (CRB)
10.	Eng. Fares Washa	Assistant Registrar	Engineers Registration Board (ERB)
11.	Dr. Prosper Mgaya	Deputy Rector ARC	National Institute of Transport (NIT)

In addition, the Council hopes to further improve the international level of occupational standards, and promote the modernization and internationalization of industrial industries, so as to make Tanzania's occupational standards more in line with the international ones and expand its development potential. Therefore, the Council has invited China & Africa Technical and Vocational Education Cooperation Alliance and China & Africa (Chongqing) Technical and Vocational Education Cooperation Alliance to develop, revise and review vocational standards together with vocational colleges in China. Based on their rich experience in vocational education, as well as China's advanced and complete industrial chain and its position in the international market, they will help Tanzania develop its vocational education and related industries.

Therefore, I would like to express my heartfelt thanks to the team composed of many Chinese colleges and relevant experts, for their hard work and dedication, and for their wisdom and experience in preparing this document. They are listed below:

S/N	Organization	Name	Tile/Field of Expertise

1	Chongqing Vocational Institute of Engineering	Li Hongli	Professor/Project Management
2		Xu Xiaoshan	Associate Professor/Architectural Engineering Technology
3		Jiang Bolin	Associate Professor/Road and Bridge Engineering Technology
4		Tang Xianzhi	Senior Engineer/Municipal Engineering
5		Xiang Yang	Lecturer/Architectural Engineering Technology
6		Pi Yingxing	Lecturer/Road and Bridge Engineering Technology
7		Zhang Xiu	Lecturer/Road and Bridge Engineering Technology
1	Shanghai Urban Construction Vocational College	Huang Tianrong	Professor/Architectural Engineering and Vocational Education
2		Wu Xiangxiang	Associate Professor/Structural Engineering
3		Fu Xiaochao	Engineer/Structural Engineering
4		Gu Xueying	Engineer/Architectural Engineering Technology
5		Shi Qinyu	Assistant/Architectural Engineering Technology
6		Li Jialu	Assistant/Architectural Engineering Technology

Last, but not least, I would like to acknowledge the enormous inputs from all stakeholders who were consulted during the validation process to provide their expert views and opinions on the validity of the contents and preparation of this document for customers' consumption.

Dr. A. B. Rutayuga — Dar es Salaam

Executive Secretary — **November 2022**

ABBREVIATIONS

CBR	California Bearing Ratio
MOPP	Maintenance Operating Policy and Procedures
NACTE	National Council for Technical Education
NOS	National Occupational Standards
OS	Occupational Standards
PCC	Portland Cement Concrete
PPE	Personal Protective Equipment
PPR	Poly Propylene
PVC	Poly Vinyl Chloride
RC	Reinforced Concrete
RCC	Reinforced Cement Concrete
RPM	Revolutions Per Minute
SPT	Standard Penetration Test
TET	Technical Education and Training
TVET	Technical and Vocational Education and Training

GLOSSARY OF TERMS

Circumstantial Knowledge:	Detailed knowledge, which allows the decision-making in regard to different circumstances and cross cutting issues
Competence:	The ability to use knowledge, understanding, practical and thinking skills to perform effectively to the workplace standards required in employment.
Competency:	A description of the ability one possesses when able to perform a given occupational task effectively and efficiently.
Competency-Based Education:	An instructional program that derives its content from validated tasks and bases assessment on the learner's performance
Curriculum:	A description or composite of statements about "what is to be learned" by the trainee/student in a particular instructional programme; a product that states the "intended learning outcomes".
Educational/Training Programme:	The complete curriculum and instruction (what and how) that is designed to prepare a person for employment in a job or other particular performance situation.
Occupation:	A specific position requiring the performance of specific tasks – essentially the same tasks are performed by all employees having the same title. (Example: baker)
Occupational Analysis:	A process used to identify the tasks that are important to employees in any given occupation
Occupational Area:	This is a broad grouping of related jobs. Example: food service
Occupational Competence:	The application of knowledge and skills to perform consistently to the standards required in the work context.
Occupational Standards:	Specific requirements of competences people are expected to demonstrate in a particular occupational area, including knowledge and relevant attitudes. They also act as performance tool of assessment of the pre – scribed outcomes.

Performance Criteria:	Indicate the expected end results or outcome in form of evaluative statements.
Skills:	The ability to perform occupational tasks with a high degree of proficiency within a given occupation. Skill is conceived of as a composite of three completely interdependent components: cognitive, affective, and psychomotor.
Standards:	It is a set of statement, which if proved true under working conditions, means that an individual is meeting an expected level and type of performance
Task Analysis:	The process of analysing each task to determine the steps, related knowledge, attitudes, performance standards, tools and materials needed, and safety concerns required of employees performing it.
Tasks:	A work activity that has a definite beginning and ending, is observable or measurable, consists of two or more definite steps, and leads to a product, service, or decision.
Underpinning Knowledge:	This is crucial knowledge that an individual must acquire in order to demonstrate competences that are associated in performing a given task.
Verification Process:	The process of having experts review and conform the importance of the task (competency) statements identified through occupational analysis. Other questions, such as the degree of task learning difficulty are also frequently asked. This process is also sometimes referred to as validation.

1.0. INTRODUCTION

Technical Education and Training (TET) is one of the most important education sub-sectors in Tanzania, responsible for developing a skilled workforce to support the country's industrialization economic agenda. Tanzania's Development Vision 2025 intends to raise the country's economy to a middle-income status. This requires a skilled workforce that is aligned with the needs of the public and private sectors of the economy. The National Council for Technical Education has begun the job of drafting Occupational Standards that will eventually be adopted as National Occupational Standards for TET in order to ensure that it meets the needs of the labour market and the country's economic agenda.

National Occupational Standards (NOS) are performance criteria that are matched with labour market demands. Each National Occupation Standard describes functions, performance standards, and knowledge/understanding for one important function or task. They combine skills, knowledge, and attitudes to describe best practice. They are useful tools for establishing job roles, personnel recruiting, supervision, and appraisal, as well as TET standards. They're also helpful for benchmarking and harmonizing qualifications on a national and international level. Standards, in general, provide a solid framework for high-quality TET that is labour market-relevant, current and consistent in delivery across all public and private institutions.

However, it must be noted that, Occupational Standards and Training standards/qualifications standards are different. Occupational standards are defined in terms of activities performed by a person in a selected occupation (e.g., an electrical engineer designs electrical wiring circuits, performs trouble shooting in electrical wiring, etc.) and they are usually defined by employers following procedures agreed upon by all stakeholders. Education and training standards are developed from the activities defined in occupational standards, and they include learning objectives to ensure that the necessary skills and knowledge are developed by a person to enable him or her to function at an agreed level in an occupation. Education and Training standards are used to define curricula in training institutions. It is however critical that there must be a direct link between the occupational standards and the training standards to respond to demands of the labour market.

In TET delivery, Tanzania adopted the Competency-based Education and Training (CBET) approach. The CBET approach focuses on providing learners with the skills and knowledge required to meet the occupational standards. Occupational standards are thus the starting point for developing Competency-based Education and Training (CBET) programs. TET institutions will be required to benchmark their curricula with relevant occupational standards.

Occupational Standards are developed based on a given occupation's current and future demands. As a result, they serve as a means of bridging the gap between the worlds of employment and technical education and training (TET).

The Civil Engineer Occupation has its own set of occupational standards. The document explains how the occupational standards were developed, as well as the scope, the occupational profile in the form of DACUM charts, and the Occupational Standards.

2.0. OCCUPATIONAL STANDARD DEVELOPMENT PROCESS

The Occupational standards development process began with an examination of major documents that guide Tanzanian skill development. The 10-year National Skills Development Strategy (2016-2026) was one of the documents reviewed, and it outlined six (6) economic sectors that should be prioritized when developing skills development programmes.

These sectors include: Transport and logistics, Tourism and Hospitality, Agribusiness, Construction, Energy and ICT. NACTE labour market reports were also used in the literature review to determine the skills demand in the Tanzanian labour market as a whole.
After the literature review, a workshop comprised of expert workers and educators with substantial knowledge and experience in the occupation conducted an occupational analysis utilizing the DACUM approach to produce the occupational profile. The analysis resulted in DACUM Charts, which are attached as **Appendix 1** to this document.

The occupational standards were then developed. Experts in Occupational Analysis and the Development of Occupational Standards facilitated the workshop. Interviews, online surveys, and a stakeholder forum were used to validate the occupational standards. Engineers, supervisory technicians on the job, and experienced Civil Engineering technicians were key

informants in the survey to discover occupational trends. This information was used to gain insight from the workplaces regarding trends and changes in the profession, including how well graduates are prepared for working in the occupation. A total of …….. online surveys were completed by experts from the labour market across the country. Apart from the survey aiding in defining the scope for the occupational analysis, they served to engage a wide cross-section of experts in the occupation. The stakeholders' forum was attended by 100 participants from different parts of the country representing various companies.

3.0. THE SCOPE AND OVERVIEW OF THE OCCUPATION STANDARDS FOR CIVIL ENGINEERS

These standards cover a broad range of duties and tasks that can be performed by a Civil Engineer. However, the occupational standards are not meant to replace individual job descriptions, they are to be used for guidance in defining skill levels and knowledge for the technician in specific settings or positions. The Civil Engineer may perform tasks in a number of key areas of the occupational standards, but not necessarily in all areas. For example, in large operations other individuals may be employed or designated to perform specific tasks.

Civil engineers are in charge of overseeing and managing civil engineering projects. They plan, design, construct, manage, run, and maintain public and private infrastructure projects and systems, such as roads, buildings, airports, maritime ports, trains, pipelines, tunnels, canals, dams, bridges, and water supply and sanitation systems. Their activities require compliance to standards and rules approved by a competent authority.

The Occupational standards developed cover the following main duties of Civil Engineers:

a) Carryout feasibility study of civil engineering projects;
b) Design civil engineering infrastructures;
c) Perform survey for civil engineering infrastructures;
d) Perform geotechnical investigation;
e) Provide technical data during the tender document preparation for construction and maintenance of civil works.
f) Manage civil engineering projects and deliver on time, while observing quality and cost.
g) Design mixes of materials for building and civil engineering works.
h) Ensuring compliance to health and safety standards.

i) Perform structural integrity assessment and demolition of building and civil engineering infrastructures.

The Occupational standards have been clustered into NTA qualification levels i.e. NTA level 7 and 8.

4.0. VALIDITY PERIOD

The occupational standards will be valid for 3-5 years due to the fast-changing nature of technology. The review will proceed in the same manner as the previous one, with new occupational standards being developed based on current labour market information.

5.0. OCCUPATIONAL STANDARDS

5.1. OCCUPATIONAL STANDARDS FOR CIVIL ENGINEERS – NTA 7

OCCUPATION	CIVIL ENGINEER	**OCCUPATION CODE**	
DUTY TITLE	DESIGN ROAD AND RAILWAY INFRASTRUCTURES	**DUTY NO.**	701
TASK TITLE	CARRY OUT GEOMETRIC DESIGN OF ROADS	**TASK NO.**	7011
PERFORMANCE CRITERIA	The person performing this task must be able to design road geometry as per standards and guidelines approved by a competent authority.		
RANGE STATEMENT	The task will be performed in the office under the supervision of an engineer. The following tools and materials will be required in performing the task: computer, stationery, standards and design codes, office furniture.		

EVIDENCE REQUIREMENTS

PRACTICAL PERFORMANCE	**UNDERPINNING KNOWLEDGE**
The person performing this task must be able do the following: 1. Select right tools and equipment for the task; 2. Carry out engineering surveys for road alignment; 3. Determine design parameters for design of road geometry; 4. Design horizontal road alignment; 4.1. Straight line; 4.2. Circular curve; 4.3. Transition curve; 5. Design vertical road alignment; 5.1 Ground elevation; 5.2 Design elevation; 5.3 Construction elevation (filling and excavation height); 6. Design road cross sectional elements; 6.1 Embankment; 6.2 Cutting; 6.3 Carriageway, median belt, shoulder, emergency parking strip, climbing lane and speed change lane, etc.; 6.4 Calculate earthwork quantities; 7. Design road intersections; 7.1 Select the type of	**Detailed knowledge about:** **1.0. Methods** This person performing this task must be able to explain how to: 1.1. Carry out engineering surveys for road alignment; 1.2. Determine design parameters for design of road geometry; 1.3. Design horizontal road alignment; 1.4. Design vertical road alignment; 1.5. Design road cross sectional elements 1.6. Determine road intersections; 1.7. Prepare construction drawings; 1.8. Calculate earthwork quantities. **2.0. Principles** The person must be able to explain the principles of: 2.1. Engineering surveys; 2.2. Route location; 2.3. Design of horizontal curves; 2.4. Design of vertical curves; 2.5 Design of cross section; 2.6. Design of geometrical intersections; 2.7. Preparation of construction drawing; 2.8. Calculation of earthwork quantities. **3.0. Theories** The person must be able to explain: 3.1. Road design and construction; 3.2. Traffic engineering; 3.3. Engineering drawing;

intersection; 7.2 Arrange various traffic facilities reasonably; 7.3 Check the driving sight distance at the intersection; 7.4 Carry out interior design of the intersection; 8. Prepare construction drawings; 9. Clean work place, equipment and tools; 10. Store tools and equipment appropriately.	3.4. Quantity survey; 3.5. Engineering geology; 3.6. Geotechnical engineering; 3.7. Construction materials Computer Aided Design. **4.0. Essential skills** 4.1. Team work skills; 4.2. Communication skills; 4.3. Computer skills; 4.4. Analytical skills; 4.5. Creativity skills; 4.6. Mathematics skills in algebra, trigonometry, circles and spheres, calculus; 4.7. Work ethic; 4.8. Adaptability; 4.9. Time management; 4.10. Respect.
DESCRIPTION OF END PRODUCTS/SERVICE	Road geometry is designed as per standards and guidelines approved by a competent authority.
CIRCUMSTANTIAL KNOWLEDGE	**Detailed knowledge about:** 1. Safe handling of equipment and tools; 2. Extent of responsibility; 3. Occupational safety and health.

OCCUPATION	CIVIL ENGINEER	**OCCUPATION CODE**	
DUTY TITLE	DESIGN ROAD AND RAILWAY INFRASTRUCTURES	**DUTY NO.**	701
TASK TITLE	CARRY OUT DESIGN OF ROAD PAVEMENTS	**TASK NO.**	7012
PERFORMANCE CRITERIA	The person performing this task must be able to design road pavements as per standards and guidelines approved by a competent authority.		
RANGE STATEMENT	The task will be performed in the office under the supervision of an engineer. The following tools and materials will be required in performing the task: computer, stationery, standards and design codes, office furniture.		

EVIDENCE REQUIREMENTS

PRACTICAL PERFORMANCE	**UNDERPINNING KNOWLEDGE**
The person performing this task must be able do the following: 1. Select right tools and equipment for the task; 2. Estimate traffic loading; 3. Evaluate subgrade characteristics; 4. Demarcate homogeneous sections; 5. Design gravel pavement structures 6. Design bituminous pavement structures; 6.1 Design criteria for bituminous pavement; 6.2 Combination design of bituminous pavement structures; 6.3 Design and checking calculation of bituminous pavement structures; 6.4 Reconstruction design of bituminous pavement structures; 7. Design concrete pavement structures; 7.1 Structural combination design; 7.2 Plane size design and reinforcement design; 7.3 Thickness design; 8. Prepare construction drawings; 9. Clean work place, equipment and tools; 10. Store tools and equipment appropriately.	**Detailed knowledge about:** **1.0. Methods** This person performing this task must be able to explain how to: 1.1. Estimate traffic loading; 1.2. Evaluate subgrade characteristics; 1.3. Demarcate homogeneous sections; 1.4. Design pavement layers for gravel roads 1.5. Design pavement layers for bituminous surfaced roads; 1.6. Design layers for concrete pavements; 1.7. Prepare construction drawings. **2.0. Principles** The person must be able to explain the principles of: 2.1. Subsurface exploration; 2.2. Traffic load estimation; 2.3. Theories and methods of pavement design; 2.4. Preparation of construction drawing. **3.0. Theories** The person must be able to explain: 3.1. Road design and construction; 3.2. Pavement analysis and design; 3.3. Traffic engineering; 3.4. Engineering drawing; 3.5. Engineering geology; 3.6. Geotechnical engineering; 3.7. Construction materials; 3.8. Highway engineering materials;

	3.9. Concrete technology; 3.10. Computer Aided Design.; **4.0. Essential skills** 4.1. Team work skills 4.2. Communication skills; 4.3. Computer skills; 4.4. Analytical skills; 4.5. Creativity skills; 4.6. Mathematics skills in algebra, coordinate geometry; 4.7. Work ethic; 4.8. Adaptability; 4.9. Time management; 4.10. Respect.
DESCRIPTION OF END PRODUCTS/SERVICE	Road pavement is designed as per standards and guidelines approved by a competent authority.
CIRCUMSTANTIAL KNOWLEDGE	**Detailed knowledge about:** 1. Safe handling of equipment and tools; 2. Extent of responsibility; 3. Occupational safety and health.

OCCUPATION	CIVIL ENGINEER	**OCCUPATION CODE**	
DUTY TITLE	DESIGN ROAD AND RAILWAY INFRASTRUCTURES	**DUTY NO.**	701
TASK TITLE	CARRY OUT DESIGN OF RAILWAYS	**TASK NO.**	7013
PERFORMANCE CRITERIA	The person performing this task must be able to design railways as per standards and guidelines approved by a competent authority.		
RANGE STATEMENT	The task will be performed in the office and outdoors under the supervision of an engineer. The following tools and materials will be required in performing the task: computer, stationery, standards and design codes, office furniture, measuring instrument.		

EVIDENCE REQUIREMENTS

PRACTICAL PERFORMANCE	**UNDERPINNING KNOWLEDGE**
The person performing this task must be able do the following: 1. Select right tools, equipment and safety gears for the task; 2. Conducthealth and safety precautions when performing the task; 3. Carry out engineering surveys for railway alignment; 4. Determine various design parameters for design of railway geometry; 5. Design horizontal railway alignment; 6. Design railway profile alignment; 7. Design railway cross sectional elements; 8. Compare schemes; 9. Design railway subgrades; 10. Design railway stations; 11. Carry out track structure and geometry design; 12. Carry out track maintenance and management; 13. Read and plot construction drawings; 14. Clean workplace, tools and equipment; 15. Store drawings, tools and equipment appropriately.	**Detailed knowledge about:** **1.0. Methods** This person performing this task must be able to explain how to: 1.1. Carry out engineering surveys for railway alignment; 1.2. Determine various design parameters for design of railway geometry; 1.3. Design horizontal railway alignment; 1.4. Design railway profile alignment; 1.5. Design railway cross sectional elements; 1.6. Compare schemes; 1.7. Design railway subgrades; 1.8. Design railway stations; 1.9. Carry out track structure and geometry design; 1.10 Carry out track maintenance and management; 1.11 Read and plot construction drawings. **2.0. Principles** The person must be able to explain the principles of: 2.1. Engineering surveys; 2.2. Route selection and determination; 2.3. Designing horizontal curves; 2.4. Design of vertical curves; 2.5 Design of cross section elements; 2.6. Track geometry design; 2.7. Design of railway subgrades; 2.8. Design of railway stations; 2.9. Reading and plotting construction drawings.

	3.0. Theories The person must be able to explain: 3.1. Railway design and construction; 3.2. Traffic engineering; 3.3. Engineering drawing; 3.4. Engineering survey; 3.5. Engineering geology; 3.6. Geotechnical engineering; 3.7. Construction materials; 3.8. Computer Aided Design software. **4.0. Essential skills** 4.1. Team work skills; 4.2. Communication skills; 4.3. Computer skills; 4.4. Analytical skills; 4.5. Creativity skills; 4.6. Mathematics skills in algebra, trigonometry, circles and spheres, calculus; 4.7. Work ethic; 4.8. Adaptability; 4.9. Time management capability; 4.10. Instrument operation capability.
DESCRIPTION OF END PRODUCTS/SERVICE	Railway is designed as per standards and guidelines approved by a competent authority.
CIRCUMSTANTIAL KNOWLEDGE	**Detailed knowledge about:** 1. Operation of equipment, instruments and tools. 2. Extent of responsibility; 3. Professional quality; 4. Occupational safety and health.

OCCUPATION	CIVIL ENGINEER	**OCCUPATION CODE**	
DUTY TITLE	DESIGN REINFORCED CONCRETE (RC) AND MASONRY STRUCTURES	**DUTY NO.**	702
TASK TITLE	DESIGN REINFORCED CONCRETE (RC) BUILDING STRUCTURES	**TASK NO.**	7021
PERFORMANCE CRITERIA	The person performing this task must be able to design RC building structures as per standards and guidelines approved by a competent authority.		
RANGE STATEMENT	The task will be performed in the office under the supervision of an Engineer. The following tools and materials will be required in performing the task: computer, stationery, standards and design codes, office furniture, structural analysis and design software, drawing software.		

EVIDENCE REQUIREMENTS

PRACTICAL PERFORMANCE	**UNDERPINNING KNOWLEDGE**
The person performing this task must be able do the following: 1. Select right tools and equipment for the task; 2. Determine static system; 3. Determine design load; 4. For simple structures, establish a simplified structural calculation model; 5. For complex structures, select the appropriate structural analysis software and establish a structural model; 6. Carry out structural analysis and obtain internal forces of members according to the structural analysis results; 7. Design RC slabs according to internal forces; 8. Design RC beams according to internal forces; 9. Design RC columns according to internal forces; 10. Design RC portal frames according to internal forces; 11. Design RC foundations according to internal forces;	**Detailed knowledge about:** **1.0. Methods** This person performing this task must be able to explain how to: 1.1. Determine static system; 1.2. Determine design load; 1.3. For manual calculation of structures, determine a simplified calculation model; 1.4. Use finite element structural analysis software; 1.5. Carry out structural analysis; 1.6. Design different types of RC slabs; 1.7. Design RC beam; 1.8. Design RC column; 1.9. Design RC portal frame; 1.10. Design RC foundation; 1.11. Design drainage structures; 1.12. Prepare detailed structural drawings using a drawing software; 1.13. Prepare bar bending schedule. **2.0. Principles** The person must be able to explain the principles of: 2.1 Finite element structural analysis principle; 2.2. Designing RC structures; 2.3. Detailing RC structures; 2.4. Foundation works.

12. Carry out detailing of structural members, e.g. designing reinforcement details at the member edges, openings, joints and anchorages; 13. Prepare structural drawings using a drawing software; 14. Prepare bar bending schedule; 15. Clean workplace, tools and equipment; 16. Store drawings, tools and equipment appropriately.	**3.0. Theories** The person must be able to explain: 3.1. Design philosophy (Safety, economic and aesthetics); 3.2. Structural mechanics; 3.3. Finite element structural analysis; 3.4. Reinforced Concrete Design and construction; 3.5. Foundation engineering; 3.6. Soil mechanics; 3.7. Concrete technology; 3.8. Civil engineering materials; 3.9. Mechanics of materials; 3.10. Engineering drawing; 3.11. Computer Aided Design software. **4.0. Essential skills** 4.1. Team work skills; 4.2. Communication skills; 4.3. Computer skills; 4.4. Analytical skills; 4.5. Creativity skills; 4.6. Mathematics skills in algebra, calculus; 4.7. Work ethic; 4.8. Adaptability; 4.9. Time management; 4.10. Respect.
DESCRIPTION OF END PRODUCTS/SERVICE	The Designing of reinforced concrete building structure is performed as per standards and guidelines approved by a competent authority.
CIRCUMSTANTIAL KNOWLEDGE	**Detailed knowledge about:** 1. Safe handling of equipment and tools; 2. Extent of responsibility; 3. Occupational safety and health.

OCCUPATION	CIVIL ENGINEER	**OCCUPATION CODE**	
DUTY TITLE	DESIGN REINFORCED CONCRETE (RC) AND MASONRY STRUCTURES	**DUTY NO.**	702
TASK TITLE	DESIGN REINFORCED CONCRETE (RC) RETAINING WALLS	**TASK NO.**	7022
PERFORMANCE CRITERIA	The person performing this task must be able to design reinforced concrete (RC) retaining walls as per standards and guidelines approved by a competent authority.		
RANGE STATEMENT	The task will be performed in the office under the supervision of an Engineer. The following tools and materials will be required in performing the task: computer, stationery, standards and design codes, office furniture, structural analysis and design software, drawing software.		

EVIDENCE REQUIREMENTS

PRACTICAL PERFORMANCE	**UNDERPINNING KNOWLEDGE**
The person performing this task must be able do the following: 1. Select right tools, equipment and safety gears for the task; 2. Observe health and safety precautions when performing the task; 3. Know two types and structural requirements of concrete retaining wall; Select the appropriate type of retaining wall; 4. Analyze forces; For simple structures, establish a simplified structural calculation model. For complex structures, select the appropriate structural analysis software and establish a structural model; 5. Calculate the reinforcements at the vertical board, wall toe board and wall heel board of the retaining wall based on the stress analysis; 6. Check the stability of the retaining wall against sliding and overturning;	**Detailed knowledge about:** **1.0. Methods** This person performing this task must be able to explain how to: 1.1. Determine static system; 1.2. Determine design load; 1.3. For manual calculation of structures, determine a simplified calculation model; 1.4. Use finite element structural analysis software; 1.5. Carry out structural analysis; 1.6. Design reinforcement for retaining walls; 1.7. Perform stability checks; 1.8 Check retaining wall cracks; 1.9. Prepare detailed drawings using a drawing software. **2.0. Principles** The person must be able to explain the principles of: 2.1. Analyzing lateral earth pressure; 2.2. Designing RC retaining walls; 2.3. Detailing RC retaining walls. **3.0. Theories** The person must be able to explain: 3.1. Structural mechanics; 3.2. Structural analysis; 3.3. Reinforced Concrete Design;

7. Perform checking calculations of cracks on sides toward and opposite to the retaining wall; 8. Prepare detailed drawings using a drawing software; 9. Clean work place, tools and equipment; 10. Store drawings, tools and equipment appropriately.	3.4. Foundation engineering; 3.5. Soil mechanics; 3.6. Concrete technology; 3.7. Civil engineering materials; 3.8. Strength of materials; 3.9. Engineering drawing; 3.10. Computer Aided Design software. **4.0. Essential skills** 4.1. Team work skills; 4.2. Communication skills; 4.3. Computer skills; 4.4. Analytical skills; 4.5. Creativity skills; 4.6. Mathematics skills in algebra, calculus; 4.7. Work ethic; 4.8. Adaptability; 4.9. Time management; 4.10. Respect.
DESCRIPTION OF END PRODUCTS/SERVICE	The Designing of (RC) retaining walls is performed as per standards and guidelines approved by a competent authority.
CIRCUMSTANTIAL KNOWLEDGE	**Detailed knowledge about:** 1. Safe handling of equipment and tools; 2. Extent of responsibility; 3. Occupational safety and health.

OCCUPATION	CIVIL ENGINEER	**OCCUPATION CODE**	
DUTY TITLE	DESIGN REINFORCED CONCRETE (RC) AND MASONRY STRUCTURES	**DUTY NO**	702
TASK TITLE	DESIGN MASONRY WALLS	**TASK NO**	7023
PERFORMANCE CRITERIA	The person performing this task must be able to design masonry walls as per standards and guidelines approved by a competent authority.		
RANGE STATEMENT	The task will be performed in the office under the supervision of an Engineer. The following tools and materials will be required in performing the task: computer, stationery, standards and design codes, office furniture, structural calculation software, drawing software.		

EVIDENCE REQUIREMENTS	
PRACTICAL PERFORMANCE	**UNDERPINNING KNOWLEDGE**
The person performing this task must be able do the following: 1. Select right tools and equipment; 2. Determine design loads; 3. Select material to be used; 4. Carry out structural type selection and structure processing; 5. Determine size of the walls; 6. Design masonry walls; 7. Prepare construction drawings; 8. Clean work place, tools and equipment; 9. Store drawings, tools and equipment appropriately.	**Detailed knowledge about:** **1.0. Methods** This person performing this task must be able to explain how to: 1.1. Determine design loads; 1.2. Select material to be used; 1.3. Select structural load bearing system; 1.4. Carry out structure processing; 1.5. Determine size of the walls; 1.6. Design masonry walls; 1.7. Prepare construction drawings. **2.0. Principles** The person must be able to explain the principles of: 2.1. Analyze lateral pressure; 2.2. Sizing of walls; 2.3. Designing masonry walls; 2.4. Construction of masonry walls. **3.0. Theories** The person must be able to explain: 3.1. Structural mechanics; 3.2. Structural analysis; 3.3. Foundation engineering; 3.4. Soil mechanics; 3.5. Civil engineering materials; 3.6. Strength of materials; 3.7. Engineering drawing. **4.0. Essential skills**

	4.1. Team work skills; 4.2. Communication skills; 4.3. Computer skills ; 4.4. Skills in using structural software and drawing software; 4.5. Analytical skills; 4.6. Creativity skills; 4.7. Mathematics skills in algebra, calculus; 4.8. Work ethic; 4.9. Adaptability; 4.10. Time management; 4.11. Respect.
DESCRIPTION OF END PRODUCTS/SERVICE	The Designing of masonry wall is performed as per standards and guidelines approved by a competent authority.
CIRCUMSTANTIAL KNOWLEDGE:	**Detailed knowledge about:** 1. Safe handling of equipment and tools; 2. Extent of responsibility; 3. Occupational safety and health.

OCCUPATION	CIVIL ENGINEER	**OCCUPATION CODE**	
DUTY TITLE	DESIGN WATER SUPPLY, WASTEWATER, IRRIGATION SYSTEMS AND HYDRAULIC STRUCTURERS	**DUTY NO.**	703
TASK TITLE	DESIGN WATER SUPPLY SYSTEM	**TASK NO.**	7031
PERFORMANCE CRITERIA	The person performing this task must be able to design water supply system as per standards and guidelines approved by a competent authority.		
RANGE STATEMENT	The task will be performed in a design office under supervision of a senior design engineer. The following equipment and materials will be required in performing the task: computer, design software and stationery.		

EVIDENCE REQUIREMENTS

PRACTICAL PERFORMANCE	**UNDERPINNING KNOWLEDGE**
The person performing this task must be able do the following: 1. Select right tools, equipment, software and safety gears for the task; 2. Observe health and safety precautions when performing the task; 3. Conduct a field investigation; 4. Determine the type of water supply system; 5. Estimate the design water demand. 6. Determine the water supply source and water intake method; 7. Determine the water supply and treatment schemes according to the raw water quality and water quality standards; 8. Design the intake pump station and booster pump station; 9. Design water treatment facilities; 10. Design sludge treatment facilities; 11. Design water delivery pipe network and water distribution pipe network; 12. Design regulation and storage	**Detailed knowledge about:** **1.0. Methods** This person performing this task must be able to explain how to: 1.1. Calculation methods of design water demand; 1.2. Calculation methods for pipe diameters of water delivery pipe network and water distribution pipe network; 1.3. Calculation methods for process design of water treatment facilities; 1.4. Calculation methods for process design of sludge treatment facilities; 1.5. Calculation methods for storage capacity of regulation and storage structures; 1.6. Calculation methods for pump station scale design. **2.0. Principles** The person must be able to explain the principles of: 2.1 Operating principles of water pump; 2.2 Operating principles of water delivery pipe network and water distribution pipe network; 2.3 Water purification principles of various treatment structures; 2.4 Operating principles of regulation and storage structures; 2.5 Principles and requirements of water supply source selection.

structures; 13. Be proficient in using computer-aided design related software; 14. Plot construction drawings; 15. Determine technical specifications of process and equipment; 16. Prepare the bill of quantities; 17. Clean workplaces, tools, equipment and software; 18. Store drawings, tools, equipment and software appropriately; 19. Apply new technologies, new materials, new processes and new equipment.	**3.0. Theories** The person must be able to explain: 3.1 Have the knowledge of comprehensive pipeline layout; 3.2 Have the comprehensive knowledge of hydraulics, calculation of velocity, discharge and head loss, etc.; 3.3 Have the comprehensive knowledge of water supply and treatment; 3.4 Get familiar with the national standards on water supply quality and the treated water quality standards; 3.5 Get familiar with the general water quality inspection; 3.6 Have a comprehensive knowledge of pump and pump station; 3.7 Get familiar with automatic control and electrical equipment in the water plant; 3.8 Get familiar with geological survey; 3.9 Have relevant knowledge of construction machines and materials; 3.10 Know and promote new technologies, new materials and new processes. **4.0. Essential skills** 4.1. Team work skills; 4.2. Communication skills; 4.3. Computer skills; 4.4. Analytical skills; 4.5. Creativity skills; 4.6. Mathematics skills in algebra, calculus; 4.7. Work ethic; 4.8. Adaptability; 4.9. Time management; 4.10. Respect.
DESCRIPTION OF END PRODUCTS/SERVICE	The Designing of water supply system is performed as per standards and guidelines approved by a competent authority.
CIRCUMSTANTIAL KNOWLEDGE	**Detailed knowledge about:** 1. Safe handling of equipment and tools; 2. Extent of responsibility; 3. Occupational safety and health.

OCCUPATION	CIVIL ENGINEER	**OCCUPATION CODE**	
DUTY TITLE	DESIGN WATER SUPPLY, WASTEWATER, IRRIGATION SYSTEMS AND HYDRAULIC STRUCTURERS	**DUTY NO.**	703
TASK TITLE	DESIGN WATER SUPPLY AND WASTEWATER SYSTEMS IN A BUILDING	**TASK NO.**	7032
PERFORMANCE CRITERIA	The person performing this task must be able to design water supply and wastewater systems in a building as per standards and guidelines approved by a competent authority.		
RANGE STATEMENT	The task will be performed in a design office under supervision of a senior design engineer. The following equipment and materials will be required in performing the task: computer, design software and stationery.		

EVIDENCE REQUIREMENTS

PRACTICAL PERFORMANCE	**UNDERPINNING KNOWLEDGE**
The person performing this task must be able do the following: 1. Select right tools, equipment, software and safety gears for the task; 2. Observe health and safety precautions when performing the task; 3. Interpret architectural, structural, HVAC, electrical drawings; 4. Determine the number and layout positions of water points and sanitary wares for buildings; 5. Determine the water supply sources and discharge points of wastewater and rainwater; 6. Calculate the water supply of buildings; 7. Calculate the wastewater amount of buildings; 8. Calculate the rainwater amount of buildings; 9. Determine the water supply, wastewater and rainwater systems; 10. Determine the water supply mode of the building and the capacity of the water tank; 11. Calculate the diameters of water	**Detailed knowledge about:** **1.0. Methods** This person performing this task must be able to explain how to: 1.1. Calculation methods for water supply of the building; 1.2. Calculation methods for wastewater amount of the building; 1.3 Calculation methods for rainwater amount of the building; 1.4 Calculation methods for hot water amount of the building; 1.5 Calculation methods for diameters of water supply, wastewater, rainwater and hot water pipes in the building; 1.6 Calculation methods for capacity of water tanks in the building; 1.7 Calculation methods for the pressure of water supply and pressurization systems in the building; 1.8 Calculation methods for heat consumption of heating equipment; 1.9 Calculation methods for water consumption of fire protection systems in the building. **2.0. Principles** The person must be able to explain the principles of: 2.1. Layout principles of building pipeline;

supply pipe, wastewater pipe and rainwater pipe; 12. Plot construction drawings for water supply pipe, wastewater pipe and rainwater pipe; 13. Calculate the hot water consumption of the building, design the hot water system and select hot water equipment type; 14. Determine the type of building fire protection system, calculate the fire water consumption, and design the fire protection system; 14. Determine technical specifications of equipment; 15. Prepare the bill of quantities; 16. Clean workplaces, tools, equipment and software; 17. Store drawings, tools, equipment and software appropriately; 18. Apply new technologies, new materials, new processes and new equipment.	2.2. Operating principles of water supply and pressurization systems in the building; 2.3. Operating principles of water supply, wastewater, rainwater and hot water systems in the building; 2.4. Principles of health protection in the building; 2.5 Types and operating principles of fire protection systems in the building. **3.0. Theories** The person must be able to explain: 3.1. Be able to read building drawings and have the comprehensive knowledge of pipeline layout; 3.2. Have the comprehensive knowledge of hydraulics, calculation of velocity, discharge and head loss, etc.; 3.3 Get familiar with the types of sanitary wares and water pollution prevention; 3.4 Get familiar with the national standards for water supply, wastewater, rainwater and fire protection design in the building; 3.5 Get familiar with water supply & storage tanks and pressurization systems; 3.6 Get familiar with fire prevention of the building and protection measures; 3.7 Get familiar with technology, engineering safety and protection; 3.8 Have relevant knowledge of construction machines and materials; 3.9 Know and promote new technologies, new materials and new processes. **4.0. Essential skills** 4.1. Team work skills; 4.2. Communication skills; 4.3. Computer skills; 4.4. Analytical skills; 4.5. Creativity skills; 4.6. Mathematics skills in algebra, calculus; 4.7. Work ethic; 4.8. Adaptability; 4.9. Time management; 4.10. Respect.
DESCRIPTION OF END PRODUCTS/SERVICE	The Designing of water supply and wastewater systems in a building is performed as per standards and guidelines approved by a competent authority.
CIRCUMSTANTIAL	**Detailed knowledge about:**

KNOWLEDGE:	1. Safe handling of equipment and tools; 2. Extent of responsibility; 3. Occupational safety and health.

OCCUPATION	CIVIL ENGINEER	**OCCUPATION CODE**	
DUTY TITLE	DESIGN OF WATER SUPPLY, WASTEWATER, IRRIGATION SYSTEMS AND HYDRAULIC STRUCTURERS	**DUTY NO.**	703
TASK TITLE	DESIGN OF WASTEWATER SYSTEM	**TASK NO.**	7033
PERFORMANCE CRITERIA	The person performing this task must be able to design wastewater system as per standards and guidelines approved by a competent authority.		
RANGE STATEMENT	The task will be performed in a design office under supervision of a senior design engineer. The following equipment and materials will be required in performing the task: computer, design software and stationery.		

EVIDENCE REQUIREMENTS

PRACTICAL PERFORMANCE	**UNDERPINNING KNOWLEDGE**
The person performing this task must be able do the following: 1. Select right tools, equipment, software and safety gears for the task; 2. Observe health and safety precautions when performing the task; 3. Conduct a field investigation; 4. Determine the types and composition of wastewater and rainwater systems; 5. Calculate the designed wastewater amount and the designed rainwater amount; 6. Determine the designed water quality and discharge standards; 7. Determine wastewater treatment technologies and schemes; 8. Design wastewater and rainwater pipe networks; 9. Design wastewater and rainwater booster stations; 10. Design wastewater and rainwater treatment facilities; 11. Design sludge treatment facilities;	**Detailed knowledge about:** **1.0. Methods** This person performing this task must be able to explain how to: 1.1. Calculation methods for wastewater amount and rainwater amount; 1.2. Calculation methods for wastewater and rainwater pipe diameters; 1.3. Calculation methods for process design of water treatment facilities; 1.4. Calculation methods for process design of sludge treatment facilities; 1.5. Calculation methods for pump station scale design. **2.0. Principles** The person must be able to explain the principles of: 2.1. Operating principles of water pump; 2.2. Layout principles and operating principles of wastewater and rainwater pipes; 2.3. Water purification principles of wastewater treatment structures; 2.4 Operating principles of wastewater treatment structures; 2.5 Operating principles of automatic control and electrical equipment in the water plant. **3.0. Theories** The person must be able to explain:

12. Be proficient in using computer-aided design related software; 13. Plot construction drawings; 14. Determine technical specifications of process and equipment; 15. Prepare the bill of quantities; 16. Clean workplaces, tools, equipment and software; 17. Store drawings, tools, equipment and software appropriately; 18. Apply new technologies, new materials, new processes and new equipment.	3.1 Have the knowledge of comprehensive pipeline layout; 3.2 Have the comprehensive knowledge of hydraulics, calculation of velocity, discharge and head loss, etc.; 3.3 Have the comprehensive knowledge of wastewater and sludge treatment; 3.4 Get familiar with urban flood control and drainage; 3.5 Get familiar with wastewater quality and national standards for wastewater discharge; 3.6 Get familiar with the general water quality inspection; 3.7 Have the comprehensive knowledge of pump and pump station; 3.8 Get familiar with automatic control and electrical equipment in the water plant; 3.9 Get familiar with the geological survey; 3.10 Get familiar with technology, engineering safety and protection; 3.11 Have relevant knowledge of construction machines and materials; 3.12 Know and promote new technologies, new materials and new processes. **4.0. Essential skills** 4.1. Team work skills; 4.2. Communication skills; 4.3. Computer skills; 4.4. Analytical skills; 4.5. Creativity skills; 4.6. Mathematics skills in algebra, calculus; 4.7. Work ethic; 4.8. Adaptability; 4.9. Time management.
DESCRIPTION OF END PRODUCTS/SERVICE	The Designing of wastewater system is performed as per standards and guidelines approved by a competent authority.
CIRCUMSTANTIAL KNOWLEDGE:	**Detailed knowledge about:** 1. Safe handling of equipment and tools; 2. Extent of responsibility; 3. Occupational safety and health.

OCCUPATION	CIVIL ENGINEER	**OCCUPATION CODE**	
DUTY TITLE	DESIGN WATER SUPPLY, WASTEWATER, IRRIGATION SYSTEMS AND HYDRAULIC STRUCTURERS	**DUTY NO.**	703
TASK TITLE	DESIGN IRRIGATION SYSTEM	**TASK NO.**	7034
PERFORMANCE CRITERIA	The person performing this task must be able to design irrigation system as per standards and guidelines approved by a competent authority.		
RANGE STATEMENT	The task will be performed in a design office under supervision of a senior design engineer. The following equipment and materials will be required in performing the task: computer, design software and stationery.		

EVIDENCE REQUIREMENTS

PRACTICAL PERFORMANCE	**UNDERPINNING KNOWLEDGE**
The person performing this task must be able do the following: 1. Select right tools, equipment, software and safety gears for the task; 2. Observe health and safety precautions when performing the task; 3. Conduct reconnaissance and surveying of the marked irrigation area; 4. Obtain characteristic data of soil and types of crops planted in the irrigation area; 5. Obtain irrigation standards, drainage standards and irrigation and drainage water quality standards for the irrigation area; 6. Obtain the water demand data of crops to be irrigated; 7. Determine the irrigation water source and water diversion mode; 8. Determine the general layout type of the irrigation system; 9. Prepare the plan of the irrigation area with contour lines; 10. Design the water diversion headwork, water storage	**Detailed knowledge about:** **1.0. Methods** This person performing this task must be able to explain how to: 1.1 Calculation methods for designed irrigation flowrate; 1.2 Calculation methods for designed drainage flowrate; 1.3 Calculation methods for regulation and storage capacity; 1.4 Calculation methods for sectional sizes of channels (drainage ditches) 1.5 Calculation methods for pump station design; 1.6 Hydraulic calculation methods for channel system structures. **2.0. Principles** The person must be able to explain the principles of: 2.1 Operating principles of water pump; 2.2 Operating principles of irrigation channel (pipe) and drainage ditch (pipe); 2.3 Law of water demand for crop growth; 2.4 Principles for water source selection; 2.5 Layout principles of pipe and channel system; 2.6 Layout principles of farmland works. **3.0. Theories** The person must be able to explain: 3.1 Master the layout of pipe and channel systems; 3.2 Have the comprehensive knowledge of

headwork and pump station; 11. Design irrigation channels (pipes); 12. Design drainage ditches (pipes); 13. Design channel system structures; 14 Be proficient in using computer-aided design related software; 15. Plot construction drawings; 16. Determine technical specifications of process and equipment; 17. Prepare the bill of quantities; 18. Clean workplaces, tools, equipment and software; 19. Store drawings, tools, equipment and software appropriately; 20. Apply new technologies, new materials, new processes and new equipment.	hydraulics, calculation of velocity, discharge and head loss, etc.; 3.3 Master the national irrigation standards, drainage standards, irrigation and discharged water quality standards; 3.4 Know the impacts of soil characteristics on irrigation water amount; 3.5 Know the water demand for crop growth; 3.6 Get familiar with the general water quality inspection; 3.7 Have the comprehensive knowledge of pump and pump station; 3.8 Get familiar with the geological survey; 3.9 Have relevant knowledge of construction machines and materials; 3.10 Know and promote new technologies, new materials and new processes. **4.0. Essential skills** 4.1. Team work skills; 4.2. Communication skills; 4.3. Computer skills; 4.4. Analytical skills; 4.5. Creativity skills; 4.6. Mathematics skills in algebra, calculus; 4.7. Work ethic; 4.8. Adaptability; 4.9. Time management.
DESCRIPTION OF END PRODUCTS/SERVICE	The Designing of irrigation system is performed as per standards and guidelines approved by a competent authority.
CIRCUMSTANTIAL KNOWLEDGE	**Detailed knowledge about:** 1. Safe handling of equipment and tools; 2. Occupational safety and health.

OCCUPATION	CIVIL ENGINEER	**OCCUPATION CODE**	
DUTY TITLE	DESIGN WATER SUPPLY, WASTEWATER, IRRIGATION SYSTEMS AND HYDRAULIC STRUCTURERS	**DUTY NO.**	703
TASK TITLE	DESIGN HYDRAULIC STRUCTURERS	**TASK NO.**	7035
PERFORMANCE CRITERIA	The person performing this task must be able to design hydraulic structures as per standards and guidelines approved by a competent authority.		
RANGE STATEMENT	The task will be performed in a design office under supervision of a senior design engineer. The following equipment and materials will be required in performing the task: computer, design software and stationery.		

EVIDENCE REQUIREMENTS

PRACTICAL PERFORMANCE	**UNDERPINNING KNOWLEDGE**
The person performing this task must be able do the following: 1. Select right tools, equipment, software and safety gears for the task; 2. Observe health and safety precautions when performing the task; 3. Conduct relevant investigations, reconnaissance and surveys of hydraulic structure construction areas and areas affected by dam impounding; 4. Collect hydrological data required for design; 5. Collect soil characteristic data required for design; 6. Determine the dam site and dam type; 7. Design dam structures and their components (spillway, gate and water diversion structure, etc.); 8. Design water retaining walls and water diversion tunnels; 9. Design dam body temperature control; 10. Be proficient in using	**Detailed knowledge about:** **1.0. Methods** This person performing this task must be able to explain how to: 1.1 Investigation methods for present situations, hydrology and soil characteristics of the dam-affected area; 1.2 Runoff calculation methods for the dam-affected area; 1.3 Stress calculation and analysis methods for dam and hydraulic structure; 1.4 Calculation and analysis methods for bearing capacity of dam and hydraulic structure; 1.5 Stability analysis methods for dam body. **2.0. Principles** The person must be able to explain the principles of: 2.1 Operating principles of dam and hydraulic structure; 2.2 Dam body temperature control principles; 2.3 Flowrate regulation and control principles of dam-controlled area; 2.4 Site selection principles of dam and hydraulic structure. **3.0. Theories** The person must be able to explain: 3.1 Have the comprehensive knowledge of hydraulics and hydrodynamics;

computer-aided design related software; 11. Plot construction drawings; 12. Determine technical specifications of process and equipment; 13. Prepare the bill of quantities; 14. Clean workplaces, tools, equipment and software; 15. Store drawings, tools, equipment and software appropriately; 16. Apply new technologies, new materials, new processes and new equipment.	3.2 Have the comprehensive knowledge of hydrology; 3.3 Have the comprehensive knowledge of geology; 3.4 Have the comprehensive knowledge of structural mechanics; 3.5 Have the comprehensive knowledge on mechanical properties of building materials; 3.6 Master the national standards for dam and hydraulic structure; 3.7 Get familiar with the types of dams and hydraulic structures and their service conditions; 3.8 Have relevant knowledge of construction machines and materials; 3.9 Know and promote new technologies, new materials and new processes. **4.0. Essential skills** 4.1. Team work skills; 4.2. Communication skills; 4.3. Computer skills; 4.4. Analytical skills; 4.5. Creativity skills; 4.6. Mathematics skills in algebra, calculus; 4.7. Work ethic; 4.8. Adaptability; 4.9. Time management.
DESCRIPTION OF END PRODUCTS/SERVICE	The Designing of hydraulic structures is performed as per standards and guidelines approved by a competent authority.
CIRCUMSTANTIAL KNOWLEDGE	**Detailed knowledge about:** 1. Safe handling of equipment and tools; 2. Extent of responsibility; 3. Occupational safety and health.

OCCUPATION	CIVIL ENGINEER	**OCCUPATION CODE**	
DUTY TITLE	PERFORM SURVEY FOR CIVIL ENGINEERING INFRASTRUCTURES	**DUTY NO.**	704
TASK TITLE	PERFORM CONTROL SURVEY FOR CIVIL ENGINEERING INFRASTRUCTURES	**TASK NO.**	7041
PERFORMANCE CRITERIA	The person performing this task must be able to carry out control survey and prepare survey plan as per approved standards.		
RANGE STATEMENT	The task will be performed in the field under the supervision of an engineer. The following equipment, tools and materials will be required in performing the task: measuring tape, Theodolite, ranging poles, levelling staff, level and/or total station, prism, total station accessory and P.P.E.		

EVIDENCE REQUIREMENTS

PRACTICAL PERFORMANCE	**UNDERPINNING KNOWLEDGE**
The person performing this task must be able do the following: 1. Conduct site reconnaissance; 2. Select tools, equipment and safety gears; 3. Select reference points and establish signs. 4. Set out and surveying equipment and level it; 5. Measure directions, angles and lengths of the survey lines; 6. Record results in field book; 7. Process the results; 7.1 Data post-processing; 7.2 Adjustment calculation; 7.3 Accuracy evaluation; 8. Prepare survey plan of established control points; 9. Observe health and safety precautions when performing the task; 10. Clean the equipment, tools and working area; 11. Store tools, equipment and safety gear.	**Detailed knowledge about:** **1.0. Methods** This person performing this task must be able to explain how to: 1.1. Perform site reconnaissance; 1.2. Set out surveying equipment; 1.3. Measure directions, angles and lengths of survey lines; 1.4. Process survey data from control surveying. **2.0. Principles** The person must be able to explain the principles of: 2.1. Working from whole to part; 2.2. Location of point by measurement from two points of reference; 2.3. Consistence of work; 2.4. Independent check; 2.5. Accuracy; 2.6. Operating survey equipment; 2.7. control Surveying; 2.8. Ranging survey; 2.9. Angle surveying; 2.10. Leveling; 2.11. Mapping; 2.12. Site reconnaissance. **3.0. Theories** The person must be able to explain:

	3.1. Control surveying; 3.2. Surveying. **4.0. Essential skills** 4.1. Team work skills; 4.2. Communication skills; 4.3. Computer application skills; 4.4. Mathematics skills in Trigonometry, Coordinate Geometry, Geometry; 4.5. Work ethic; 4.6. Adaptability; 4.7. Time management; 4.8. Respect; 4.9 Ability to operate surveying instruments correctly; 4.10 Ability to process data.
DESCRIPTION OF END PRODUCTS/SERVICE	Control survey for civil engineering infrastructures is performed with all details as per approved surveying standards.
CIRCUMSTANTIAL KNOWLEDGE:	**Detailed knowledge about:** 1. Safe handling of equipment and tools; 2. Extent of responsibility; 3. Occupational safety and health.

OCCUPATION	CIVIL ENGINEER	**OCCUPATION CODE**	
DUTY TITLE	PERFORM SURVEY FOR CIVIL ENGINEERING INFRASTRUCTURES.	**DUTY NO.**	704
TASK TITLE	PERFORM TOPOGRAPHICAL SURVEY FOR CIVIL ENGINEERING INFRASTRUCTURES.	**TASK NO.**	7042
PERFORMANCE CRITERIA	The person performing this task must be able to carry out topographic survey and prepare survey plan as per approved standards.		
RANGE STATEMENT	The task will be performed in the field under the supervision of an engineer. The following equipment, tools and materials will be required in performing the task: measuring tape, Theodolite, ranging poles, levelling staff, level and/or total station, prism, total station accessory and P.P.E.		

EVIDENCE REQUIREMENTS	
PRACTICAL PERFORMANCE	**UNDERPINNING KNOWLEDGE**
The person performing this task must be able do the following: 1. Make work plans and determine implementation schemes; 2. Conduct site reconnaissance; 3. Select tools, equipment and safety gears; 4. Observe health and safety precautions when performing the task; 5. Identify control point both horizontal and vertical; 6. Determine horizontal and vertical location of ground points; 7. Locate natural and man-made features; 8. Set out surveying equipment; 9. Collect data on plane positions and elevations of feature points and topographic points. 10. Record results in field book; 11. Compute distance, angles and elevations; 12. Prepare topographic plan; 13. Clean the equipment, tools and working area;	**Detailed knowledge about:** **1.0. Methods** This person performing this task must be able to explain how to: 1.1. Perform site reconnaissance; 1.2. Set out surveying equipment; 1.3. Measure distance, angles and elevations; 1.4. Process survey data from topographical surveying; 1.5. Prepare topographic map. **2.0. Principles:** The person must be able to explain the principles of: 2.1. Working from whole to part; 2.2. Location of point by measurement from two points of reference; 2.3. Consistence of work; 2.4. Independent check; 2.5. Accuracy; 2.6. Operating survey equipment; 2.7. Control Surveying; 2.8. Ranging survey; 2.9. Plotting topographic map; 2.10. Site reconnaissance. **3.0. Theories** The person must be able to explain: 3.1. Topographical surveying;

14. Store tools, equipment and safety gear.	3.2. Surveying. **4.0. Essential skills** 4.1. Team work skills; 4.2. Communication skills; 4.3. Computer application skills; 4.4. Mathematics skills in Trigonometry, Coordinate Geometry, Geometry; 4.5. Work ethic; 4.6. Adaptability; 4.7. Time management; 4.8. Respect; 4.9 Ability to operate surveying instruments correctly; 4.10 Ability to process data.
DESCRIPTION OF END PRODUCTS/SERVICE	Topographical survey for civil engineering infrastructures is performed with all details as per approved surveying standards.
CIRCUMSTANTIAL KNOWLEDGE:	**Detailed knowledge about:** 1. Safe handling of equipment and tools. 2. Extent of responsibility; 3. Occupational safety and health.

OCCUPATION	CIVIL ENGINEER	**OCCUPATION CODE**	
DUTY TITLE	PERFORM GEOTECHNICAL INVESTIGATION	**DUTY NO.**	705
TASK TITLE	CONDUCT GROUND INVESTIGATION	**TASK NO.**	7051
PERFORMANCE CRITERIA	The person performing this task must be able to carry out ground investigation as per standards and guidelines approved by a competent authority.		
RANGE STATEMENT	The task will be performed on field or construction site under the supervision of an Engineer. The following equipment, tools and materials will be needed in performing the task: Drilling tools (auger, core cutter, wash borer), spades, hoe, P.P.E.		

EVIDENCE REQUIREMENTS	
PRACTICAL PERFORMANCE	**UNDERPINNING KNOWLEDGE**
The person performing this task must be able do the following: 1. Select right tools, equipment and safety gears for the task. Be able to check the performance of tools, equipment and safety gears, and develop geotechnical drilling tools and instruments; 2. Observe health and safety precautions when performing the task. Supervise other relevant personnel on site to observe health and safety precautions and conduct safety management of drilling production; 3. Collect samples. Collect, prepare and test the chemical composition of geological samples, as well as their material composition, structure and physical & chemical properties; 4. Supervise execution of field and laboratory tests as per relevant specifications or standards; 5. Participate in the preparation of relevant technical and quality standards and regulations for geological tests;	**Detailed knowledge about:** **1.0. Methods** This person performing this task must be able to explain how to: 1.1. Collect samples according to relevant specifications and operating guidelines: Sampling method, quantity and sample quality requirements; 1.2. Execute field and laboratory tests: Bases, scope, methods, contents of field test and laboratory test and standard operation procedures for such tests; 1.3. Analyze test results: Analysis bases and methods for test results; 1.4. Prepare ground investigation reports as per the specifications: bases, methods and contents of reports prepared. **2.0. Principles** The person must be able to explain the principles of: 2.1. Operating boring equipment; 2.1.1 Basic performance of drilling equipment; 2.1.2 Standard operation procedures for drilling equipment; 2.1.3 Maintenance of drilling equipment; 2.2. Collecting and preserving soil samples; 2.2.1 Bases and methods for undisturbed soil sample collection and their quantities; 2.2.1 Methods and requirement for preservation of disturbed soil samples; 2.3. Conducting Field tests; 2.3.1 Bases, methods and contents of field test;

6. Be able to use new drilling technologies, techniques and methods; 7. Prepare technical standards, specifications and regulations for geotechnical drilling engineering; 8. Analyze test results. Analyze material composition, structure and physical & chemical properties of geological samples; 9. Participating in prepare ground investigation reports; 10. Clean tools and equipment; 11. Store tools and equipment appropriately; 12. Be able to provide technical consulting services for geotechnical drilling.	2.4. Handling samples; 2.5. Conducting laboratory tests; 2.5.1 Bases, methods and contents of laboratory test; 2.6. Ground investigation; 2.6.1 Bases, methods and contents of ground investigation. **3.0. Theories** The person must be able to explain: 3.1. Soil mechanics: Physical properties of soil, permeability and seepage of soil, calculation of additional stress in soil, compression and settlement of soil; 3.2. Civil engineering materials: Classification, composition and structure, physical properties and mechanical properties of civil engineering materials; 3.3. Engineering geology: Rock classification, rock mass structure and stability analysis, dynamic geology, groundwater. **4.0. Essential skills** 4.1. Team work skills; 4.2. Communication skills; 4.3. Computer application skills; 4.4. Mathematics skills in Coordinate Geometry; 4.5. Work ethic; 4.6. Adaptability; 4.7. Time management; 4.8. Respect.
DESCRIPTION OF END PRODUCTS/SERVICE	Ground investigation is performed as per standards and guidelines approved by a competent authority.
CIRCUMSTANTIAL KNOWLEDGE	**Detailed knowledge about:** 1. Safe handling of equipment and tools; 2. Extent of responsibility; 3. Occupational safety and health.

OCCUPATION	CIVIL ENGINEER	**OCCUPATION CODE**	
DUTY TITLE	PERFORM GEOTECHNICAL INVESTIGATION	**DUTY NO.**	705
TASK TITLE	ANALYZE SOIL TEST RESULTS	**TASK NO.**	7052
PERFORMANCE CRITERIA	The person performing this task must be able to analyze test results for soil as per standards and guidelines approved by a competent authority.		
RANGE STATEMENT	The task will be performed in the field and in the laboratory under the supervision of an engineer. The following equipment, tools and materials will be needed in performing the task: consolidation test machine, triaxial test equipment, shear box, permeability apparatus, CBR machine, compaction mold, CBR molds, standard spirit sampler, drop hammer, guiding rod, drilling rig, driving head, Drilling tools (auger, core cutter, wash borer), spades, hoe, P.P.E.		

EVIDENCE REQUIREMENTS

EVIDENCE REQUIREMENTS	**PRACTICAL PERFORMANCE**
The person performing this task must be able do the following: 1. Mechanical analysis method: Determine the engineering classification of soil by measuring the soil particle size based on the sieve analysis method; 2. Physical analysis method: Determine the engineering classification of soil by measuring the soil particle size based on the densimeter method; 3. Analyze Atterberg limit test results: Determine the category of soil by using the limit moisture content of water in soil; 4. Analyze (proctor) soil compaction test results: Determine the selection and quality control of filling methods based on the maximum dry density and optimal moisture content; 5. Analyse direct shear test results and triaxial test results to	**Detailed knowledge about:** **1.0. Methods** This person performing this task must be able to explain how to: 1.1. Analyze the results obtained by sieve analysis and densimeter methods: Calculate and determine the soil particle size according to the measured data, and classify the soil according to relevant standards; 1.2. Analyze Atterberg limit test results: Calculate the liquid limit, plastic limit and shrinkage limit according to the measured data, and determine the soil category according to relevant standards; 1.3. Analyze (proctor) soil compaction test results: Calculate the maximum dry density and optimal moisture content of soil according to the measured data, so as to determine filling methods and quality control parameters; 1.4. Analyze shear test results and triaxial test results: Calculate the shear strength parameters, compressive strength, sensitivity and stress-strain relationship according to the measured data, so as to judge the stability of ground, slope and retaining wall; 1.5. Analyze consolidation test results: Calculate the void ratio and draw the pressure curve and compression curve according to the measured data, so as to calculate the soil settlement amount and settlement rate;

determine the stability of ground, slope and retaining wall; 6. Analyze consolidation test results, and calculate the settlement amount and settlement rate of cohesive soil; 7. Analyze SPT results, and determine the bearing capacity of ground on site; 8. Analyze permeability test results, and determine the permeability of soil; 9. Analyze CBR test results, and evaluate the bearing capacity of subgrade and pavement materials; 10. Prepare soil investigation reports; 11. Prepare relevant technical and quality standards and codes for geological tests.	1.6. Analyze SPT results: Record the times and depth of hammering, and determine the bearing capacity of ground according to relevant standards; 1.7. Analyze permeability test results: Calculate the permeability coefficient according to the measured data, so as to judge the soil permeability; 1.8. Analyze CBR test results: Calculate CBR value according to the measured data, so as to evaluate the bearing capacity of subgrade and pavement materials. 1.9. Prepare soil investigation reports. **2.0. Principles** The person must be able to explain the principles of: 2.1. Operating soil tests equipment 2.1.1 Get familiar with the performance of the corresponding test equipment; 2.1.2 Be able to operate the corresponding test equipment in a standardized manner; 2.2. Sample preparation; 2.2.1 Bases and methods for sample preparation and their quantities; 2.3. Conducting Soil tests. **3.0. Theories** The person must be able to explain: 3.1. Soil mechanics: Physical properties of soil, permeability and seepage of soil, calculation of additional stress in soil, compression and settlement of soil; 3.2. Types and operation soil equipment; 3.2.1 Corresponding equipment and tools for various tests; 3.2.2 Be able to use equipment and tools in a standardized manner; 3.3. Civil engineering materials: Classification, composition and structure, physical properties and mechanical properties of civil engineering materials. **4.0. Essential skills** 4.1. Team work skills; 4.2. Communication skills; 4.3. Mathematics skills in logarithms, algebra; 4.4. Work ethic; 4.5. Adaptability; 4.6. Time management; 4.7. Respect.
DESCRIPTION OF END PRODUCTS/SERVICE	Analysis of test results for soil tests is performed as per standards and guidelines approved by a competent authority.

CIRCUMSTANTIAL KNOWLEDGE	**Detailed knowledge about:** 1. Safe handling of equipment and tools; 2. Extent of responsibility; 3. Occupational safety and health; 4. Waste disposal methods.

OCCUPATION	CIVIL ENGINEER	**OCCUPATION CODE**	
DUTY TITLE	PREPARE TENDER DOCUMENT FOR CONSTRUCTION AND MAINTENANCE OF CIVIL WORKS	**DUTY NO.**	706
TASK TITLE	ESTIMATE QUANTITIES FOR CIVIL ENGINEERING WORKS	**TASK NO.**	7061
PERFORMANCE CRITERIA	The person performing this task must be able to estimate quantities for civil engineering works as per standards and guidelines approved by a competent authority.		
RANGE STATEMENT	The task will be performed in the office under the supervision of an Engineer. The following tools and materials will be required in performing the task: computer, stationery, standards and manuals, office furniture.		

EVIDENCE REQUIREMENTS

PRACTICAL PERFORMANCE	**UNDERPINNING KNOWLEDGE**
The person performing this task must be able do the following: 1. Recognize full project scope; 2. Review construction drawings; 3. Take-off measurements from the drawings; (prepare construction drawing budget); 4. List material and quantities taken off; 5. Identify percentage for waste; 6. Prepare and manage the bill of quantities, budgetary estimate, budget and settlement; 7. Determine and control the project cost; 8. Master the analysis methods for measurement and valuation of construction projects.	**Detailed knowledge about:** **1.0. Methods** This person performing this task must be able to explain how to: 1.1. Interpret construction drawings; 1.2. Take off measurement of building and civil works; 1.3. Record the amount and unit of measure; 1.4. Identity percentage for waste; 1.5. Prepare and manage the bill of quantities, budgetary estimate, budget and settlement; 1.6. Determine and control the project cost; 1.7. Master the measurement and valuation of construction projects. **2.0. Principles** The person must be able to explain the principles of: 2.1. Quantity surveying; 2.2. Taking-off; 2.3. Estimating quantities; 2.4. Building and civil works measurement; 2.5 Measurement and valuation of construction projects. **3.0. Theories** The person must be able to explain: 3.1. Quantity surveying of buildings and civil works; 3.2. Construction of buildings and civil works;

	3.3 Reading of architectural construction drawings. **4.0. Essential skills** 4.1. Team work skills; 4.2. Communication skills; 4.3. Computer skills; 4.4. Analytical skills; 4.5. Creativity skills; 4.6. Mathematics skills in algebra and geometry; 4.7. Work ethic; 4.8. Adaptability; 4.9. Time management; 4.10. Respect; 4.11. Communication skills.
DESCRIPTION OF END PRODUCTS/SERVICE	Estimation of quantities for civil engineering works is performed as per standards and guidelines approved by a competent authority.
CIRCUMSTANTIAL KNOWLEDGE	**Detailed knowledge about:** 1. Safe handling of equipment and tools; 2. Extent of responsibility; 3. Occupational safety and health.

OCCUPATION	CIVIL ENGINEER	**OCCUPATION CODE**	
DUTY TITLE	PREPARE TENDER DOCUMENT FOR CONSTRUCTION AND MAINTENANCE OF CIVIL WORKS	**DUTY NO.**	706
TASK TITLE	PARTICIPATE IN TENDERING PROCESS	**TASK NO.**	7062
PERFORMANCE CRITERIA	The person performing this task must be able to participate in tendering process as per standards and guidelines approved by a competent authority.		
RANGE STATEMENT	The task will be performed in the office and on the construction site under the supervision of an engineer. The following tools and materials will be required in performing the task: computer, stationery, standards and office furniture.		

EVIDENCE REQUIREMENTS

PRACTICAL PERFORMANCE	**UNDERPINNING KNOWLEDGE**
The person performing this task must be able do the following: 1. Prepare expression of interest for consultancy service; 2. Prepare technical proposal for consultancy service; 3. Prepare financial proposal for consultancy service; 4. Prepare prequalification document for works; 5. Perform bidding for works. 6. Prepare the project construction brief and the Bid; 7. Collect and sort out the technical data on project construction.	**Detailed knowledge about:** **1.0. Methods** This person performing this task must be able to explain how to: 1.1. Prepare expression of interest for consultancy service; 1.2. Prepare technical proposal for consultancy service; 1.3. Prepare financial proposal for consultancy service; 1.4. Prepare prequalification document for works; 1.5. Perform bidding for works; 1.6. Prepare the project construction brief and the Bid; 1.7. Collect and sort out the technical data on project construction. **2.0. Principles** The person must be able to explain the principles of: 2.1. Preparing bidding document; 2.2. Bidding tender; 2.3. Public procurement; 2.4. Bidding & tendering procedures and contents; 2.5 Qualification examination. **3.0. Theories** The person must be able to explain: 3.1. Construction management; 3.2. Quantity surveying; 3.3. Professional ethics; 3.4. Construction contract law; 3.5. Health and safety management; 3.6. Laws and regulations related to construction

	project bidding & tendering. **4.0. Essential skills** 4.1. Team work skills; 4.2. Communication skills; 4.3. Computer skills; 4.4. Analytical skills; 4.5. Creativity skills; 4.6. Work ethic; 4.7. Adaptability; 4.8. Time management; 4.9. Respect; 4.10 Prevention and management ability; 4.11. Communication skills; 4.12. Ability to collect data and solve problems.
DESCRIPTION OF END PRODUCTS/SERVICE	Tendering process is performed as per standards and guidelines approved by a competent authority.
CIRCUMSTANTIAL KNOWLEDGE	**Detailed knowledge about:** 1. Safe handling of equipment and tools; 2. Extent of responsibility; 3. Occupational safety and health.

OCCUPATION	CIVIL ENGINEER	**OCCUPATION CODE**	
DUTY TITLE	DESIGN MIXES FOR BUILDING AND CIVIL ENGINEERING WORKS.	**DUTY NO.**	707
TASK TITLE	DESIGN CEMENT CONCRETE MIXTURES	**TASK NO.**	7071
PERFORMANCE CRITERIA	The person performing this task must be able to design cement concrete mixtures as per standards and guidelines approved by a competent authority.		
RANGE STATEMENT	The task will be performed in the laboratory. The following tools and materials will be required in performing the task: cement test set, coarse aggregates test set, fine aggregates test set, fresh concrete test set, hardened concrete test set, computer, stationary, standards and design guidelines, office furniture.		

EVIDENCE REQUIREMENTS

PRACTICAL PERFORMANCE	**UNDERPINNING KNOWLEDGE**
This person performing this task must be able to explain how to: 1. Select right tools, equipment and safety gears for the task, and check the performance of tools, equipment and safety gears; 2. Observe health and safety precautions when performing the task. Supervise other relevant personnel on site to observe health and safety precautions; 3. Test aggregates (coarse and fine) for cement concrete mixtures using a coarse/fine aggregate testing set; 4. Determine the variety and strength grade of aggregate according to the concrete category; 5. Test cement for concrete mixtures using a cement testing set; 6. Determine the variety and strength grade of cement according to the design, construction requirements and	**Detailed knowledge about:** **1.0. Methods** This person performing this task must be able to explain how to: 1.1. Test aggregates (coarse and fine) for cement concrete mixtures; 1.1.1 Testing methods and steps of coarse and fine aggregates; 1.2. Select aggregates for concrete mixtures; 1.2.1 Determine the requirements for the main control items of aggregate quality according to the design, construction requirements and the engineering environment; 1.3. Test cement for concrete mixtures; 1.3.1 Testing methods and steps of cement; 1.4. Select cement for concrete mixtures; 1.4.1 Determine the requirements for the main control items of cement quality according to the design, construction requirements and the engineering environment; 1.5. Blend aggregates for cement concrete mixtures; 1.5.1 Safe operation procedures of equipment; 1.5.2 Common ways of feeding raw materials and feeding sequence for different raw material feeding methods; 1.6. Prepare trial mix specimens;

engineering environment; 7. Blend aggregates for cement concrete mixtures. Manually weigh various materials accurately using a metering instrument according to the requirements of mixture ratio for construction, and control the weighing error within the allowable range of deviation. Adopt the correct feeding method to feed raw materials, and put the raw materials into the mixer accurately in sequence, and fully mix them within the specified time; 8. Prepare trial mix specimens with the selected aggregate and cement; 9. Perform workability tests according to relevant specifications; 10. Cure trial mix specimen according to relevant specifications; 11. Perform compressive strength tests according to relevant specifications; 12. Determine mix proportion of concrete constituent materials (cement, sand, aggregates and water), which shall be in accordance with the requirements of concrete construction performance. Meanwhile, their other mechanical properties and durability shall meet the design requirements; 13. Clean workplace, tools and equipment. Clean up the workplace, tools and equipment in time after work, and pile up the tools, equipment and other operating supplies by categories; 14. Store tools and equipment appropriately. Carry out pre-operation inspection, post-	1.6.1 Safe operation procedures of mixing equipment; 1.6.2 General requirements and steps of concrete mixing; 1.6.3 Requirements and methods for curing trial mix samples; 1.7 Equipment maintenance; 1.7.1 Knowledge on operation inspection, cleaning and daily maintenance of equipment. **2.0. Principles** The person must be able to explain the principles of: 2.1. Operating test equipment and tools; 2.1.1 Usage of coarse/ fine aggregate testing set; 2.1.2 Usage of cement testing set; 2.2. Preparation of samples; 2.2.1 Requirements for allowable metering deviation of concrete raw materials; 2.2.2 Specified concrete mixing time; 2.3. Conducting laboratory tests; 2.3.1 Requirements and test methods of workability test; 2.3.2 Requirements and test methods of compressive strength test. **3.0. Theories** The person must be able to explain: 3.1. Aggregates (coarse, fine, and filler): Main control items of aggregate quality; 3.2. Cement: Main control items of cement quality; 3.3. Concrete technology: Impacts of mixing on the basic performance of mixed concrete; basic knowledge on the performance of concrete mixture; basic requirements and testing methods for the performance of concrete mixture; 3.4. Mix design of cement concrete mixtures: Classification, characteristics and main technical performance of concrete; composition and performance grade of concrete; basic knowledge on concrete mix proportion. **4.0. Essential skills** 4.1. Team work skills; 4.2. Communication skills; 4.3. Computer skills; 4.4. Analytical skills; 4.5. Creativity skills; 4.6. Mathematics skills in algebra; 4.7. Work ethic; 4.8. Adaptability; 4.9. Time management; 4.10. Respect.

operation cleaning and daily maintenance for tools and equipment.	
DESCRIPTION OF END PRODUCTS/SERVICE	Cement concrete mixtures are designed as per standards and guidelines approved by a competent authority.
CIRCUMSTANTIAL KNOWLEDGE	**Detailed knowledge about:** 1. Safe handling of equipment and tools; 2. Extent of responsibility; 3. Occupational safety and health.

OCCUPATION	CIVIL ENGINEER	**OCCUPATION CODE**	
DUTY TITLE	DESIGN MIXES FOR BUILDING AND CIVIL ENGINEERING WORKS	**DUTY NO.**	707
TASK TITLE	DESIGN ASPHALT MIXTURES	**TASK NO.**	7072
PERFORMANCE CRITERIA	The person performing this task must be able to design asphalt mixtures as per standards and guidelines approved by a competent authority.		
RANGE STATEMENT	The task will be performed in the laboratory. The following tools and materials will be required in performing the task: bituminous binders test set, asphalt mixtures test set, Marshall mix design test set, Super pave mix design test set; computer, stationary, standards and design guidelines, office furniture.		

EVIDENCE REQUIREMENTS

PRACTICAL PERFORMANCE	**UNDERPINNING KNOWLEDGE**
The person performing this task must be able do the following: 1. Select right tools, equipment and safety gears for the task; 2. Observe health and safety precautions when performing the task; 3. Test aggregates for asphalt mixtures; 3.1 Be able to complete all tests on coarse aggregate; 3.2 Be able to complete relevant tests on fine aggregate; 4. Select aggregates for asphalt mixtures; 4.1 Determine the gradation range of designed mineral aggregates in engineering; 4.2 Select the gradation type that meets the requirements under different pavement requirements; 5. Test bituminous binders for asphalt mixtures; 6. Select bituminous binder for asphalt mixtures; 7. Blend aggregates for asphalt mixtures; 7.1 Be able to calculate mix	**Detailed knowledge about:** **1.0. Methods** This person performing this task must be able to explain how to: 1.1. Test aggregates for asphalt mixtures; 1.1.1 Test coarse aggregate and fine aggregate; 1.2. Select aggregates for asphalt mixtures; 1.2.1 Select coarse aggregate and fine aggregate; 1.3. Test bituminous binders for asphalt mixtures; 1.3.1 Test various indicators of asphalt; 1.4. Select bituminous binder for asphalt mixtures; 1.4.1 Scope of application and technical requirements of various asphalts; 1.5. Design aggregates blend for asphalt mixtures; 1.5.1 Inspection methods for mineral aggregate gradation of asphalt mixtures; 1.6. Prepare trial mix specimens; 1.7. Perform density-voids analysis; 1.7.1 Density test of asphalt mixtures; 1.7.2 Theoretical maximum relative density test of asphalt mixtures; 1.8. Perform stability tests; 1.8.1 Marshall stability test of asphalt mixtures; 1.9. Perform tensile strength test on dry and moisture conditioned mix specimens; 1.9.1 Splitting tests of asphalt mixtures; 1.10. Determine optimum binder content; 1.10.1 Test methods for Marshall test mix proportion design.

proportions of various aggregates; 8. Prepare trial mix specimens; 9. Perform density-voids analysis; 9.1 Be able to carry out density test of asphalt mixtures and analyse them; 10. Perform stability tests; 11. Perform tensile strength test on dry and moisture conditioned mix specimens; 11.1 Be able to complete splitting tests of asphalt mixtures; 12. Determine optimum binder content; 13. Clean workplace, tools and equipment; 14. Store tools and equipment appropriately**.**	**2.0. Principles** The person must be able to explain the principles of: 2.1. Operating test equipment and tools; 2.2. Preparation of samples; 2.3. Conducting laboratory tests. **3.0. Theories** The person must be able to explain: 3.1. Aggregates (coarse, fine, and filler); 3.2. Bituminous materials; 3.3. Asphalt mixtures; 3.4. Mix design of asphalt mixtures. **4.0. Essential skills** 4.1. Team work skills; 4.2. Communication skills; 4.3. Computer skills; 4.4. Analytical skills; 4.5. Creativity skills; 4.6. Mathematics skills in algebra; 4.7. Work ethic; 4.8. Adaptability; 4.9. Time management; 4.10. Respect.
DESCRIPTION OF END PRODUCTS/SERVICE	Asphalt mixtures are designed as per standards and guidelines approved by a competent authority.
CIRCUMSTANTIAL KNOWLEDGE	**Detailed knowledge about:** 1. Safe handling of equipment and tools; 2. Extent of responsibility; 3. Occupational safety and health.

TABLE 1: DACUM CHART FOR CIVIL ENGINEERS NTA LEVEL 7

S/No	**DUTIES**	**TASKS**	**ENABLERS**
01	Design road and railway infrastructures.	1.1. Carry out geometric design of roads. 1.2. Carry out design of road pavements. 1.3. Carry out design of railways.	**Generic skills and knowledge** • Using communication skills to work with others, reporting to superiors • Use of manufacturer's manual • Skills and knowledge on Taking measurements & measuring units. • Machine elements • Interpretation of technical drawing • Civil Engineering Material • Highway engineering • Engineering survey **Tools and Equipment** • computer, stationary, standards and design guidelines, office furniture. **Materials** **Worker behaviours** Team spirit, trustworthy, time management, commitment, Work ethic, Adaptability and Respect
02	Design reinforced concrete (RC) and masonry structures.	2.1 Design reinforced concrete (RC) building structures. 2.2 Design reinforced concrete (RC) retaining walls. 2.3 Design masonry walls.	**Generic skills and knowledge** • Using communication skills to work with others, reporting to superiors • Skills and knowledge on Taking measurements & measuring units. • Interpretation of architectural drawing • Civil Engineering Material

S/No	DUTIES	TASKS	ENABLERS
			• Reinforced concrete design **Tools and Equipment** • computer, stationery, standards and design codes, office furniture **Materials** Concrete, steel bar etc. **Worker behaviours** Team spirit, trustworthy, time management, commitment, Work ethic, Adaptability and Respect
03	Design of water supply, wastewater, irrigation systems and hydraulic structurers.	3.1 Design of water supply system. 3.2 Design of water supply and wastewater systems in a building. 3.3 Design of wastewater system. 3.4 Design of irrigation system. 3.5 Design of hydraulic structurers.	**Generic skills and knowledge** • Using communication skills to work with others, reporting to superiors • Skills and knowledge on Taking measurements & measuring units. • Interpretation of Technical drawings • Fluid mechanics • Types of water supply systems **Tools and Equipment** • computer, design software and stationery. **Worker behaviours** Team spirit, trustworthy, time management, commitment, Work ethic, Adaptability and Respect
04	Perform survey for civil engineering infrastructures.	4.1 Perform control survey for civil engineering infrastructures.	**Generic skills and knowledge** • Using communication skills to work with others, reporting

S/No	DUTIES	TASKS	ENABLERS
		4.2 Perform topographical survey for civil engineering infrastructures.	to superiors • Use of manufacturer's manual • Skills and knowledge on Taking measurements & measuring units. • Machine elements • Interpretation of technical drawing • Engineering Survey **Tools and Equipment** • PPE such as Safety Shoes, Glasses, Gloves, Hard Hats. • measuring tape, Theodolite, ranging poles, leveling staff, level machine and/or total station, prism targets **Worker behaviours** Team spirit, trustworthy, time management, commitment, Work ethic, Adaptability and Respect
05	Perform geotechnical investigation.	5.1 Conduct ground investigation. 5.2 Analyze soil test results.	**Generic skills and knowledge** • Using communication skills to work with others, reporting to superiors • Use of manufacturer's manual • Skills and knowledge on Taking measurements & measuring units. • Machine elements • Civil Engineering Materials • Soil mechanics **Tools and Equipment** • PPE such as Safety Shoes, Glasses, Gloves, Hard Hats. • Drilling tools (auger, core cutter, wash borer), spades, hoe.

S/No	DUTIES	TASKS	ENABLERS
			Worker behaviours Team spirit, trustworthy, time management, commitment, Work ethic, Adaptability and Respect
06	Prepare tender document for construction and maintenance of civil works.	6.1 Estimate quantities for civil engineering works. 6.2 Perform tendering process.	**Generic skills and knowledge** • Using communication skills to work with others, reporting to superiors • Skills and knowledge on Taking measurements & measuring units. • Quantity surveying of buildings and civil works • Construction of buildings and civil works **Tools and Equipment** • computer, stationery, standards and office furniture **Worker behaviours** Team spirit, trustworthy, time management, commitment, Work ethic, Adaptability and Respect
07	Design mixes for building and civil engineering works.	7.1 Design cement concrete mixtures. 7.2 Design asphalt mixtures.	**Generic skills and knowledge** • Using communication skills to work with others, reporting to superiors • Use of manufacturer's manual • Skills and knowledge on Taking measurements & measuring units. • Machine elements • Interpretation of technical drawing • Civil Engineering Material

S/No	**DUTIES**	**TASKS**	**ENABLERS**
			Tools and Equipment • PPE such as Safety Shoes, Glasses, Gloves, Hearing Protection, Hard Hats. • bituminous binders test set, asphalt mixtures test set, Marshall mix design test set, Superpave mix design test set; cement test set, coarse aggregates test set, fine aggregates test set, fresh concrete test set, hardened concrete test set; computer, stationary, standards and design guidelines, office furniture. **Materials** • Bituminous binders, oil, cement, aggregates, water, etc. **Worker behaviours** Team spirit, trustworthy, time management, commitment, Work ethic, Adaptability and Respect