



National Vocational Certificate level-4, in (Construction Materials Technician)



Competency Standards

National Vocational and Technical Training Commission
(NAVTTTC) Government of Pakistan



Table of Contents

1. Introduction	4
2. Purpose of the Qualification	4
3. Core competencies of the Qualification	5
4. Date of Validation	7
5. Codes of Qualifications	7
6. Members of Qualifications Development Committee	8
7. Members of Qualifications Validation Committee	8
8. Entry Requirements	8
9. Scheme of Studies	9
10. A- Occupation Packaging of Construction Materials Testing	9
10. B-Qualification Packaging of Construction Materials Testing	10
11. Detail of Qualifications and its Competency Standards	11
C. National Qualification Certificate Level 4 in Construction Material Technician	11
11.8. Construction Practices II	11
11.8.1 Prepare subgrade, base, and bedding course for paving	11
11.8.2 Lay paving	14
11.8.3 Carry out reinforced concrete work	17
11.8.4 Produce sketches of bridges w.r.t. material of construction	20
11.8.5 Produce sketches of permanent Way	22
11.8.6 Produce sketches of station yards and signals	24
11.8.7 Produce sketches of canals and head works	26
11.9. Soil Mechanics	30
11.9.1 Determine Basic Properties of soil	30
11.9.2 Determine Atterberg's Limits	33
11.9.3 Classify Soils	35
11.9.4 Conduct soil compaction tests in field	38
11.9.5 Conduct soil compaction tests in Lab	40
11.9.6 Determine permeability of soil	43
11.9.7 Determine the shear strength of soil	45
11.9.8 Conduct California Bearing Tests	48
11.9.9 Find out bearing capacity of soil	51
11.10. Concrete Technology	54
11.10.1 Test the Properties of Fresh Concrete	54
11.10.2 Perform the Quality Tests on Fine Aggregates for Concrete	56
11.10.3 Perform Quality tests on Coarse Aggregates for Concrete Mix Design	58
11.10.4 Perform quality tests for Cement	63
11.10.5 Perform Destructive Tests on Hardened Concrete	66
11.10.6 Evaluate Concrete Mix Design	68
11.11. Water and Waste Water Testing	71
11.11.1 Determine the inorganic matters in water and wastewater	71
11.11.2 Determine the Organic Matters in water and wastewater	75
11.11.3 Determine the of Physical Characteristics in water and wastewater.	77
11.11.4 Determine the Hardness in Water and Wastewater	80
11.11.5 Determine the bacteriological impurities in Water and Wastewater.	82
11.12. Soft Skills	84
11.12.1 Manage meetings	84
11.12.2 Manage workforce planning	86



11.12.3	Undertake project work	89
11.12.4	Identify and communicate trends in career development	92
11.12.5	Work safely in an office environment	94
11.12.6	Develop workplace documents	96
11.12.7	Maintain professionalism in the workplace	99
11.12.8	Organize schedules	101
11.13.	Highway Material Testing	103
11.13.1	Determine the physical properties of the road metal	103
11.13.2	Determine the Basic Properties of Road Metal	106
11.13.3	Determine Strength Properties of road Metal	109
11.13.4	Determine California bearing ratio of Road Base and Sub-Base	112
11.13.5	Measure the basic properties of bitumen	114
11.13.6	Determine the bituminous content in a pavement sample	120
11.13.7	Determine the Mix Design by Marshall Method	122
11.13.8	Evaluate the Job Mix Formula for Asphaltic Concrete	125
11.14.	Masonry Material Testing	128
11.14.1	Perform Physical Test for Brick & Block	128
11.14.2	Perform Chemical Test for Brick & Block	132
11.14.3	Perform Strength Test for Bricks & Blocks	135
11.14.4	Perform Physical Test for Lime	141
11.14.5	Perform Chemical Test of lime	146
11.14.6	Perform Strength Test for lime	149
11.14.7	Perform Physical Test for Stones	153
11.14.8	Perform Chemical Test of stones	157
11.14.9	Perform Strength Test for stones	162
11.15.	Testing Properties of Timber	166
11.15.1	Perform Strength Test on wood	166
11.15.2	Determine hardness and impact timber	169
11.15.3	Determine properties and types of locally manufactured timber	172
11.15.4	Make simple calculations of timber	174



1. Introduction

Materials which are used for construction purposes are known as the engineering materials or building materials or construction materials. A wide range of building materials are available for the construction of rural buildings and structures. The proper selection of materials to be used in a particular building or structure can influence the Safety, original cost, maintenance, ease of cleaning, durability and, of course, appearance. Usually, construction materials are classified into natural construction material (Water, Mud, Stone, Sand, Wood, Leaves, Lime, Fiber and etc.) and artificial construction material (cement, Brick, Tiles, Glass, Metals, Plastic and etc.). It is necessary for the Civil Engineers/Civil Technologist/Lab Engineers/Lab Assistant to have knowledge about materials, properties and their standard testing methods.

Construction Materials Testing have significant role in the life of every human being, though one may not truly sense its importance in our daily routine. Thus, the importance of civil engineering may be determined according to its usefulness in our daily life. Therefore, industry expectations for skilled workforce are also dynamic which can only be managed through setting relevant competency standards in collaboration with the leading industries. Being familiar of this fact, National Vocational & Technical Training Commission (NAVTTTC) developed competency standards for Construction Material Testing Technology under National Vocational Qualifications Framework (NVQF). These competency standards have been developed by a Qualifications Development Committee (QDC) and validated by the Qualifications Validation Committee (QVC) having representation from the leading Construction, Real States & Builder industry of the country.

2. Purpose of the Qualification

The purpose of this qualification is to set high professional standards for construction Materials Testing technology sector. The specific objectives of developing these qualifications are as under:

- Improve the professional competence of the trainees
- Provide opportunities for recognition of skills attained through non-formal or informal pathways
- Improve the quality and effectiveness of training and assessment for construction Materials Testing industry
- Enable the existing workforce to capacitate themselves in new technologies and methods



3. Core competencies of the Qualification

The construction Materials Technician qualifications of level 4 consists 20% Theory and 80% Practical. The Core competencies of the qualification are as follows:

Construction Material Technician Level-4 Part-I

11.08 Construction Practices II

No.	Name of Occupations and Competency Standards	Level	Contact Hour		
			Th	Pr	Total
11.08.1	Prepare subgrade, base, and bedding course for paving	4	4	9	13
11.08.2	Lay paving	4	2	6	8
11.08.3	Carry out reinforced concrete work	4	4	9	13
11.08.4	Produce sketches of bridges w.r.t. material of construction	4	6	12	18
11.08.5	Produce sketches of permanent Way	4	4	12	16
11.08.6	Produce sketches of station yards and signals	4	6	24	30
11.08.7	Produce sketches of canals and head works	4	6	24	30
Total			32	96	128

11.09 Soil Testing

No.	Name of Occupations and Competency Standards	Level	Contact Hour		
			Th	Pr	Total
11.09.1	Determine Basic Properties of soil	4	4	24	28
11.09.2	Determine Atterberg's Limits	4	3	9	12
11.09.3	Classify Soils	4	3	12	15
11.09.4	Conduct soil compaction tests in field	4	3	12	15
11.09.5	Conduct soil compaction tests in Lab	4	3	16	19
11.09.6	Determine permeability of soil	4	4	30	34
11.09.7	Determine the shear strength of soil	4	4	24	28
11.09.8	Conduct California Bearing Tests	4	4	33	37
11.09.9	Find out bearing capacity of soil	4	4	32	36
Total			32	192	224

11.10 Concrete Testing

No.	Name of Occupations and Competency Standards	Level	Contact Hour		
			Th	Pr	Total
11.10.1	Test the Properties of Fresh Concrete	4	6	21	27
11.10.2	Perform the Quality Tests on Fine Aggregates for Concrete	4	4	12	16
11.10.3	Perform Quality tests on Coarse Aggregates for Concrete Mix Design	4	6	18	24
11.10.4	Perform quality tests for Cement	4	6	24	30
11.10.5	Perform Destructive Tests on Hardened Concrete	4	6	24	30
11.10.6	Evaluate Concrete Mix Design	4	4	32	36
Total			32	131	163

**11.11 Water and Waste Water Testing**

No.	Name of Occupations and Competency Standards	Level	Contact Hour		
			Th	Pr	Total
11.11.1	Determine the inorganic matters in water and wastewater.	4	2	14	16
11.11.2	Determine the Organic Matters in water and wastewater.	4	3	12	15
11.11.3	Determine the Physical Characteristics in water and wastewater.	4	3	12	15
11.11.4	Determine the Hardness in Water and Wastewater.	4	2	8	10
11.11.5	Determine the bacteriological impurities in Water and Wastewater.	4	4	20	24
Total			14	66	80
Grand Total of Level-4 (Part-I)			110	485	595

Construction Material Technician Level-4 Part-II**11.12 Soft Skills**

No.	Name of Occupations and Competency Standards	Level	Contact Hour		
			Th	Pr	Total
11.12.1	Manage meetings	4	3	6	9
11.12.2	Manage workforce planning	4	6	12	18
11.12.3	Undertake project work	4	3	12	15
11.12.4	Identify and communicate trends in career development	4	4	12	16
11.12.5	Work safely in an office environment	4	3	9	12
11.12.6	Develop workplace documents	4	6	12	18
11.12.7	Maintain professionalism in the workplace	4	3	9	12
11.12.8	Organize schedules	4	4	24	28
Total			32	96	128

11.13 Highway Materials Testing

No.	Name of Occupations and Competency Standards	Level	Contact Hour		
			Th	Pr	Total
11.13.1	Determine the Physical properties of road metals	4	2	12	14
11.13.2	Determine the Basic properties of road metals	4	3	18	21
11.13.3	Determine the Strength properties of road metals	4	3	24	27
11.13.4	Perform CBR test on road metals	4	2	10	12
11.13.5	Measure the basic properties of bitumen	4	8	30	38
11.13.6	Determine the bituminous content in a pavement sample	4	4	12	16
11.13.7	Determine the Mix Design by Marshall Method	4	6	18	24
11.13.8	Evaluate the Job Mix Formula for Asphaltic Concrete	4	4	36	40
Total			32	160	192

11.14 Masonry Materials Testing

No.	Name of Occupations and Competency Standards	Level	Contact Hour		
			Th	Pr	Total
11.14.1	Perform Physical Test on bricks and blocks	4	6	21	27
11.14.2	Perform Chemical Test on Bricks and blocks	4	4	8	12



11.14.3	Perform Strength Test on bricks and blocks	4	4	16	20
11.14.4	Determine the Physical Properties of lime	4	3	12	15
11.14.5	Perform Chemical Test on Lime	4	4	8	12
11.14.6	Perform Strength Test on Lime	4	4	16	20
11.14.7	Perform Physical Test on stones	4	8	32	40
11.14.8	Perform Chemical Test on stones	4	8	29	37
11.14.9	Perform Strength Test on stones	4	6	16	22
Total			47	158	205

11.15 Testing Properties of Timber

No.	Name of Occupations and Competency Standards	Level	Contact Hour		
			Th	Pr	Total
11.15.1	Perform the Strength Tests on Wood	4	5	28	33
11.15.2	Perform the Hardness and impact test on timber	4	3	19	22
11.15.3	Determine properties and types of locally manufactured timber	4	3	11	14
11.15.4	Make simple calculations of timber	4	2	9	11
Total			13	67	80
Grand Total of Level-4 (part-2)			124	481	605
Grand Total of Level 4			234	966	1200

4. Date of Validation

The level 4 of National qualification on construction Materials Technician has been validated by the Qualifications Development Committee (QDC) members on **04-08-2020 to 08-08-2020** and will remain valid for 10 years

5. Codes of Qualifications

The International Standard Classification of Education (ISCED) is a framework for assembling, compiling and analyzing cross-nationally comparable statistics on education and training. ISCED codes for these qualifications are assigned as follows:

ISCED Classification for Construction Materials Testing level-5	
Code	Description
	Level 2 National Qualification Certificate, in “construction Materials Sampler”
	Level 3 National Qualification Certificate, in “construction Materials Assistant”
	Level 4 National Qualification Certificate, in “construction Materials Technician”
	Level 5 National Qualification Diploma, in “construction Materials Supervisor”



6. Members of Qualifications Development Committee

The following members participated in the qualification's development and validation of these qualifications:

S#	Name	Designation	Organization
1	Engr. Azhar Iqbal Shad	Principal	GCT Raiwind Road, LHR
2	Mr. Nadeem Zaigham	Senior Instructor	GCT Raiwind Road, LHR
3	Mr. Imtiaz Ahmad Awan	Sr. Instructor Civil	GCT Rasul (M.B.Din)
4	Muhammad Amjad Rafique	Sr. Instructor Civil	GCT Rasul (M.B.Din)
5	Mr. Liaquat Ali Sajid	Sr. Instructor Civil	GCT Rasul (M.B.Din)
6	Engr. Arslan Hameed	Research, Associate Officer	Planning & Project Deptt. Lahore
7	Engr. Ayub Nasir	Site Material Testing Engr.	Ex. FWO Islamabad
8	Engr. Inayat ur Rehman	DACUM, Facilitator	Peshawar
9	Muhammad Ishaq	QDC Coordinator	NAVTTC, Islamabad

7. Members of Qualifications Validation Committee

The following members participated in the qualification's development and validation of these qualifications:

S#	Name	Designation	Organization
1	Engr. Azhar Iqbal Shad	Principal	GCT Raiwind Road, LHR
2	Mr. Nadeem Zaigham	Senior Instructor Civil	GCT Raiwind Road, LHR
3	Mr. Imtiaz Ahmad Awan	Senior Instructor Civil	GCT Rasul (M.B.Din)
4	Mr. Muhammad Amjad Rafique	Senior Instructor Civil	GCT Rasul (M.B.Din)
5	Engr. Abdul Rasheed	Associate Professor Civil	GCT Peshawar KPTEVTA
6	Engr. Norheen Amina	Consultant	Allied Engg Services/ Lahore
7	Engr. Rebab Maria Mahmood	Site Engineer	IMC Lahore/ Industry
8	Engr. Habiba Mohsin	Project Manager	Jers Engg Lahore/ Industry
9	Mr. Muhammad Dawood Bashir	STI	GCT Mirpur AJK TEVTA
10	Mrs. Syeda Fatima Iqbal	Representative	PBTE Lahore
11	Mr. Liaqat Ali Jhamroo	Representative	STEVTA
12	Engr. Inayat ur Rehman	DACUM, Facilitator	Peshawar
13	Mr. Muhammad Ishaq	QDC Coordinator	NAVTTC, Islamabad

8. Entry Requirements

The entry for National Certificate level 4, in Construction Materials Technician are

1. A person having National Vocational Certificate level 3, in Construction Materials Technician for entry in level 4.



9. Scheme of Studies

Construction Material Technician Level-4 Part-I

S#	Occupation/ Subjects	Category	Total Contact Hours			Credit	Periods Per Week			No. of Weeks
			Th	Pr.	Total		Th	Pr	Total	
11.8	Construction Practices II	Technical	32	96	128	12.8	2	6	8	16
11.9	Soil Testing	Technical	32	192	224	22.4	2	12	14	16
11.10	Concrete Testing	Technical	32	131	163	16.3	2	8	10	16
11.11	Water and Waste Water Testing	Technical	14	66	80	8	1	4	5	16
		Allied								
	Total		110	485	595	59.5	7	30	37	

Construction Material Technician Level-4 Part-II

S#	Occupation/ Subjects	Category	Total Contact Hours			Credit	Periods Per Week			No. of Weeks
			Th	Pr.	Total		Th	Pr	Th	
11.12	Soft Skills	Generic	32	96	128	12.8	2	6	8	16
11.13	Highway Materials Testing	Technical	32	160	192	19.2	2	10	12	16
11.14	Masonry Materials Testing	Technical	47	158	205	20.5	3	10	13	16
11.15	Testing Properties of Timber	Technical	13	67	80	8	1	4	5	16
		Allied								
		Allied								
	Total		124	481	605	60.5	8	30	38	
	Grand Total of Level 4		234	966	1200	120	15	60	75	

10. A- Occupation Packaging of Construction Materials Testing

S.#	Name of Occupation	Level	Generic Skills	Core Skills
1.	Building Materials Sampler	2	11.2.1, 11.2.4, 11.2.5	11.1.01, 11.1.02, 11.1.03, 11.1.05, 11.2.6
2.	Highway Materials Testing Sampler	2	11.2.1, 11.2.4, 11.2.5	11.1.01, 11.1.03, 11.1.04, 11.1.05, 11.1.06, 11.2.6
3.	Building Materials Assistant	3	11.6.4, 11.6.5, 11.4.5	11.4.1 to 11.4.4, 11.6.1, 11.7.1, 11.7.2
4.	Highway Materials Testing Assistant	3	11.6.4, 11.6.5, 11.4.5	11.4.1 to 11.4.2, 11.2.4, 11.6.1, 11.9.1 to 11.9.5
5.	Building Materials Technician	4	11.12.5, 11.12.7, 11.24.3	11.10.1 to 11.10.6, 11.14.1 to 11.14.10, 11.15.1 to 11.15.4, 11.16.1 to 11.16.3, 11.21.3, 11.23.1 to 11.23.6.



6.	Highway Quality Control Inspector	4	11.12.5, 11.12.7, 11.24.3	11.9.1 to 11.9.9, 11.13.1 to 11.13.7, 11.16.1 to 11.16.3, 11.19.2, 11.21.3
7.	Bridge Inspector (NDT)	4	11.12.5, 11.12.7, 11.24.3	11.22.1 to 11.22.11, 11.23.1 to 11.23.12
8.	Public Health Quality Control Inspector	4	11.12.5, 11.12.7	11.11.1 to 11.11.5, 11.22.8 to 11.22.10
9.	Construction Plants Operator	4	11.12.5, 11.12.7, 11.24.3	11.13.8, 11.17.1 to 11.17.3
10	Field Testing Lab Assistant	3	11.6.1, 11.6.3, 11.6.4, 11.6.5	11.4.1, 11.1.1, 11.1.3, 11.1.4, 11.1.5, 11.1.6, 11.3.8, 11.9.1 11.9.4, 11.10.1, 11.10.3, 11.14.1 to 11.17.3
11.	Field Testing Lab Technician	4	11.2.6, 11.2.8, 11.2.9, 11.2.10, 11.2.11, 11.2.15,	11.4.1, 11.1.2, 11.1.3, 11.1.4, 11.1.5, 11.1.6, 11.4.3, 11.4.4, 11.3.8, 11.9.1, 11.9.3, 11.9.4, 11.9.8, 11.10.1 to 11.10.3, 11.10.5, 11.14.1, 11.14.3

10. B-Qualification Packaging of Construction Materials Testing

S.#	Name of Qualification	Level	Generic Skills	Core Skills
1	Construction Materials Sampler	2	11.2.1 to 11.2.5	11.1.1 to 11.1.6, 11.2.6, 11.3.1 to 11.3.8
2	Construction Materials Assistant	3	11.4.5, 11.6.1 to 11.6.6	11.4.1 to 11.4.5, 11.5.1 to 11.5.4, 11.7.1 to 11.4.3
3	Construction Materials Technician	4	11.12.1 to 11.12.8	11.8.1 to 11.8.7, 11.9.1 to 11.9.9, 11.10.1 to 11.10.6, 11.11.1 to 11.11.5, 11.13.1 to 11.13.8, 11.14.1 to 11.14.10, 11.15.1 to 11.15.4
4	Construction Materials Supervisor	5	11.24.1 to 11.24.9	11.16.1 to 11.16.3, 11.17.1 to 11.17.3, 11.18.1 to 11.18.3, 11.19.1 to 11.19.5, 11.20.1 to 11.20.2, 11.21.1 to 11.21.4, 11.22.1 to 11.22.11, 11.23.1 to 11.23.12



11. Detail of Qualifications and its Competency Standards

C. National Qualification Certificate Level 4 in Construction Material Technician

11.8. Construction Practices II

11.8.1 Prepare subgrade, base, and bedding course for paving

Overview: This competency standard covers the skills and knowledge required to prepare subgrade, base and bedding course in preparation for laying paving.

Competency Units	Performance Criteria
CU1. Prepare for work	P1 Confirm work instructions with supervisor. P2. Select required tools and equipment, check for serviceability and any faults. P3. Calculate materials quantity requirements in accordance with specifications. P4. Obtain materials needed and check for compliance
CU2. Identify soil	P1 Identify class of soil used as per soil classification charts. P2. Determine properties of soil assessed to its class. P3. Determine subgrade requirements of penetration tests.
CU3. Prepare subgrade	P1. Identify drainage and other features are within the area to be paved. P2. Identify drains put in place where required P3. Identify services in work area P4. Identify damp proof courses and paving is constructed so that it does not compromise them. P5. Components are cleaned, stacked and stored for reuse or bundled for removal.
CU4. Install base course materials	P1. Calculate quantity of base course materials is based upon the subgrade type and purpose of the paved area. P2. Distribute material over area, allowing for compaction. P3. Perform compaction on area taking care not to over-compact base materials.
CU5. Install bedding course materials	P1. Select bedding course material P2. Calculate quantity of layer course materials P3. Distribute material over the area to be paved within tolerances



	stipulated by relevant standards. P4. Handle compacting machinery correctly. P5. Screed base materials to levels as determined, and set out by string lines or other mechanisms. P6. Clean the work area.
--	--

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- K1.** Explain principles of California bearing ratio (CBR)
- K2.** Explain properties of bedding course materials
- K3.** Explain properties of geotextile materials
- K4.** Explain relevant Pakistan standards
- K5.** Explain stabilizing bedding sand

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Locate, interpret and apply relevant information, standards and specifications
- Comply with site safety plan and OHS legislation, regulations and codes of practice applicable to workplace operations
- Comply with organizational policies and procedures including quality requirements
- Safely and effectively operate and use tools, plant and equipment
- Communicate and work effectively and safely with others.

Instruments & Consumables

S No.	Description (Instruments)
1	Personal protective equipment for construction industry.
2	Tools and equipment: compactors



	concrete mixer levelling devices rakes screed shovels string lines Wheelbarrows.
	Materials required: aggregates bedding sand cement concrete crushed rock road base sand.



11.8.2 Lay paving

Overview: This competency standard covers the skills and knowledge required to plan for work, set out work area and lay paving.

Competency Units	Performance Criteria
CU1. Plan for work	P1. Confirm work instructions with supervisor. P2. Select tools and equipment are selected as required, check for service and any faults P3. Calculate material quantity requirements in accordance with specifications P4. Obtain and prepare materials needed for compliance
CU2 Set out work area	P1. Identify location and area of paved area from plans and specifications P2. Identify sub-soil and footing types according to standards. P3. Locate underground services P4. Set out location and shape of paving area to dimensions from plans and specifications.
CU3. Lay paving	P1. Excavate area is to required depth, allowing for base and thickness and specified finish level. P2. Position drainage pipes in sub soil in accordance with plan specifications. P3. Mix mortar for masonry paving to specifications and standards. P4. Spread substrate base material and compact to specifications. P5. Spread and screed bedding material is spread to designed level and alignment. P6. Position edge boards to set out and specifications. P7. Grade paving surface to fall evenly, without ponding, to outlets or surface run-off system. P8. Determine initial starting line is and lay pavers to line conform to specified pattern. P9. Cut paving units and segments and lay to designed pattern and specifications, with joints to specifications and surface finish aligned. P10. Maintain finished level is across junctions between different finishes. P11. Complete paving installation with joints finished to specifications. P12. Clean paving surface according to specifications.

Knowledge & Understanding



The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- K1.** Explain characteristics and applications of materials for laying pavers
- K2.** Define corner geometry
- K3.** Explain paving bonds and patterns, joints and finishing
- K4.** Draw plans, specifications and drawings
- K5.** Explain techniques for laying pavers

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Pave a level area of 3m x 5m with clay pavers, using sand as a bedding material on compacted crushed rock (closed finish with sand brushed in); and
- Pave an area of 3m x 5m over a fall with clay bricks, incorporating control joints and using mortar as a bedding material on concrete (mortar joints finish).

Instruments & Consumables

S No.	Description (Instruments)
1	Personal protective equipment for construction industry.
2	Construction Lab Equipment: • Bolsters • Brick buggies • Buckets • Builders' lines • Builders squares • Concrete mixers • Forklifts • Hammers • Hoses • Line blocks • Line pins • Masonry saws • Mason's squares measuring tapes and rules • Mortar boards • Pallet trolleys



	• Rakes and brooms • Rubber mallets • Screed boards • Shovels • Small petrol or diesel engines • Compressors or mixers • Spirit levels • Straight edges • String lines • Trowels • Vibrating plates • Wheelbarrows
--	--



11.8.3 Carry out reinforced concrete work

Overview: This competency standard covers the skills and knowledge required to plan and prepare work, place and fix reinforcement, carry out concrete placement and clean-up work site area.

Competency Units	Performance Criteria
CU1. Plan and prepare work	P1. Recognize quality assurance requirements of construction operations and adhered to. P2. Recognize OH&S requirements for application tasks and workplace environment adhered to. P3. Identify reinforcement, type of fixing and locations from instructions/reinforcement schedule, job drawings and specifications. P4. Check formwork/excavation for completion and conformity to receive reinforcement. P5. Select, fit and use appropriate personal protective equipment correctly. P6. Select tools and equipment consistent with job requirements P7. Check delivered reinforcement for correct size type and quantities against reinforcement schedule/details shown in job detail drawings
CU2. Place and fix reinforcement	P1. Cut and bend reinforcement bars to required set -out and drawing details. P2. Tie bars to designed configuration from drawings. P3. Cut reinforcement sheets to required sizes, where applicable. P4. Attach stiffening rods to panels to instructions as required to facilitate handling processes P5. Locate bar chairs/spacers to requirements of reinforcement schedule and job drawings.
CU3. Carry out concrete placement	P1. Provide assistance provide with the undertaking of relevant concrete tests. P2. Transport concrete correctly and safely with wheelbarrow and discharge into formwork using correct manual handling techniques. P3. Place concrete to instruction, minimizing spillage.



	P4. Compact concrete to specification and instruction using immersion vibrator or other specified method. P5. Screed concrete to specified levels/grades as per instructions. P6. Finish concrete to instruction to specified surface finish. P7. Identify and apply curing process. P8. Cover concrete surface adequately with appropriate material to support curing process and protect it from damage.
CU4. Clean-up work site area	P1. Clear work are by disposing of materials (reused or recycled) in accordance to legislation and regulations P2. Clean, check, maintain and store tools and equipment according to requirement

Knowledge & Understanding

The candidate must be able to develop skills and understanding to plan and prepare work, place and fix reinforcement, carry out concrete placement and clean-up work site area required to carry out tasks covered in this competency standard. This includes the knowledge of:

- K1. Explain workplace and equipment safety requirements
- K2. Describe formwork for concrete
- K3. Enlist portable power tools, hand tools
- K4. Define plant and equipment
- K5. Enlist materials relevant to steel-fixing
- K6. Describe materials handling
- K7. Knowledge of drawings and specifications
- K8. Describe reinforcement schedule
- K9. Describe appropriate steel-fixing procedures and legislative requirements

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Demonstrate compliance with Occupational Health and Safety regulations applicable to workplace operations
- Select and use appropriate processes, tools and equipment



- Apply quality procedures and processes within the context of fixing steel reinforcing
- Check materials for conformity with specifications and job requirements
- Identify and follow assembly location and placement sequence
- Demonstrate safe and effective use of tools and equipment and handling of materials
- Place and tie/weld reinforcement to specification
- Interactively communicate with others to ensure safe and effective operations in fixing the reinforcing

Tools and Equipment

1. Shovels and rakes
2. Wooden floats
3. Steel floats
4. Bull floats
5. Immersion vibrator or vibrating table
6. Tarpaulins/covers
7. Curing agent applicator
8. Steam generator
9. Wheelbarrow
10. Tamping rods
11. Screed boards
12. Edging tool
13. Brooms
14. Bolt cutters
15. Hacksaw
16. Wire nippers
17. Tie wire spool
18. Measuring tape/rule
19. Reinforcement bender



11.8.4 Produce sketches of bridges w.r.t. material of construction

Overview: This competency standard covers the knowledge required to draw sketches of timber, masonry, steel, R.C.C and pre stressed concrete bridges.

Competency Units	Performance Criteria
CU1. Draw sketch of timber bridge	P1. Identify drawing tools for drawing P2. Fix drawing sheet on drafting table P3. Draw sketch of timber bridge P4. Label the structural components of timber bridge
CU2. Draw sketch of masonry bridge	P1. Identify drawing tools for drawing P2. Fix drawing sheet on drafting table P3. Draw sketch of masonry bridge P4. Label the structural components of masonry bridge
CU3. Draw sketch of steel bridge	P1. Identify drawing tools for drawing P2. Fix drawing sheet on drafting table P3. Draw sketch of steel bridge P4. Label the structural components of steel bridge
CU4. Draw sketch of R.C.C bridge	P1. Identify drawing tools for drawing P2. Fix drawing sheet on drafting table P3. Draw sketch of R.C.C bridge P4. Label the structural components of R.C.C bridge
CU5. Draw sketch of pre stressed concrete bridge	P1. Identify drawing tools for drawing P2. Fix drawing sheet on drafting table P3. Draw sketch of pre stressed concrete bridge P4. Label the structural components of pre stressed concrete bridge

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- K1. Explain components parts and type timber, masonry, steel, R.C.C and pre stressed concrete bridges
- K2. Necessity and suitability
- K3. Comparison of various types



- K4. Characteristics of an ideal site for a bridge (River and Banks, foundation design and construction facilities, approaches)
- K5. Location of an alignment and site
- K6. State Factors governing the choice of a bridge
- K7. Brief description of maintenance of steel, masonry, R.C.C. bridges

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Sketch of timber bridge
- Sketch of masonry bridge
- Sketch of steel bridge
- Sketch of R.C.C bridge
- Sketch of pre stressed concrete bridge

Tools and Equipment

- ❖ Paper
- ❖ Drafting table
- ❖ Pencil
- ❖ Ruler
- ❖ Rubber
- ❖ Sharpener
- ❖ Masking tape



11.8.5 Produce sketches of permanent Way

Overview: This competency standard covers the skills and knowledge required to draw rails sections (double headed, bull headed and flat footed), sketches of rail fastenings, sleeper fastenings, cross section of broad-gauge rail track.

Competency Units	Performance Criteria
CU1. Draw rails sections (double headed, bull headed and flat footed)	P1. Identify drawing tools P2. Fix drawing sheet on drafting table P3. Draw rails sections (double headed, bull headed and flat footed) P4. Perform labelling and dimensioning
CU2. Draw sketches of rail fastenings	P1. Identify drawing tools P2. Fix drawing sheet on drafting table P3. Draw sketches of rail fastenings P4. Label parts of rail fastenings
CU3. Draw sketches of sleeper fastenings	P1. Identify drawing tools P2. Fix drawing sheet on drafting table P3. Draw sketches of sleeper fastenings P4. Label parts of sleeper fastenings
CU4. Draw cross section of broad-gauge rail track	P1. Identify drawing tools P2. Fix drawing sheet on drafting table P3. Draw cross section of broad gauge rail track of in filling P4. Draw cross section of broad gauge rail track in cutting P5. Label components of rail tracks

Knowledge & Understanding

The candidate must be able to develop understanding to draw rails sections (double headed, bull headed and flat footed), sketches of rail fastenings, sleeper fastenings, cross section of broad gauge rail track and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- K1. Define permanent way
- K2. State the requirements of permanent way
- K3. Explain the components of permanent way, their functions and types (formation, ballast and sleepers).



- K4. Explain gauge and its types
- K5. Explain factors governing adoption of a particular gauge
- K6. Explain the different types of rails, rail joints, rail fittings and accessories.
- K7. Explain carriage wheel and conning of wheels.
- K8. State the requirement of good rail joint and ballast.
- K9. Explain modern methods of laying railway track.
- K10. Definition of creep
- K11. Explain the causes of creep.
- K12. Explain with sketch magnitude of creep.
- K13. State the results of creep.
- K14. State the methods of correction of creep.

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Drawing of rails sections (double headed, bull headed and flat footed)
- Sketches of rail fastenings
- Sketches of sleeper fastenings
- Drawing of cross section of broad gauge rail track of in filling
- Drawing of cross section of broad gauge rail track in cutting

Tools and Equipment

1. Drafting Table,
2. Drawing Tools
3. Drawing Sheets



11.8.6 Produce sketches of station yards and signals

Overview: This competency standard covers the skills and knowledge required to draw sketch of coaching yard, goods yard, locomotive yard, marshalling yard and sketches of rail signals.

Competency Units	Performance Criteria
CU1. Draw sketch of coaching yard	P1. Identify drawing tools P2. Fix drawing sheet on drafting table P3. Draw border lines and title bar P4. Draw the connection of rails to sleepers
CU2. Draw sketch of goods yard	P1. Identify drawing tools P2. Fix drawing sheet on drafting table P3. Draw border lines and title bar P4. Draw cross section of broad gauge rail track in cutting
CU3. Draw sketch of locomotive yard	P1. Identify drawing tools P2. Fix drawing sheet on drafting table P3. Draw border lines and title bar P4. Draw cross section of broad gauge rail track of in filling
CU4. Draw sketch of marshaling yard	P1. Identify drawing tools P2. Fix drawing sheet on drafting table P3. Draw border lines and title bar P4. Draw various types of rails
CU5. Draw the sketches of rail signals	P1. Identify drawing tools P2. Fix drawing sheet on drafting table P3. Draw border lines and title bar P4. Draw the sketches of rail signals (semaphore, warning, light disc and dwarf signals)

Knowledge & Understanding

The candidate must be able to develop understanding to draw sketch of coaching yard, goods yard, locomotive yard, marshaling yard and sketches of rail signals and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- K1.** Explain station yards and sketch their layout.
- K2.** State the purpose and types of signals.
- K3.** State the classification of signals according to function and location.



- K4. Explain signalling and its objects.
- K5. Describe with sketches the inter locking its principles and requirements.
- K6. Explain the methods of inter locking.

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Sketch of coaching yard
- Sketch of goods yard
- Sketch of locomotive yard
- Sketch of marshalling yard
- Sketches of rail signals

Tools and Equipment

1. Drafting Table,
2. Drawing Tools
3. Drawing Sheets



11.8.7 Produce sketches of canals and head works

Overview: This competency standard covers the skills and knowledge required to draw a skeleton map of Pakistan showing rivers, main and link canal, Head works and barrages, Draw the plan of a multipurpose irrigation project, Draw a plan showing general layout of river training and protection works, Draw cross section of dams, Draw a plan showing the general layout of head works of a perennial canal, Draw cross-sections of a weir floors, Draw the plan and section of a silt ejector

Competency Units	Performance Criteria
CU1. Draw a skeleton map of Pakistan showing rivers, main and link canal, Head works and barrages	P1. Arrange drawing instruments P2. Select drawing sheet P3. Set sheet on drawing table as per standards. P4. Draw map of Pakistan. P5. Show rivers on map. P6. Draw barrages, main canals, head works and link canals
CU2. Draw the plan of a multipurpose irrigation project	P1. Arrange drawing instruments P2. Select drawing sheet P3. Set sheet on drawing table as per standards. P4. Draw plan of project. P5. Show all details on plans
CU3. Draw a plan showing river training and Protection works.	P1. Arrange drawing instruments P2. Select drawing sheet P3. Set sheet on drawing table as per standards. P4. Draw plan of training and Protection works. P5. Show all details on plans
CU4. Draw cross section of dams	P1. Arrange drawing instruments P2. Select drawing sheet P3. Set sheet on drawing table as per standards. P4. Draw x-section of dam. P5. Label all necessary details on plan.
CU5. Draw a plan showing the general layout of head works of a perennial canal	P1. Arrange drawing instruments P2. Select drawing sheet P3. Set sheet on drawing table as per standards. P4. Select suitable scale. P5. Draw layout of head works. P6. Label all necessary details on plan.



CU6. Draw cross-sections of a weir floors	P1. Arrange drawing instruments P2. Select drawing sheet P3. Set sheet on drawing table as per standards. P4. Select suitable scale. P5. Draw weir's section. P6. Label all necessary details.
CU7. Draw the plan and section of a silt ejector	P1. Arrange drawing instruments P2. Select drawing sheet P3. Set sheet on drawing table as per standards. P4. Select suitable scale. P5. Draw plan and section. P6. Label all necessary details.

Knowledge & Understanding

- K1.** Define irrigation
- K2.** State history of irrigation.
- K3.** State necessity and scope of irrigation.
- K4.** State merits and demerits of irrigation
- K5.** Explain types of irrigation i.e. flow irrigation and lift irrigation
- K6.** Explain various sources of irrigation water.
- K7.** Describe with map the irrigation network in Pakistan.
- K8.** State the characteristics of Pakistan's rivers.
- K9.** State the important barrages of Pakistan.
- K10.** State Indus Basin Project
- K11.** Explain need and details of replacement works in Indus Basin Project
- K12.** Know IRSA and PIDA
- K13.** State the necessity of storage irrigation.
- K14.** Define the various terms used in storage irrigation.
- K15.** Explain the methods of assessment of maximum run off from a catchment area
- K16.** Define reservoirs
- K17.** State the purpose of reservoir and its classification.
- K18.** Describe the location of site selection for reservoir
- K19.** State classification of dams i.e. based on function and use, structural design, materials of construction, shape of X-section
- K20.** State factors to be considered during choice of dam for hydro project



- K21. explain the construction details of earthen dams
- K22. State the causes of failure of earthen dams and their remedies
- K23. Explain methods to control seepage in earthen dams
- K24. Explain necessity of raising of dams.
- K25. Explain methods of raising dam.
- K26. Understand Features and Function of Weir/Barrages.
- K27. Define weir and barrages.
- K28. Distinguish between barrages and weirs and explain their purposes.
- K29. Describe with sketches the components/parts of a barrage.
- K30. State the factors governing the site selection of a barrage.
- K31. State the types of weirs.
- K32. Explain surface flow at weirs.
- K33. Describe the necessity and importance of regulation and silt controlling works.
- K34. Explain head regulator and its types, i.e. flume, meter flume.
- K35. Describe with sketches the silt ejector, silt vanes, silt excluder and skimming platform.
- K36. Describe the necessity and importance of regulation and silt controlling works.
- K37. Describe with sketches the silt ejector, silt vanes, silt excluder and skimming platform.
- K38. List the objects of river training.
- K39. Explain with sketches different types of protective and river training works.

Critical Evidence(s) Required

The candidate needs to produce following critical evidences in order to competent in this competency standard.

- Draw sketches showing rivers barages.
- Draw sketch of multipurpose irrigation project.
- Draw a river training works.
- Draw a dam section.
- Draw head works.
- Draw weir floor.
- Draw silt ejectors

Tools and Equipment

S No.	Description (Instruments)	S No.	Description (Consumable)
1	Drawing board	1	Drawing sheet
2	T square	2	Eraser



3	Pair of Set squares	3	HB, H, 2H, 3H Pencils
4	Drawing Box (Compasses, divider, protractor, rule)	4	Scotch tape
		5	Sharpener/ Sand paper



11.9. Soil Mechanics

11.9.1 Determine Basic Properties of soil

Overview: This competency standard covers the skills and knowledge required to determine soil moisture content by Speedy moisture, establish soil moisture content by oven drying and Identify specific gravity of soil sample by pycnometer

Competency Units	Performance Criteria
CU1. Extraction of soil sample	P1. Select and set all required tools, apparatus/ instrument/ equipment and make them ready for sample extraction as per standards. P2. Perform soil sample extraction, using core cutter or other methods, as per standard procedure P3. Carry out weighing, measuring and determine bulk density and moisture content of samples as per specified procedures. P4. Fill data in the sampling documents P5. Store and stack the test samples as per specified procedures P6. Observe safety requirements. P7. Perform housekeeping as per standard procedure.
CU2. Determine soil moisture content by Speedy moisture	P1. Identify apparatus for determining MC by speedy moisture meter as per local standards. P2. Collect soil sample to be tested P3. Identify chemical to be used in speedy moisture P4. Assemble pressure vessel according to specifications. P5. Record dial reading after shaking the vessel as per standards P6. Interpret moisture content corresponding to the reading of dial gauge
CU3. Determine soil moisture content by oven drying (Lab)	P1. Determine weight of containers P2. Determine Weight of soil sample with containers P3. Dry soil sample in oven P4. Evaluate moisture content
CU4. Evaluate specific gravity of soil sample by pycnometer	P1. Identify pycnometer apparatus P2. Assemble apparatus with soil sample P3. Record observations P4. Evaluate specific gravity using formula



CU5. Evaluate specific gravity of soil sample by density bottle	P1. Identify density bottle P2. Assemble apparatus with soil sample P3. Evaluate specific gravity using formula
CU6. Perform Sieve Analysis test	P1. Identify sieves sizes P2. Assemble nest of sieves P3. Prepare soil sample P4. Conduct soil sample shaking P5. Record observation of weights P6. Evaluate results of percentage passing
CU7. Execute Hydrometer test for fine soil	P1. Identify apparatus P2. Evaluate soil fraction passing sieve#200 P3. Prepare soil sample P4. Identify chemical P5. Conduct hydrometer test P6. Evaluate results for data collected from observations
CU8. Draw gradation curve form analysis results	P1. Identify results from analysis. P2. Draw semi log scale graph P3. Plot grain size vs percentage passing of soil sample P4. Interpret soil type graphically

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to to determine soil moisture content by Speedy moisture, establish soil moisture content by oven drying and Identify specific gravity of soil sample by pycnometer covered in this competency standard. This includes the knowledge of:

- K1. Soil, soil mechanics, soil engineering
- K2. Objectives of soil mechanics
- K3. Classification of soil
- K4. Types of soil and their formation
- K5. Soil structure and its group
- K6. Bulk density and moisture content
- K7. Three phase diagrams of soil
- K8. Physical properties of soil
- K9. Specific gravity and various densities
- K10. Sieve analysis and hydrometer



K11. Gradation curve

K12. Various interrelationships

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Report on determination of soil moisture content by Speedy moisture
- Report on determination soil moisture content by oven drying
- Report on evaluation specific gravity of soil sample by pycnometer

Tools and Equipment

1. Empty clean container
2. Moist Sample
3. Oven
4. Balance accurate to 0.01gm
5. Speedy moisture tester
6. Steel ball of 1.25 inch diameter
7. Brush for cleaning the tester
8. Scoop for measuring Calcium carbide reagent
9. Pycnometer of about 1 liter capacity
10. Glass rod
11. Vacuum pump
12. Core cutter
13. Pressure vessel
14. Density bottle
15. Sieve brushes
16. Sieving equipment
17. Hydrometer
18. Log graph



11.9.2 Determine Atterberg's Limits

Overview: This competency standard covers the skills and knowledge required to determine liquid limit of soil, plastic limit of soil and shrinkage limit of soil

Competency Units	Performance Criteria
CU1. Determine liquid limit of soil	P1. Identify apparatus P2. Prepare soil sample P3. Assemble soil sample in apparatus P4. Cut groove in sample P5. Record number of blows P6. Repeat soil sample trials by varying moisture content P7. Interpret no. of blows and water content graphically
CU2. Determine plastic limit of soil	P1. Identify apparatus P2. Prepare soil sample P3. Roll threads of soil with fingers P5. Complete Rolling and kneading of soil samples P6. Dry crumbled soil threads in oven P7. Evaluate soil water content
CU3. Determine shrinkage limit of soil	P1. Identify apparatus P2. Prepare soil sample P3. Evaluate volume of wet soil P4. Evaluate weight of wet soil P6. Evaluate volume of dry soil after soil shrinkage P7. Evaluate weight of dry soil after soil shrinkage P8. Identify shrinkage limit formula
CU4. Maintain Safe work environment	P1. Use safe work procedures and personal protective equipment (PPE) to ensure personal safety and that of other personnel P2. Clean work area and collect, recycle or dispose of all waste in accordance with workplace procedures P3. Clean and check serviceability of test equipment before storage.

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:



- K1.Consistency of soil
- K2.Description of Atterberg's Limit.
- K3.Different Indices (Plasticity index, liquidity index, consistency index etc)
- K4. Liquid limit, Plastic limit and Shrinkage limit
- K5.Methods of determination of Atterberg's Limits for given soil sample.

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Test report of liquid limit
- Test report of plastic limit
- Test report of shrinkage limit

Tools and Equipment

- Empty clean container
- Moist Sample
- Oven
- Balance accurate to 0.01gm
- Speedy moisture tester
- Steel ball of 1.25-inch Dia
- Brush for cleaning the tester
- Scoop for measuring Calcium carbide reagent
- Pycnometer of about 1-liter capacity
- Glass rod
- Vacuum pump



11.9.3 Classify Soils

Overview: This competency standard covers the skills and knowledge required to perform Sieve analysis for soil sample, execute hydrometer test for fine soil, draft gradation curve Classify soil by AASHTO classification chart, Classify soil by USCS tables and Classify soil according to textural formation

Competency Units	Performance Criteria
CU1. Prepare to classify soil samples	P1. Review job request and any accompanying documentation to identify purpose of soil classification and client's information needs P2. Identify any hazards and relevant safe work procedures associated with the types of site samples P3. Inspect supplied samples and test data, compare with specifications and record and report any discrepancies P4. Liaise with client when supplied samples, test data and/or job request forms do not comply with workplace procedures and resolve any problems P5. Assemble required equipment/materials and check that they are fit for purpose
CU2. Examine properties of soil samples	P1. Assess appearance and feel of soil to determine moisture condition P2. Use moulding/indentation tests, penetrometer and/or density index data to determine soil consistency P3. Identify the soil's major, secondary and minor components and the proportion of each P4. Assign a soil colour based on own observations and review of field log sheets P5. Determine soil structure based on own observations and review of available zoning, defect and cementing data recorded for undisturbed field samples P6. Review any additional observations and test data that may identify soil origin
CU3. Analyse available test results	P1. Compare supplied mechanical test data with standard classification values for different soil types P2. Compare particle size and percentage composition data with



	standard classification values for different soil types P3. Compare other laboratory test results with own observations to confirm assignment of plasticity, grading and strength of soil samples P4. Recognise anomalies or unexpected results and, if necessary, recheck specimens and test results and conduct repeat tests to ensure reliable results
CU4. Record soil classification.	P1. Use standard symbols and descriptors to assign a valid soil classification by AASHTO charts, USCS table, and textural formation P2. Record and store client's soil classification, samples and test data in accordance with workplace procedures P3. Maintain confidentiality of client information in accordance with workplace procedures
CU5. Maintain Safe work environment	P1. Use safe work procedures and personal protective equipment (PPE) to ensure personal safety and that of other personnel P2. Clean work area and collect, recycle or dispose of all waste in accordance with workplace procedures P3. Clean and check serviceability of test equipment before storage.

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- K1. State classification of soil and its necessity
- K2. Soil and its types
- K3. Explain Particle size classification system, Textural classification system, AASHTO soil classification system, Unified soil classification system
- K4. Explain well graded, uniformly graded soil, poorly graded soil, Effective grain size, coefficient of uniformity, coefficient of curvature
- K5. Explain the particle size analysis for different soils.

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:



- Report on sieve analysis for soil sample
- Report on Hydrometer test for fine soil
- Report on classification of soil by AASHTO classification
- Report on classification of soil by USCS
- Report on classification of soil according to textural formation

Tools and Equipment

1. Set of ASTM sieves containing sieve # 4, 10, 20, 40, 60, 100, 200
2. lid and pan
3. Balance sensitive to 0.1gm
4. Sieve shaker
5. Soft brush for cleaning
6. Evaporating dish
7. Containers
8. Oven
9. No. 40 sieve with lid and pan
10. AASHTO charts
11. USCS tables



11.9.4 Conduct soil compaction tests in field

Overview: This competency standard covers the skills and knowledge required to Conduct Standard Proctor test, conduct modified Proctor test, inspect field density by core cutter and inspect soil field density by Sand replacement method

Competency Units	Performance Criteria
CU1. Prepare the site to conduct core cutter test.	P1. Clear the site to conduct core cutter test. P2. Conduct site levelling as per standards.
CU2. Setup the apparatus to conduct core cutter test.	P1. Arrange the core cutter. P2. Check the set-up position.
CU3. Conduct the core cutter test	P1. Apply the blows using standard hammer. P2. Take out the core cutter. P3. Extrude the core of soil P4. Note down the readings-weights
CU4. Determine moisture contents	P1. Collect sample from the core as per standards. P2. Find out moisture contents of the sample
CU5. Evaluate the Results	P1. Sequence the data. P2. Calculate the bulk density. P3. Calculate the dry density. P4. Compare the results with the standards.
CU6. Maintain Safe work	P1. Use safe work procedures and personal protective equipment (PPE) to ensure personal safety and that of other personnel P2. Clean work area and collect, recycle or dispose of all waste in accordance with workplace procedures P3. Clean and check serviceability of test equipment before storage.

Knowledge & Understanding

The candidate must be able to Conduct field density by core cutter and inspect soil field density by Sand replacement method underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- K1.State term compaction its significance and necessity.
- K2.Discuss the principles of compaction
- K3.Compare between compaction and consolidation.
- K4.Describe Compaction Effort or Energy.
- K5.Define and determine Moisture content, Bulk density and dry density of soil



K6. List the procedure of field compaction tests, core cutter method and sand replacement method, Rubber balloon method, Nuclear density meter

K7. State the factors affecting compaction.

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Report on field density by core cutter
- Report on field density by Sand replacement method

Tools and Equipment

1. Apparatus Standard proctor mould
2. Balance
3. Tray
4. rammer of 2.5Kg (5.5 lb) of fall 25.4Cm (12")
5. 4.54Kg (10 lb), of fall 38Cm (18")
6. moisture container
7. sieve 19 mm (3/4") and 9.5mm (3/8")
8. straight edge
9. Apparatus Core cutter
10. Hammer
11. excavating tools
12. oven
13. Sand bottle
14. calibrating container
15. glass plate
16. base plate
17. pan
18. tools for excavating hole
19. clean dry sand passing from No.10 (2.0mm) sand retained on No.20 (850µm) sieve
20. Speedy moisture tester apparatus.



11.9.5 Conduct soil compaction tests in Lab

Overview: This competency standard covers the skills and knowledge required to Conduct Standard Proctor test, conduct modified Proctor test.

Competency Units	Performance Criteria
CU1. Prepare samples to conduct standard Proctor test	P1. Collect soil from source. P2. Reduce the sample for standard test as per standards. P3. Add decided water in soil sample for standard test.
CU2. Conduct standard Proctor test	P1. Set up proctor test apparatus P2. Measure weights during conduction of standard test. P3. Apply comp active efforts as per requirements in 3 layers P4. Inspect compacted specimen of standard test. P5. Extract sample for moisture contents for standard test. P6. Find out the moisture contents for standard test P7. Evaluate bulk density of soil for standard test P8. Evaluate dry density of compacted soil for standard test P9. Interpret water content and dry density graphically
CU3. Prepare samples to conduct modified Proctor test	P1. Collect soil from source. P2. Reduce the sample for modified test as per standards. P3. Add decided water in soil sample for modified test..
CU4. Conduct modified Proctor test	P1. Set up modified proctor test apparatus P2. Measure weights during conduction of s modified test. P3. Apply comp active efforts as per requirements in 3 layers P4. Inspect compacted specimen of modified test. P5. Extract sample for moisture contents for modified test. P6. Find out the moisture contents for modified test P7. Evaluate bulk density of soil for modified test P8. Evaluate dry density of compacted soil for modified test P9. Interpret water content and dry density graphically
CU5. Maintain Safety work requirement	P1. Use safe work procedures and personal protective equipment (PPE) to ensure personal safety and that of other personnel P2. Clean work area and collect, recycle or dispose of all waste in accordance with workplace procedures



	P3. Clean and check serviceability of test equipment before storage.
--	---

Knowledge & Understanding

The candidate must be able to Conduct Standard Proctor test, conduct modified Proctor test, inspect field density by core cutter and inspect soil field density by Sand replacement method underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- K1.State term compaction its significance and necessity.
- K2.Discuss the principles of compaction
- K3.Compare between compaction and consolidation.
- K4.Describe Compaction Effort or Energy.
- K5.List the procedure of standard proctor test and modified compaction test.
- K6.State the factors affecting compaction.

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Report on standard Proctor test
- Report on modified Proctor test

Tools and Equipment

1. Apparatus Standard proctor mould
2. Balance
3. Tray
4. rammer of 2.5Kg (5.5 lb) of fall 25.4Cm (12")
5. 4.54Kg (10 lb), of fall 38Cm (18")
6. moisture container
7. sieve 19 mm (3/4") and 9.5mm (3/8")
8. straight edge
9. Hammer
10. excavating tools
11. oven
12. calibrating container
13. glass plate



14. base plate
15. pan
16. tools for excavating hole
17. clean dry sand passing from No.10 (2.0mm) sand retained on No.20 (850 μ m) sieve
18. Speedy moisture tester apparatus.



11.9.6 Determine permeability of soil

Overview: This competency standard covers the skills and knowledge of permeability constant head method and permeability falling head method

Competency Units	Performance Criteria
CU1. Prepare specimen to conduct permeability by constant head method	P1. Collect the soil from source. P2. Prepare the specimen for permeability test.
CU2. Setup the Apparatus to conduct permeability test by Constant head method	P1. Identify the apparatus for constant head method. P2. Assemble apparatus. P3. Place the specimen in constant head permeameter.
CU3. Perform constant head permeability test	P1. Identify water head level difference. P2. Record the observations. P3. Evaluate permeability of cohesion-less soil
CU4. Prepare specimen to conduct permeability by variable head method	P1. Collect the soil from source. P2. Prepare the specimen for permeability test.
CU5. Setup the Apparatus to conduct permeability test by variable head method	P1. Identify the apparatus for variable head method. P2. Complete apparatus calibration P3. Assemble apparatus. P4. Place the specimen in variable head permeameter.
CU6. Perform variable head permeability test	P1. Identify water head level difference. P2. Record the observations. P3. Evaluate permeability of cohesive soil
CU7. Maintain Safe work environment	P1. Use safe work procedures and personal protective equipment (PPE) to ensure personal safety and that of other personnel P2. Clean work area and collect, recycle or dispose of all waste in accordance with workplace procedures P3. Clean and check serviceability of test equipment before storage

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:



- K1.Introduction to permeability
- K2.Description of factors affecting permeability.
- K3. Darcy's Law and its validity
- K4.Laboratory permeability tests
- K5.Field permeability tests
- K6.Constant head method and falling head method
- K7.Introduction to cohesive and non-cohesive soils
- K8.Numerical problems on permeability.

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Report on permeability constant head method
- Report on permeability falling head method

Tools and Equipment

1. Constant head Permeameter device (including constant head filter tank and manometer tubes)
2. 500ml beaker
3. Stop watch
4. Thermometer
5. Apparatus Falling/ Variable head Permeameter device
6. Ring stand with test tube clamp
7. Burette (100ml)



11.9.7 Determine the shear strength of soil

Overview: This competency standard covers the skills and knowledge required to perform direct shear test and execute triaxial shear test

Competency Units	Performance Criteria
CU1. Prepare specimen to conduct direct shear test	P1. Collect the soil whether undisturbed or remolded from source for shear test. P2. Prepare the specimen for shear test.
CU2. Setup the Apparatus to conduct direct shear test	P1. Identify the apparatus for direct shear test. P2. Assemble direct shear test apparatus P3. Place the specimen in apparatus
CU3. Perform Direct Shear test	P1. Apply the load at specified rating against normal stress. P2. Record the observations. P3. Repeat as per specs on other specimens against normal stress. P4. Perform calculations in specified format. P5. Produce the results graphically P6. Interpret internal friction angle from graph
CU4. Prepare specimen to conduct triaxial shear test	P1. Collect the soil from source for triaxial shear test. P2. Prepare the specimen consolidated drained/ consolidated undrained/ un consolidated undrained for triaxial shear test.
CU5. Setup the Apparatus to conduct triaxial shear test	P1. Identify the apparatus for triaxial shear test. P2. Assemble triaxial shear test apparatus P3. Place the specimen in apparatus
CU6. Execute triaxial Shear test	P1. Apply the stress as per test condition required P2. Record the observations. P3. Produce the results graphically P4. Interpret cohesion and internal friction angle from graph
CU7. Maintain Safe work environment	P1. Use safe work procedures and personal protective equipment (PPE) to ensure personal safety and that of other personnel P2. Clean work area and collect, recycle or dispose of all waste in accordance with workplace procedures P3. Clean and check serviceability of test equipment before storage

Knowledge & Understanding



The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- K1.Introduction to shear strength of soils.
- K2. Types of strength tests on soils.
- K3.Coulomb's Law for shear strength of soil.
- K4.Laboratory measurement of shear strength
- K5.Tri axial compression test and Mohr's circle
- K6.Unconfined compression test. Vane shear and simple shear tests.
- K7.Factors affecting shear strength of soil
- K8. Computation of shear strength and internal friction of soil
- K9.Differentiate between cohesive and non-cohesive soil

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Performance of test and evaluation of results by direct shear test apparatus.
- Performance of test and evaluation of results by triaxial shear test apparatus.
- Explain unconfined compressive strength
- Explain shear strength

Tools and Equipment

1. Shear box
1. Shear box container
2. Base plate with cross grooves on its top
3. Porous stones (2 Nos)
4. Plain Grid plates (2Nos)
5. Perforated grid plates (2Nos)
6. Loading pad with steel ball
7. Digital weighing machine
8. Loading frame with loading yoke
9. Proving ring
10. Dial gauges (2 Nos)
11. Weights
12. Tampering Rod
13. Spatula
14. Rammer
15. Sampler
16. Distribution Panel
17. Automatic Pressure/Volume Controllers
18. Load Frame
19. Load Cell
20. Displacement transducer



21. Tri axial Cell
22. Pore Pressure Transducer
23. De-aired water supplier
24. Data logger
25. Sample extruder
26. Sample moulds
27. Membranes
28. 'o' rings
29. Porous discs
30. Ruler
31. Balance
32. Filter papers



11.9.8 Conduct California Bearing Tests

Overview: This competency standard covers the skills and knowledge to Find bearing capacity of soil using Spt test and Identify bearing capacity using California bearing ratio

Competency Units	Performance Criteria
CU1. Prepare specimen to conduct direct shear test	P1. Collect the sample for subgrade/ soil, sub-base and base from source for CBR tests. P2. Prepare the specimen as per requirement for CBR tests in defined layers and number of blows.
CU2. Setup the Apparatus to conduct CBR test	P1. Identify CBR apparatus P2. Assemble the apparatus. P3. Check the assembly adjustments.
CU3. Perform CBR Test	P1. Place the soil/ subgrade sample. P2. Apply the load as per standards penetrations for soil. P3. Record observation data for soil P4. Place the sub-base layer sample. P5. Apply the load as per standards penetrations for sub-base layer. P6. Record observation data for sub-base layer. P7. Place the base layer sample. P8. Apply the load as per standards penetrations for base layer. P9. Record observation data for base layer. P10. Interpret penetration and penetration load graphically P11. Evaluate CBR from graph P12. Interpret percentage CBR and dry density of sample graphically P13. Identify CBR graphically at required degree of compaction
CU4. Design the Flexible Pavement from CBR charts.	P1. Note the depth of sub-base from CBR chart for evaluated CBR value. P2. Note the depth of base from CBR chart or evaluated CBR value. P3. Note the depth of sub-base from CBR chart or evaluated CBR value. P4. Summarize the depths of layers



CU5. Maintain safe work environment.	P1. Use safe work procedures and personal protective equipment (PPE) to ensure personal safety and that of other personnel P2. Clean work area and collect, recycle or dispose of all waste in accordance with workplace procedures P3. Clean and check serviceability of test equipment before storage
---	---

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- K1. Introduction to CBR.
- K2. Introduction to direct shear test, simple shear test
- K3. Introduction to flexible pavements
- K4. Preparation of samples and equipment required.
- K5. Procedure of performing CBR tests
- K6. Calculations and interpretation for flexible pavement design

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Demonstrate working of CBR apparatus and design of flexible pavement
- Draw and interpret graph between percentage CBR and sample dry density

Tools and Equipment

1. Mould
2. Steel Cutting collar
3. Spacer Disc
4. Surcharge weight
5. Dial gauges
6. Sieves
7. Penetration Plunger
8. Loading Machine
9. Tripod.
10. detachable extension collar
11. detachable perforated base plate



12. Spacer disc
13. Metal rammer
14. Weights.
15. Loading
16. Metal penetration piston
17. Two dial gauges reading to 0.01 mm.
18. Sieves. 4.75 mm and 20 mm I.S. Sieves
19. mixing bowl
20. straight edge
21. scales soaking tank or pan
22. drying oven
23. filter paper
24. Containers.



11.9.9 Find out bearing capacity of soil

Overview: This competency standard covers the skills and knowledge to Find bearing capacity of soil using Spt test and Identify bearing capacity using California bearing ratio

Competency Units	Performance Criteria
CU1. Prepare site to conduct Standard Penetration test	P1. Perform re connivances to reach at the location for performing SPT. P2. Conduct site clearance. P3. Perform grubbing if any required.
CU2. Setup the Apparatus to conduct SPT.	P1. Identify SPT apparatus P2. Assemble the apparatus. P3. Check the split spoon sampler dimension
CU3. Perform SPT at site.	P1. Apply the blows of standard weight as per ASTM D 1586. P2. Countdown the number of blows N_{spt} . P3. Calculate Normal 60 by standard equation P4. Calculate the relative density of soil by use of table and relevant equation. P5. Evaluate bearing capacity
CU4. Prepare site to conduct Plate Bearing test	P1. Perform re connivance to reach at the location for performing plate bearing test. P2. Conduct site clearance. P3. Perform grubbing if any required.
CU5. Setup the Apparatus to conduct Plate Bearing Test.	P1. Identify plate bearing test apparatus P2. Assemble the apparatus.
CU6. Perform Plate Bearing Test at site.	P1. Note the size of plates used as per ASTM D 1194. P2. Apply the load as per available resources. P3. Record the observations to determine stress as per requirements. P4. Evaluate the bearing capacity of soil.
CU7. Prepare sample to conduct CBR test	P1. Collect the sample for soil, from source for CBR tests. P2. Prepare the specimen as per requirement for CBR tests in defined layers and number of blows.
CU8. Setup the Apparatus to conduct CBR Test.	P1. Identify CBR apparatus P2. Assemble the apparatus. P3. Check the assembly adjustments.



CU9. Identify bearing capacity using California bearing ratio test	P1. Place the soil/ subgrade sample. P2. Apply the load as per standards penetrations for soil. P3. Record observation data for soil P4. Interpret penetration and penetration load graphically P5. Evaluate CBR from graph P6. Interpret percentage CBR and dry density of sample graphically P7. Identify CBR graphically at required degree of compaction
CU10. Maintain safe work environment	P1. Use safe work procedures and personal protective equipment (PPE) to ensure personal safety and that of other personnel P2. Clean work area and collect, recycle or dispose of all waste in accordance with workplace procedures P3. Clean and check serviceability of test equipment before storage

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- K1. Introduction to bearing capacity of soil.
- K2. Introduction of penetration and grubbing
- K3. Factors affecting bearing capacity.
- K4. Types of penetration tests
- K5. Standard penetration test (SPT)
- K6. California bearing ratio (CBR) test
- K7. Cone Penetration Test (CPT).
- K8. Plate Bearing Test
- K9. Dilatometer Test (DMT)
- K10. Scala Test

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Perform standard penetration test and evaluate bearing capacity
- Perform standard plate bearing test and evaluate bearing capacity
- Perform standard CBR test and evaluate bearing capacity
- Differentiate between field and laboratory test



Tools and Equipment

1. Drilling Rig.
2. Split spoon (tube).
3. Drop hammer
4. Driving head (anvil).
5. Guiding rod.
6. Tripod.
7. Extension rods
8. Cylindrical mould
9. detachable extension collar
10. detachable perforated base plate
11. Spacer disc
12. Metal rammer
13. Weights.
14. Loading
15. Metal penetration piston
16. Two dial gauges reading to 0.01 mm.
17. Sieves. 4.75 mm and 20 mm I.S. Sieves
18. mixing bowl
19. straight edge
20. scales soaking tank or pan
21. drying oven
22. filter paper
23. Containers.
24. Plate bearing test apparatus.



11.10. Concrete Technology

11.10.1 Test the Properties of Fresh Concrete

Overview: This competency standard covers the skills and knowledge required to check workability by slump cone, Check workability by compacting factor apparatus, prepare concrete cubes and cylinders vibrated and hand compacted hand mixed and machine mixed and with different water cement ratio.

Competency Units	Performance Criteria
CU-1 Perform the Slump Test	P1. Collect samples from a desired batch of concrete P2. Prepare the Samples as per standard guidelines P3. Select the appropriate apparatus as per requirements P4. Apply PPEs P5. Carry out the testing procedure as per standard guidelines of ASTM C-143 P6. Compute the results of the test P7. Prepare the test record sheet
CU-2 Perform the Compacting Factor Test	P1. Identify the apparatus. P2. Pour the concrete mix in Hooper's in proper sequence. P3. Weigh the concrete. P4. Fill the cylinder in specified layers P5. Weigh compacted concrete. P6. Calculate the compacting factor by using formula.
CU-3 Supervise the concrete pouring on site	P1. Check the temperature of the concrete P2. Inspect the structure to be concreted P3. Inspect the slump test values P4. Inspect the form work P5. Inspect the Bore Hole Depth as required P6. Check the length of concrete pouring pipes P7. Check the workability of concrete pump P8. Monitor the concreting procedure P9. Maintain the concrete record sheet

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:



- K1.** Explain Ingredients of Concrete
- K2.** Explain difference between good and bad concrete.
- K3.** Explain the factor influencing concrete properties
- K4.** State different factors affecting the workability of concrete.
- K5.** State the different recommended values of slumps for various conditions of placements.
- K6.** Explain different methods of mix design, transportation of fresh concrete it's placing and compaction.

Tool and equipment

- Concrete Drum Mixer
- Platform scale
- Slump Test Apparatus
- Compacting Factor Apparatus
- Mechanical Sieve Shaker
- Wheel Barrow
- Bucket
- Straight Edge
- Shovels with handle
- Spirit Level
- Mortar Pan
- Mixing Spoon Set
- Weigh balance
- Straight Edge
- Metallic Tape



11.10.2 Perform the Quality Tests on Fine Aggregates for Concrete

Overview: This competency standard covers the skills and knowledge required to perform the Gradation/Sieve Analysis of coarse Aggregates.

Competency Units	Performance Criteria
CU-1 Perform the Gradation Test	P1. Prepare the Samples as per standard guidelines P2. Select the appropriate Sieve Set as per requirements P3. Apply PPEs P4. Carry out the sieving procedure as per standard guidelines of AASHTO T-27 & ASTM C-125 P5. Compute the results of the test P6. Compute the Fineness Modulus P7. Prepare the test record sheet
CU-2 Perform the organic impurities test	P1. Prepare the Samples as per standard guidelines P2. Select the appropriate Sieve Set as per requirements P3. Apply PPEs P4. Carry out the testing procedure as per standard guidelines of AASHTO T-21 P5. Compute the results of the test P6. Prepare the test record sheet
CU-3 Perform the Sand equivalent test	P1. Prepare the Samples as per standard guidelines P2. Select the appropriate Sieve Set as per requirements P3. Apply PPEs P4. Carry out the testing procedure as per standard guidelines of AASHTO T-176 P5. Compute the results of the test P6. Prepare the test record sheet
CU-4 Compute the Specific Gravity, Unit Weight and OMC	P1. Prepare the Samples as per standard guidelines P2. Select the appropriate Sieve Set as per requirements P3. Apply PPEs P4. Carry out the testing procedure as per standard guidelines of AASHTO T-99 & T-180 P5. Compute the results of the test P6. Prepare the test record sheet



Knowledge & Understanding

The candidate must be able to demonstrate the underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

- K1.** Describe the gradation techniques
- K2.** NHA Specifications Manual 1998, American Association of State Highways and Transportation Officials (AASHTO) Manual M, R & ASTM Manuals
- K3.** Describe the AASHTO Specifications for the test
- K4.** Define specific gravity, unit weight
- K5.** Define fineness modulus
- K6.** Define organic materials

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Compute the fineness modulus
- Perform the organic impurities test
- Perform the Sand Equivalent Test
- Compute the Specific Gravity and Unit Weight

Tools and Equipment:

- Sieve Set
- Graduated Cylinder
- Sodium Sulphate
- Beaker
- Temping Rod
- Oven
- Brush
- Container
- pouring cylinder
- calibration container
- tray
- Pyconometer



11.10.3 Perform Quality tests on Coarse Aggregates for Concrete Mix Design

Overview: This competency standard covers the skills and knowledge required to conduct variety of quality tests over coarse aggregates.

Competency Units	Performance Criteria
CU-1 Prepare Samples for Petrography	P1. Select the quarry Site P2. Classify the quarry site as guided P3. Sketch a paper map of the quarry site P4. Collect the fresh sample from the quarry site P5. Transport the sample to the laboratory P6. Prepare the Fresh Samples as per standard guidelines P7. Handover the Samples for preparation of Thin Section Slides P8. Ensure the safety of the samples
CU-2 Perform the Gradation Test	P1. Prepare the Samples as per standard guidelines P2. Select the appropriate Sieve Set as per requirements P3. Apply PPEs P4. Carry out the sieving procedure as per standard guidelines of AASHTO T-27 P5. Compute the results of the test P6. Prepare the test record sheet
CU-3 Compute the Specific Gravity, Unit weight and Optimum Moisture content of the aggregate	P1. Prepare the test samples P2. Select the apparatus to be used P3. Apply PPEs P4. Ensure the workability of the apparatus P5. Conduct the test as per standard specifications of ASTM C127 P6. Compute the results of the test P7. Prepare the test record sheet
CU-4 Carry out Clay Lumps and Friable Particles Test	P1. Prepare the test samples P2. Select the apparatus to be used P3. Apply PPEs P4. Ensure the workability of the apparatus P5. Conduct the test as per standard specifications of AASHTO T-112 P6. Compute the results of the test



	P7. Prepare the test record sheet
CU-5 Perform the Soundness Test	P1. Prepare the test samples P2. Select the apparatus to be used P3. Apply PPEs P4. Ensure the workability of the apparatus P5. Conduct the test as per standard specifications of AASHTO T-104 P6. Compute the results of the test P7. Prepare the test record sheet
CU-6 Perform Flaky & Elongated Particles test	P1. Prepare the test samples P2. Select the apparatus to be used P3. Apply PPEs P4. Ensure the workability of the apparatus P5. Conduct the test as per standard specifications of ASTM D-4791-95 P6. Compute the results of the test P7. Prepare the test record sheet
CU-7 Perform the Los Angeles Abrasion Test for A & B class Material	P1. Prepare the test samples P2. Select the apparatus to be used P3. Apply PPEs P4. Ensure the workability of the apparatus P5. Conduct the test as per standard specifications of AASHTO T-96 P6. Compute the results of the test P7. Prepare the test record sheet
CU-8 Perform the Aggregate Impact Value Test	P1. Prepare the test samples P2. Select the apparatus to be used P3. Apply PPEs P4. Ensure the workability of the apparatus P5. Conduct the test as per standard specifications of ASTM C-131/C-131M P6. Compute the results of the test P7. Prepare the test record sheet



CU-9 Execute the Aggregate Crushing Value Test	P1. Prepare the test samples P2. Select the apparatus to be used P3. Apply PPEs P4. Ensure the workability of the apparatus P5. Conduct the test as per standard specifications of IS- 2386-4 P6. Compute the results of the test P7. Prepare the test record sheet
---	---

Knowledge & Understanding

The candidate must be able to demonstrate the underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

- K1.** Define the Aggregates
- K2.** State classification of aggregates according to nature of formation, size and shape
- K3.** State the characteristics of good fine and coarse aggregates
- K4.** Explain the fine aggregates (Fineness, impurities) and on coarse aggregates (sieve analysis, Flakiness, elongation and Specific gravity).
- K5.** Explain the AASHTO, ASTM and IS standards for AASHTO T-27, ASTM C127, AASHTO T-112, AASHTO T-104, ASTM D-4791-95, AASHTO T-96, ASTM C-131/C-131M, IS-2386-4
- K6.** Explain the effects of bulking of sand.
- K7.** Describe importance of gradation of aggregates.
- K8.** Explain the procedures of Petrography and its importance
- K9.** Describe the test procedures for Optimum moisture content, Specific Gravity & Unit weight
- K10.** Define the Abrasion and explain the process of Los Angeles Abrasion Test
- K11.** Describe the test procedures for Soundness Test
- K12.** Describe the test procedures for Aggregate Crushing value & Aggregate impact Value Tests
- K13.** Explain the importance of blending process of coarse aggregates
- K14.** Define quarry, quarrying and its types.
- K15.** Define aggregate crushing value and impact value.
- K16.** Explain the importance of test for road construction.

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Prepare the samples for the thin section slides
- Perform the Los Angeles Abrasion Test



- Perform Soundness Test
- Perform Aggregate Impact Value Test
- Perform Aggregate Crushing Value Test
- Perform Sieve Analysis
- Compute Unit Weight, Specific Gravity and OMC
- Perform the Flaky and elongated Particles test
- Perform the Friable Particles and Clay Lumps Test

Tools and Equipment:

Following tools and equipment are required to fulfill the execution needs of the tasks under this competency standard.

- NHA Specifications Manual 1998, American Association of State Highways and Transportation Officials (AASHTO) Manual M, R & ASTM Manuals
- Sieve Set
- PPEs
- File
- Shovel
- Rubber Hammer
- Temping Rod
- Los Angeles Abrasion Machine with spherical steel balls
- Oven
- Funnel
- Scale
- Graduated Cylinder
- Weighing balance
- Container
- Brush
- Wire bucket
- Plastic bucket
- Specific gravity Test apparatus
- Wire mesh basket
- Chemical solution (sodium sulphate, magnesium sulphate)
- Length gauge and thickness gauge
- Impact value apparatus



- Sieve set
- Hollow cylinder
- Base plate
- Cylinder
- Temping rod
- Compression machine
- Plunger
- Sieve shaker



11.10.4 Perform quality tests for Cement

Overview: This competency standard covers the skills and knowledge required to perform the Gradation/Sieve Analysis of coarse Aggregates.

Competency Units	Performance Criteria
CU-1 Check fineness of cement	P1. Take standard weight of cement sample P2. Sieve the sample on standard sieve. P3. Weigh residue retained P4. Find fineness as per standard Guidelines of ASTM C-786
CU-2 Prepare cement paste of standard consistence Test	P1. Identify the apparatus P2. Clean the tools P3. Weigh cement sample P4. Prepare cement paste and fill moulds. P5. Place the mould under Vicat apparatus. P6. Adjust zero reading P7. Drop the plunger and note reading till final value P8. Record the value of consistence
CU-3 Find out Initial setting time	P1. Weigh cement sample P2. Prepare paste of cement. P3. Start the stop watch. P4. Fill the molds P5. Put the mold under vicat apparatus. P6. Drop the needle and note reading till final value is attained. P7. Record initial setting time.
CU-4 Find out final setting time	P1. Replace the needle with the needle having circular attachment P2. Note the time when needle leave the impression only. Record final setting time
CU-5 Find soundness of cement	P1. Take sample. P2. Make paste with standard %age of water. P3. Fill the split cylinder in specified manner. P4. Measure distance between legs of apparatus after 24 hrs. P5. Put the sample in water and boil it for 3 hrs. P6. Find soundness by formula
CU-6 Find compressive strength of cement	P1. Measure the cement and sand by weight. P2. Mix the material thoroughly.



	P3. Add specified %age of water P4. Mix it for specific time. P5. Fill cube mold in specific manner. P6. Place the sample in atmosphere for specific time and then dip in fresh water. P7. Test the samples after 3,7, and 14 days P8. Record readings. P9. Plot the graph.
CU-7 Find tensile strength of cement with Briquette test	P1. Prepare cement paste with standard quantities. P2. Fill the molds for 3 and 7 days. P3. Perform test on samples. P4. Record readings. P5. Plot the graph.

Knowledge & Understanding

The candidate must be able to demonstrate the underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

- K1.** Explain the properties of Cement
- K2.** Explain types of cement
- K3.** Define fineness of cement
- K4.** Define soundness of cement.
- K5.** Define initial and final setting time of time.
- K6.** Define consistency of cement and Explain test procedure.
- K7.** Explain the role of chemicals in setting process and effects on strength due to variance in quantity in cement
- K8.** Explain the various properties (i.e. initial and final setting time. Soundness of cement, Compression strength of cement and Tensile strength of cement etc.

Critical Evidence(s) required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Observation and calculation sheet to determine fineness of cement.
- Check the consistence of cement sample.
- Check soundness of cement.



- Check initial and final setting time.
- Capable to check compressive and tensile strength.

Tools and Equipment

- BS-170 Sieve
- Sieve shaker
- Vicat Apparatus
- Le-chatlier Apparatus.
- Briquet Apparatus.
- Briquet Mold
- Digital Balance
- GI Tray
- Spatula
- Knife edge
- Digital Stop Watch
- Compression testing machine
- UTM
- Drying oven
- Glass plate
- File with record sheet



11.10.5 Perform Destructive Tests on Hardened Concrete

Overview: This competency standard covers the skills and knowledge required to check find out compression strength of concrete using cubes and cylinders, perform modulus of rupture test on standard size beams, Perform Split cylinder test,

Competency Units	Performance Criteria
CU-1 Calculate compressive strength of concrete (1:2:4) using cubes and cylinders	P1. Measure the cement and sand by weight. P2. Mix the material thoroughly. P3. Add specified %age of water P4. Fill mold in specific manner. P5. Place the sample in atmosphere for specific time, then dip in fresh water. P6. Test the samples after 3,7,14, and 28 days P7. Record readings. P8. Plot the graph.
CU-2 Perform modulus of rupture test on standard size beams.	P1. Prepare the sample of concrete beam as per specification P2. Place the specimen on loading points. P3. Apply load at a constant rate. P4. Measure the cross section of the tested specimen at each end and at center to calculate average depth and height. P5. Calculate Flexural strength by using formula.
CU-3 Perform Split cylinder test	P1. Prepare the sample of concrete cylinder as per specifications. P2. Record the weight and dimensions of sample. P3. Place the specimen on compression testing machine With ply wood strips above and below. P4. Apply the continuous load within the range of 0.72 to 1.4 Mpa / Min. P5. Observe the failure pattern P6. Record the Flexural strength.

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- K1.** Explain Ingredients of Concrete
- K2.** Explain difference between good and bad concrete.
- K3.** Explain the factor influencing concrete properties



- K4.** State different factors affecting the workability of concrete.
- K5.** State the different recommended values of slumps for various conditions of placements.
- K6.** Describe the compressive strength of cube and Cylinder,
- K7.** Explain the Tensile strength (split cylinder test), and Flexural strength (Beam test),
- K8.** Describe non-destructive tests
- K9.** Explain different methods of mix design, transportation of fresh concrete its placing and compaction.
- K10.** Explain the importance of modulus of rupture and explain the procedure of modulus of rupture test.
- K11.** Explain the importance of split tensile strength
- K12.** Explain the procedure of split tensile strength test.

Tool and equipment

- Concrete Drum Mixer
- Platform scale
- Molds 4", 6"
- Concrete cylinder 6" diameter
- Vibrating Table
- Wheel Barrow
- Bucket
- Straight Edge
- Shovels with handle
- Spirit Level
- Mortar Pan
- Mixing Spoon Set
- Weigh balance
- Straight Edge
- Metallic Tape
- Caping Compound/Pads
- Caping Molds
- Compression testing machine
- Plywood
- File
- PPEs



11.10.6 Evaluate Concrete Mix Design

Overview: This competency standard covers the skills and knowledge required to design and evaluate trial batches of concrete mixture.

Competency Units	Performance Criteria
CU-1 Perform quality tests over coarse aggregate	P1. Prepare the test samples P2. Select the apparatus to be used P3. Arrange Apparatus as per requirements P4. Apply PPEs P5. Ensure the workability of the apparatuses P6. Conduct the test as per standard specifications of AASHTO, ASTM P7. Compute the results of the test P8. Prepare the test record sheet
CU-2 Perform the quality tests over fine aggregates	P1. Prepare the test samples P2. Select the apparatus to be used P3. Arrange Apparatus as per requirements P4. Apply PPEs P5. Ensure the workability of the apparatuses P6. Conduct the test as per standard specifications of AASHTO, ASTM P7. Compute the results of the test P8. Prepare the test record sheets
CU-3 Perform the quality tests over Cement	P1. Prepare the test samples P2. Select the apparatus to be used P3. Arrange Apparatus as per requirements P4. Apply PPEs P5. Ensure the workability of the apparatuses P6. Conduct the test as per standard specifications of AASHTO, ASTM P7. Compute the results of the test P8. Prepare the test record sheets
CU-4 Perform quality tests on water	P1. Prepare the test samples P2. Select the apparatus to be used P3. Arrange Apparatus as per requirements



	P4. Apply PPEs P5. Ensure the workability of the apparatuses P6. Conduct the PH and Specific Gravity tests P7. Compute the results of the test P8. Prepare the test record sheets
CU-5 Prepare Trial batch of concrete mix design	P1. Arrange the materials as per the Batching summary sheet P2. Weigh the desired amounts of materials P3. Perform test run on the mixture machine P4. Ensure the workability of the mixer machine P5. Prepare the concrete mixture P6. Ensure the standard specifications during mixing procedure P7. Perform the Slump test P8. Fill up the concrete cylinders P9. Perform concrete compressive strength test for 7 & 28 days P10. Compute the test results P11. Fill up the Concrete mix design summary sheet P12. Prepare the record sheet P13. Submit the record sheets for approval

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge to,

- K1.** Explain the working of Concrete mixer machine (Automatic and Manual)
- K2.** Explain different quality tests carried out for concrete Mix design
- K3.** Describe the mixing , transporting and pouring procedure of concrete.
- K4.** Define concrete mix design.
- K5.** Explain test procedures for water, cement, coarse and fine aggregate.
- K6.**

Critical Evidence(s) required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Perform calculations for concrete mix design

Tools and Equipment



- PPEs
- Multimeter
- Circuit Diagrams for Plants
- Digital Balance
- Digital Thermometer
- GI Tray
- Spatula
- Knife edge
- Test equipment
- Digital Stop Watch
- File



11.11. Water and Waste Water Testing

11.11.1 Determine the inorganic matters in water and wastewater.

Overview: This competency standard covers the skills and knowledge required to determine the pH, Turbidity, Acidity, Alkalinity, Chlorides, Nitrogen, Sulfur, Heavy metals in water and waste water as per *Standard Method for the Examination of Water and Waste water*.

Competency Units	Performance Criteria
CU1. CU-1. Collect, Transport and Prepare the samples for determination of organic chemicals of water and wastewater	P1. Locate sampling site. P2. Assemble required equipment P3. Check operations of all sampling equipment & accessories. P4. Decontaminate the sample container and sampling tools P5. Collect samples according to sampling plan & standard sampling procedures P6. Take photos/snaps of sampling sites and samples. P7. Record all information and label samples in accordance with traceability requirements. P8. Transport samples from site to lab in accordance with standards
CU-2. Determine pH of water and wastewater as per Standard Method for the Examination of Water and Wastewater. .	P1. Prepare apparatus to determining pH of Water and Wastewater. P2. Prepare the Samples as per standard guidelines P3. Identify chemicals to be used as reagents. P4. Perform test as per standard procedure. P5. Record the results of the test. P6. Compare the test results with NEQS P7. Prepare the test record sheet
CU-3. Determine Turbidity of water and wastewater as per Standard Method for the Examination of Water and Wastewater.	P1. Prepare apparatus to determining turbidity. P2. Prepare the Samples as per standard guidelines P3. Identify chemicals to be used as reagents. P4. Perform test as per standard procedure. P5. Record the results of the test. P6. Compare the test results with NEQS P7. Prepare the test record sheet



CU-4. Determine Acidity of water and wastewater as per Standard Method for the Examination of Water and Wastewater.	P1. Prepare apparatus for determining acidity as per Standard Method for the Examination of Water and Wastewater. P2. Prepare the Samples as per standard guidelines P3. Identify chemicals to be used as reagents. P4. Perform test as per standard procedure. P5. Record the results of the test. P6. Compare the test results with NEQS P7. Prepare the test record sheet
CU-5. Determine Alkalinity of water and wastewater as per Standard Method for the Examination of Water and Wastewater.	P1. prepare apparatus to determining alkalinity. P2. Prepare the Samples as per standard guidelines P3. Identify chemicals to be used as reagents. P4. Perform test as per standard procedure. P5. Record the results of the test. P6. Compare the test results with NEQS P7. Prepare the test record sheet
CU-6. Determine Chlorides of water and wastewater as per Standard Method for the Examination of Water and Wastewater.	P1. prepare apparatus for determining chlorides. P2. Prepare the Samples as per standard guidelines P3. Identify chemicals to be used as reagents. P4. Perform test as per standard procedure. P5. Record the results of the test. P6. Compare the test results with NEQS. P7. Prepare the test record sheet.
CU-7. Determine Sulfur of water and wastewater as per Standard Method for the Examination of Water and Wastewater.	P1. prepare apparatus to determining sulphur. P2. Prepare the Samples as per standard guidelines P3. Identify chemicals to be used as reagents. P4. Perform test as per standard procedure. P5. Record the results of the test. P6. Compare the test results with NEQS. P7. Prepare the test record sheet.
CU-8. Determine Heavy metals of water and wastewater as per Standard Method for the Examination of Water and Wastewater.	P1. prepare apparatus to determining Heavy metals. P2. Prepare the Samples as per standard guidelines P3. Identify chemicals to be used as reagents. P4. Perform test as per standard procedure. P5. Record the results of the test. P6. Compare the test results with NEQS.



	P7. Prepare the test record sheet.
CU-9. Maintain a safe work environment	P1. Use safe work procedures. P2. Adopt personal protective equipment (PPE) P3. Minimize generation of wastes and environmental impacts of testing P4. Collect or dispose of all waste in accordance with environmental/quarantine requirements and workplace procedures P5. Place store equipment properly P6. Back-up samples in accordance with workplace procedures

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard.

This includes the knowledge of:

- K1. Brief on Inorganic Chemicals (pH, Turbidity, Acidity, Alkalinity, Chlorides, Nitrogen, Sulfur, Heavy metals) in water and wastewater.
- K2. Explain Principles of Inorganic matter
- K3. Apparatus used in experiments
- K4. Explain Reagents used in experiments
- K5. Precautions
- K6. Describe Performance Procedure
- K7. Explain Performance Techniques.
- K8. National Environmental Quality Standards
- K9. Knowledge of Personal Protective Equipment (PPE)

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Report on determination of inorganic chemicals.

Tools and Equipment

1. pH meter
2. Beaker
3. Turbidity meter
4. Burette
5. Pipette



6. Erlenmeyer flasks
7. Indicator solutions

Reagent:

Buffers Solutions/reagents as per Standard Method for the Examination of Water and Wastewater



11.11.2 Determine the Organic Matters in water and wastewater.

Overview: This competency standard covers the skills and knowledge required to determine the Bio-chemical Oxygen Demand, Chemical Oxygen Demand and Total Organic carbon in water and wastewater as per **Standard Method for the Examination of Water and Wastewater**.

Competency Units	Performance Criteria
CU1. Collect, Transport and Prepare the samples for determination of organic chemicals of water and wastewater	P1. Locate Sample Site P2. Access relevant job instructions from Standard Method for the Examination of Water and Wastewater. P3. Assemble all required equipment and reagents. P4. Collect samples from site and preserve with labeling (including location, documentation and holding time) in accordance with appropriate test method P5. Transport samples from site to lab in accordance with standards
CU2. Determine Chemical Oxygen Demand (COD) in water and wastewater as per Standard Method for the Examination of Water and Wastewater.	P1. Prepare apparatus for determining COD as per Standard Method for the Examination of Water and Wastewater. P2. Prepare the Samples as per standard guidelines P3. Identify chemicals to be used as reagents. P4. Perform test as per standard procedure. P5. Record the results of the test. P6. Compare the test results with NEQS P7. Prepare the test record sheet
CU3. Determine Total Organic Carbon (TOC) in water and wastewater as per Standard Method for the Examination of Water and Wastewater	P1. Prepare apparatus for determining TOC as per Standard Method for the Examination of Water and Wastewater. P2. Prepare the Samples as per standard guidelines P3. Identify chemicals to be used as reagents. P4. Perform test as per standard procedure. P5. Record the results of the test. P6. Compare the test results with NEQS P7. Prepare the test record sheet
CU4. Maintain a safe work environment	P1. Use safe work procedures and personal protective equipment (PPE) to ensure personal safety and that of others P2. Minimize generation of wastes and environmental impacts of testing



	P3. Collect and/or dispose of all waste in accordance with environmental/quarantine requirements and workplace procedures P4. Care for and store equipment, used test pieces and back-up samples in accordance with workplace procedures
--	--

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard.

This includes the knowledge of:

- K1. Brief on organic matter (Bio-chemical Oxygen Demand, Chemical Oxygen Demand and Total Organic carbon) in water and wastewater.
- K2. Explain Principles of organic matter
- K3. Apparatus used in experiments
- K4. Explain Reagents used in experiments
- K5. Precautions
- K6. Describe Performance Procedure
- K7. Explain Performance Techniques.
- K8. National Environmental Quality Standards
- K9. Knowledge of Personal Protective Equipment (PPE)

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Report on determination of organic matters.

Tools and Equipment

1. BOD bottle
2. Beaker (250 ml)
3. Measuring cylinder
4. Dropper
5. Stirrer

Reagent:

Buffers Solutions/reagents as per Standard Method for the Examination of Water and Wastewater



11.11.3 Determine the of Physical Characteristics in water and wastewater.

Overview: This competency standard covers the skills and knowledge required to determine the Total Solids, Dissolved Solids and Suspended Solids in water and wastewater as per **Standard Method for the Examination of Water and Wastewater**

Competency Units	Performance Criteria
CU1. Collect, Transport and Prepare of samples for determination of inorganic chemicals of water and wastewater.	P1. Locate sampling site. P2. Assemble required equipment P3. Check operations of all sampling equipment & accessories. P4. Decontaminate the sample container and sampling tools P5. Collect samples according to sampling plan & standard sampling procedures P6. Take photos/snaps of sampling sites and samples. P7. Record all information and label samples in accordance with traceability requirements. P8. Transport samples from site to lab in accordance with standards
CU2. Determine Total Solids (TS) in water and wastewater as Standard Method for the Examination of Water and Wastewater.	P1. Prepare apparatus for determining Total Solids for Water and Wastewater. P2. Prepare the Samples as per standard guidelines P3. Identify chemicals to be used as reagents. P4. Perform test as per standard procedure. P5. Record the results of the test. P6. Compare the test results with NEQS P7. Prepare the test record sheet
CU3. Determine Total Dissolved Solids (TDS) in water and wastewater as per Standard Method for the Examination of Water and Wastewater.	P1. Prepare apparatus for determining Dissolved Solids of Water and Wastewater. P2. Prepare the Samples as per standard guidelines P3. Identify chemicals to be used as reagents. P4. Perform test as per standard procedure. P5. Record the results of the test. P6. Compare the test results with NEQS P7. Prepare the test record sheet



CU4. Determine Total Suspended Solids (TSS) in water and wastewater as per Standard Method for the Examination of Water and Wastewater.	P1. Prepare apparatus for determining Suspended Solids for Examination of Water and Wastewater. P2. Prepare the Samples as per standard guidelines P3. Identify chemicals to be used as reagents. P4. Perform test as per standard procedure. P5. Record the results of the test. P6. Compare the test results with NEQS P7. Prepare the test record sheet
CU5. Maintain a safe work environment	P1. Use PPEs and apply safe work practices P2. Rehabilitate sampling site and Minimize generation of wastes P3. Collect waste material P4. Dispose waste Material in accordance with environmental / quarantine requirements and workplace procedures P5. Clean the equipment P6. Check serviceability of equipment before storage

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard.

This includes the knowledge of:

- K1. Brief on physical characteristics (Total Solids, Dissolved Solids and Suspended Solids) in water and wastewater.
- K2. Explain Principles of physical characteristics.
- K3. Apparatus used in experiments
- K4. Explain Reagents used in experiments
- K5. Precautions
- K6. Describe Performance Procedure
- K7. Explain Performance Techniques.
- K8. National Environmental Quality Standards
- K9. Knowledge of Personal Protective Equipment (PPE)

Critical Evidence(s) Required



The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Report on determination of physical characteristics.

Tools and Equipment

1. Balance
2. Beaker
3. Measuring Cylinder
4. Filter paper
5. Funnel
6. Dropper



11.11.4 Determine the Hardness in Water and Wastewater.

Overview: This competency standard covers the skills and knowledge required to determine the Hardness in Water and Wastewater as per **Standard Method for the Examination of Water and Wastewater**.

Competency Units	Performance Criteria
CU1. Collect, Transport and Prepare the samples for determination of inorganic chemicals of water and wastewater	P1. Locate sampling site. P2. Assemble required equipment P3. Check operations of all sampling equipment & accessories. P4. Decontaminate the sample container and sampling tools P5. Collect samples according to sampling plan & standard sampling procedures P6. Take photos/snaps of sampling sites and samples. P7. Record all information and label samples in accordance with traceability requirements. P8. Transport samples from site to lab in accordance with standards
CU2. determine the Hardness in water and wastewater as per Standard Method for the Examination of Water and Wastewater.	P1. Prepare apparatus for determining Hardness as per Standard Method for the Examination of Water and Wastewater. P2. Prepare the Samples as per standard guidelines P3. Identify chemicals to be used as reagents. P4. Perform test as per standard procedure. P5. Record the results of the test. P6. Compare the test results with NEQS P7. Prepare the test record sheet
CU3. Maintain a safe work environment	P1. Use PPEs and apply safe work practices P2. Rehabilitate sampling site and Minimize generation of wastes P3. Collect waste material P4. Dispose waste Material in accordance with environmental / quarantine requirements and workplace procedures P5. Clean the equipment P6. Check serviceability of equipment before storage

Knowledge & Understanding



The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard.

This includes the knowledge of:

- K1. Brief on Hardness in water and wastewater.
- K2. Explain Principles of hardness.
- K3. Apparatus used in experiments
- K4. Explain Reagents used in experiments
- K5. Precautions
- K6. Describe Performance Procedure
- K7. Explain Performance Techniques.
- K8. National Environmental Quality Standards
- K9. Knowledge of Personal Protective Equipment (PPE)

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Report on determination of hardness.

Tools and Equipment

- 1. Beaker
- 2. Measuring cylinder
- 3. Dropper
- 4. Stirrer
- 5. Auto-titration device

Reagent:

Buffers Solutions/reagents as per Standard Method for the Examination of Water and Wastewater.



11.11.5 Determine the bacteriological impurities in Water and Wastewater.

Overview: This competency standard covers the skills and knowledge required to determine the Hardness in Water and Wastewater as per **Standard Method for the Examination of Water and Wastewater**.

Competency Units	Performance Criteria
CU1. Collect, Transport and Prepare the samples for determination of inorganic chemicals of water and wastewater	P1. Locate sampling site. P2. Assemble required equipment P3. Check operations of all sampling equipment & accessories. P4. Decontaminate the sample container and sampling tools P5. Collect samples according to sampling plan & standard sampling procedures P6. Take photos/snaps of sampling sites and samples. P7. Record all information and label samples in accordance with traceability requirements. P8. Transport samples from site to lab in accordance with standards
CU2. Determine Pathogens in water and wastewater as per Standard Method for the Examination of Water and Wastewater.	P1. Prepare apparatus for determining Pathogens for water and Wastewater. P2. Prepare the Samples as per standard guidelines P3. Identify chemicals to be used as reagents. P4. Perform test as per standard procedure. P5. Record the results of the test. P6. Compare the test results with NEQS P7. Prepare the test record sheet
CU3. Maintain a safe work environment	P1. Use PPEs and apply safe work practices P2. Rehabilitate sampling site and Minimize generation of wastes P3. Collect waste material P4. Dispose waste Material in accordance with environmental / quarantine requirements and workplace procedures P5. Clean the equipment P6. Check serviceability of equipment before storage

Knowledge & Understanding



The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard.

This includes the knowledge of:

- K1.** Brief on bacteriological impurities in water and wastewater.
- K2.** Explain Principles of hardness.
- K3.** Apparatus used in experiments
- K4.** Explain Reagents used in experiments
- K5.** Precautions
- K6.** Describe Performance Procedure
- K7.** Explain Performance Techniques.
- K8.** National Environmental Quality Standards
- K9.** Knowledge of Personal Protective Equipment (PPE)

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Report on determination of bacteriological impurities.

➤ Tools and Equipment

- 1. Beaker
- 2. Measuring cylinder
- 3. Dropper
- 4. Stirrer
- 5. Auto-titration device



11.12. Soft Skills

11.12.1 Manage meetings

Overview: This unit describes the skills and knowledge required to manage a range of meetings including overseeing the meeting preparation processes, chairing meetings, organizing the minutes and reporting meeting outcomes. It applies to individuals employed in a range of work environments who are required to organize and manage meetings within their workplace, including conducting or managing administrative tasks in providing agendas and meeting material. They may work as senior administrative staff or may be individuals with responsibility for conducting and chairing meetings in the workplace.

Unit of Competency	Performance Criteria
1. Prepare for meetings	P1 Develop agenda in line with stated meeting purpose P2 Ensure style and structure of meeting are appropriate to its purpose P3 Identify meeting participants and notify them in accordance with organizational procedures P4 Confirm meeting arrangements in accordance with requirements of meeting P5 Dispatch meeting papers to participants within designated timelines
2. Conduct meetings	P1 Chair meetings in accordance with organizational requirements, agreed conventions for type of meeting and legal and ethical requirements P2 Conduct meetings to ensure they are focused, time efficient and achieve the required outcomes P3 Ensure meeting facilitation enables participation, discussion, problem-solving and resolution of issues P4 Brief minute-taker on method for recording meeting notes in accordance with organizational requirements and conventions for type of meeting
3. Follow up meetings	P1 Check transcribed meeting notes to ensure they reflect a true and accurate record of the meeting and are formatted in accordance with organizational procedures and meeting conventions P2 Distribute and store minutes and other follow-up documentation within designated timelines, and according to organizational requirements P3 Report outcomes of meetings as required, within designated timelines



Knowledge & Understanding

K1: outline meeting terminology, structures, arrangements

K2: outline responsibilities of the chairperson and explain group dynamics in relation to managing meetings

K3: describe options for meetings including face-to-face, teleconferencing, web-conferencing and using webcams

K4: identify the relevant organizational procedures and policies regarding meetings, chairing and minutes including identifying organizational formats for minutes and agendas.

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) to be competent in this competency standard:

A person who demonstrates competency in this unit must be able to provide evidence of the ability to manage meetings. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- apply conventions and procedures for formal and informal meetings including:
 - developing and distributing agendas and papers
 - identifying and inviting meeting participants
 - organizing and confirming meeting arrangements
 - running the meeting and following up
- organize, take part in and chair a meeting
- record and store meeting documentation
- Follow organizational policies and procedures.



11.12.2 Manage workforce planning

Overview: This unit describes the skills and knowledge required to manage planning in relation to an organization's workforce including researching requirements, developing objectives and strategies, implementing initiatives and monitoring and evaluating trends. It applies to individuals who are human resource managers or staff members with a role in a policy or planning unit that focuses on workforce planning.

Unit of Competency	Performance Criteria
1. Research workforce requirements	P1 Review current data on staff turnover and demographics P2 Assess factors that may affect workforce supply P3 Establish the organization's requirements for a skilled and diverse workforce
2. Develop workforce objectives and strategies	P1 Review organizational strategy and establish aligned objectives for modification or retention of the workforce P2 Consider strategies to address unacceptable staff turnover, if required P3 Define objectives to retain required skilled labor P4 Define objectives for workforce diversity and cross-cultural management P5 Define strategies to source skilled labor P6 Communicate objectives and rationale to relevant stakeholders P7 Obtain agreement and endorsement for objectives and establish targets P8 Develop contingency plans to cope with extreme situations
3. Implement initiatives to support workforce planning objectives	P1 Implement action to support agreed objectives for recruitment, training, redeployment and redundancy P2 Develop and implement strategies to assist workforce to deal with organizational change P3 Develop and implement strategies to assist in meeting the organization's workforce diversity goals P4 Implement succession planning system to ensure desirable workers are developed and retained P5 Implement programs to ensure workplace is an employer of choice
4. Monitor and evaluate workforce trends	P1 Review workforce plan against patterns in exiting employee and workforce changes P2 Monitor labor supply trends for areas of over- or under-supply in the



	external environment P3 Monitor effects of labor trends on demand for labor P4 Survey organizational climate to gauge worker satisfaction P5 Refine objectives and strategies in response to internal and external changes and make recommendations in response to global trends and incidents P6 Regularly review government policy on labor demand and supply P7 Evaluate effectiveness of change processes against agreed objectives
--	---

Knowledge & Understanding

- K1: explain current information about external labor supply relevant to the specific industry or skill requirements of the organization
- K2: outline industrial relations relevant to the specific industry
- K3: describe labor force analysis and forecasting techniques

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) to be competent in this competency standard:

A person who demonstrates competency in this unit must be able to provide evidence of the ability to manage workforce planning. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- review and interpret information from a range of internal and external sources to identify:
 - current staff turnover and demographics
 - labor supply trends factors that may affect workforce supply
 - organization's workforce requirements objectives and strategies
- manage workforce planning including developing, implementing, monitoring and reviewing strategies to meet workforce needs
- review relevant trends and supply and demand factors that will impact on an organization's workforce



- Develop a workforce plan that includes relevant research and specific strategies to ensure access to a skilled and diverse workforce.



11.12.3 Undertake project work

Overview: This unit describes the skills and knowledge required to undertake a straightforward project or a section of a larger project. It covers developing a project plan, administering and monitoring the project, finalizing the project and reviewing the project to identify lessons learned for application to future projects. This unit applies to individuals who play a significant role in ensuring a project meets timelines, quality standards, budgetary limits and other requirements set for the project.

Unit of Competency	Performance Criteria
1. Define project	P1 Access project scope and other relevant documentation P2 Define project stakeholders P3 Seek clarification from delegating authority of issues related to project and project parameters P4 Identify limits of own responsibility and reporting requirements P5 Clarify relationship of project to other projects and to the organization's objectives P6 Determine and access available resources to undertake project
2. Develop project plan	P1 Develop project plan in line with the project parameters P2 Identify and access appropriate project management tools P3 Formulate risk management plan for project, including Work Health and Safety (WHS) P4 Develop and approve project budget P5 Consult team members and take their views into account in planning the project P6 Finalize project plan and gain necessary approvals to commence project according to documented plan
3. Administer and monitor project	P1 Take action to ensure project team members are clear about their responsibilities and the project requirements P2 Provide support for project team members, especially with regard to specific needs, to ensure that the quality of the expected outcomes of the project and documented time lines are met P3 Establish and maintain required recordkeeping systems throughout the project P4 Implement and monitor plans for managing project finances, resources and quality P5 Complete and forward project reports as required to stakeholders



	P6 Undertake risk management as required to ensure project outcomes are met P7 Achieve project deliverables
4. Finalize project	P1 Complete financial recordkeeping associated with project and check for accuracy P2 Ensure transition of staff involved in project to new roles or reassignment to previous roles P3 Complete project documentation and obtain necessary sign-offs for concluding project

Knowledge & Understanding

K1: give examples of project management tools and how they contribute to a project

K2: outline types of documents and other sources of information commonly used in defining the parameters of a project

K3: explain processes for identifying and managing risk in a project

K4: outline the organization's mission, goals, objectives and operations and how the project relates to them

K5: explain the organization's procedures and processes that are relevant to managing a project including:

- lines of authority and approvals
- quality assurance
- human resources
- budgets and finance
- recordkeeping
- reporting

Outline the legislative and regulatory context of the organization in relation to project work, including work health and safety (WHS) requirements.

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) to be competent in this competency standard:

A person who demonstrates competency in this unit must be able to provide evidence of the ability to undertake project work. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.



Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- define the parameters of the project including:
 - project scope
 - project stakeholders, including own responsibilities
 - relationship of project to organizational objectives and other projects
 - reporting requirements
 - resource requirements
- use project management tools to develop and implement a project plan including:
 - deliverables
 - work breakdown
 - budget and allocation of resources
 - timelines
 - risk management
 - recordkeeping and reporting
- consult and communicate with relevant stakeholders to generate input and engagement in planning, implementing and reviewing the project
- provide support to team members to enable them to achieve deliverables and to transition them as appropriate at completion of the project
- finalize the project including documentation, sign-offs and reporting Review and document the project outcomes.



11.12.4 Identify and communicate trends in career development

Overview: This unit describes the skills and knowledge required to conduct research to identify and communicate career trends. It establishes the need to interact professionally with others in assessing career needs, to effectively assist clients identify competencies they require for a career and employability in a given context. It also examines how to maintain quality of career development services and professional practice. It applies to individuals seeking to identify and communicate trends in career development.

Unit of Competency	Performance Criteria
1. Research and confirm career trends	P1 Apply knowledge of changing organizational structures, lifespan of careers and methods of conducting work search, recruitment and selection processes P2 Analyze changing worker and employer issues, rights and responsibilities in context of changing work practices P3 Examine importance of quality careers development services P4 Maintain all research, documentation, sources and references (electronic or physical) to a high degree of currency and relevance P5 Analyze implications of relevant policy, legislation, professional codes of practice and national standards relating to worker and employer issues P6 Research changes and trends in theory of career development counseling and practice P7 Confirm clusters, levels and combinations of transferable employability skills and preferences that may open employment options spanning more than one occupation or career pathway
2. Assess and confirm ongoing career development needs of target group	P1 Analyze history and records in assessing needs of target group P2 Assess success of previous career development services and techniques used for individual or target group P3 Deploy other means to investigate appropriate care and counseling approaches as required P4 Maintain privacy and security of all data, research and personal records according to relevant policy, legislation, professional codes of practice and national standards P5 Establish existing work-life balance requirements, issues and needs
3. Maintain quality of career development	P1 Analyze and review relevance of career theories, models, frameworks



services and professional practice	and research for target group P2 Incorporate into career development services and professional practice, major changes and trends influencing workplace and career-related options and choices P3 Comply with all relevant policy, legislation, professional codes of practice and national standards that influence delivery of career development services
------------------------------------	---

Knowledge & Understanding

- K1: explain client care and counseling techniques and processes in the context of career development services
- K2: describe diversity and its potential effects on career choices
- K3: outline human psychological development and needs in relation to careers development
- K4: outline relevant policy, legislation, codes of practice and standards relevant to career development
- K5: explain recruitment and selection processes in the context of career development services
- K6: describe a range of data gathering and research techniques
- K7: explain techniques used to analyze trends.

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) to be competent in this competency standard:

A person who demonstrates competency in this unit must be able to provide evidence of the ability to identify and communicate trends in career development. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- research and analyze current economic, labor market, employment, career and vocational, educational and training trends
- identify choices and career development needs for individuals and target groups within a given context
- report and document management of research and career development materials
- Comply with all relevant local, state/territory and national legislation, policies and practices.



11.12.5 Work safely in an office environment

Overview: This unit describes the performance outcomes, skills and knowledge required to participate in workplace occupational health and safety (OHS) processes to protect workers own health and safety, and that of others.

Unit of Competency	Performance Criteria
1. Work safely	P1 Follow established safety procedures when conducting work P2 Carry out pre-start systems and equipment checks in accordance with workplace procedures
2. Implement workplace safety requirements	P1 Identify designated persons for reporting queries and concerns about safety in the workplace P2 Identify existing and potential hazards in the workplace, report them to designated persons and record them in accordance with workplace procedures P3 Identify and implement workplace procedures and work instructions for controlling risks P4 Report emergency incidents and injuries to designated persons
3. Participate in OHS consultative processes	P1 Contribute to workplace meetings, inspections or other consultative activities P2 Raise OHS issues with designated persons in accordance with organizational procedures P3 Take actions to eliminate workplace hazards or to reduce risks
4. Follow safety procedures	P1 Identify and report emergency incidents P2 Follow organizational procedures for responding to emergency incidents

Knowledge & Understanding

- K1: Explain responsibilities of employers and employees under relevant health and safety regulation
K2: describe emergency procedures including procedures for fires, accidents and evacuation
K3: outline commonly used hazard signs and safety symbols

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) to be competent in this competency standard:



A person who demonstrates competency in this unit must be able to provide evidence of the ability to participate in workplace OHS processes. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. The unit assessment must ensure the safety processes; hazards and risk are relevant to the area of work. Evidence of the following is essential:

- Accurately following all relevant safety procedures
- Identifying and reporting hazards to designated personnel
- Knowledge of relevant health and safety regulations
- Knowledge of relevant materials, equipment and work processes.



11.12.6 Develop workplace documents

Overview: This unit covers interpreting and composing a range of workplace documents from a number of sources. It includes interpreting written information for workplace purposes as well as planning, drafting and reviewing a basic document before writing the final version. The focus is on the content and structure of written materials and not on the use of computer technology

Unit of Competency	Performance Criteria
1. Interpret written information	P1 Read workplace materials to identify the subject and key information for using or reporting to others. P2 Read procedural manuals and codes of practice to locate specific information to carry out work functions in accordance with policy and standards. P3 Read a range of written materials to locate and select required information for summaries, short reports and responses to requests. P4 Identify the cultural context and prior knowledge required to interpret workplace information and obtain assistance when required. P5. Determine audience and purpose for the document P6 Seek assistance with interpretation of complex materials in accordance with organizational procedures.
2. Develop written materials	P1 Identify and comply with established requirements for a range of written materials in accordance with organizational procedures and standard templates. P2. Determine format and structure P3. Establish key points for inclusion P4. Identify organizational requirements P5. Establish method of communication P6. Establish means of communication
3. Draft document	P1 Develop draft document to communicate key points P2. Obtain and include any required additional information P3 Prepare written information in an accurate, concise and unambiguous manner that meets intended audience and organizational requirements.
4. Review document	P1 Check draft for suitability of tone for audience, purpose, format and communication style P2. Check draft for readability, grammar, spelling, sentence and



	paragraph construction and correct any inaccuracies or gaps in content. P3. Check draft for sequencing and structure P4. Check draft to ensure it meets organizational requirements P5. Ensure draft is proofread, where appropriate, by supervisor or colleague
5. Write final document	P1 Make and proofread necessary changes P2. Ensure document is sent to intended recipient within required time frames P3. File copy of document in accordance with organizational policies and procedures

Knowledge & Understanding

- K1: Explain the reading and writing procedures at a level to cope with a range of workplace materials
- K2: Explain the integration of information from a number of sources in order to generate meaning
- K3: Describe the ways to write and sequence paragraphs according to the required purpose of written material
- K4: Outline the linking ideas in written material through selection and use of words, grammatical structures, headings and punctuation appropriate to the purpose
- K5: Elaborate spelling, punctuation and grammar for workplace documents at an experienced level
- K6: Explain the response to diversity, including gender and disability
- K7: Explain the implementation of ergonomic requirements for office work
- K8: Explain the environmental policies such as those relating to paper use/wastage/recycling
- K9: Describe the preparation of general information and papers according to target audience
- K10: Elaborate the ways of proofreading and editing documents to ensure clarity of meaning and conformity to organizational requirements
- K11: Describe the problem-solving skills to determine document design and production processes
- K12: Explain the usage of resources to assist in document production, such as dictionary, thesaurus, templates, style sheets
- K13: Describe the ways to produce business letters, memos, job applications, resumes, meeting agendas and minutes
- K14: Explain the ways to fold and insert letters into a standard and window faced envelope.

Critical Evidence(s) Required



The candidate needs to produce following critical evidence(s) to be competent in this competency standard:

A person who demonstrates competency in this unit must be able to provide evidence of the ability to interpret written information for workplace purposes and

Plan draft and review a basic document before writing the final version.

The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Evidence of the following is essential:

- Producing a range of documents that accurately convey required information including single and multipage business letters, memos, job applications, resumes, meeting agendas and minutes.
- Using formatting suitable for intended audience
- Knowledge of organizational policies and procedures for document production



11.12.7 Maintain professionalism in the workplace

Overview: This unit of competency describes the outcomes required maintain a professional image in the workplace, including behaving ethically, demonstrating motivation, respecting timeframes and maintaining personal appearance.

Unit of Competency	Performance Criteria
1. Respect work timeframes	P1 Demonstrate punctuality in meeting, set working hours and times. P2 Utilize working hours only for working and follow company regulations. P3 Complete work tasks within deadlines according to order of priority P4 Supervisors are informed of any potential delays in work times or projects.
2. Maintain personal appearance and hygiene	P1 Clean hair, body and nails regularly. P2 Wear suitable cloths for the workplace, and respect local and cultural contexts P3 Meet specific company dress code requirements
3. Maintain adequate distance with colleagues and clients	P1 Respect personal space of colleagues and clients with reference to local customs and cultural contexts. P2 Keep sufficient distance from others P3 Avoid cross transmission of infections (especially through respiration).
4. Work in an ethical manner	P1 Follow company values/ethics codes of ethics and/or conduct, policies and guidelines. P2 Use company resources in accordance with company ethical standards. P3 Conduct personal behavior and relationships in accord with ethical standards and company policies. P4 Undertake work practices in compliance with company ethical standards, organizational policy and guidelines. P5 Instruct co-workers on ethical, lawful and reasonable directives. P6 Share company values/practices with co-workers using appropriate behavior and language. P7 Report work incidents/situations and/or resolved in accordance with company protocol/guidelines.

Knowledge & Understanding



- K1: Explain application of good manners and right conduct
- K2: Explain basic practices for oral and personal hygiene
- K3: Describe common products used for oral and personal hygiene
- K4: Outline the company code of conduct/values
- K5: Outline the Company regulations, performance and ethical standards
- K6: Explain work responsibilities/job functions
- K7: Describe communication skills
- K8: State workplace hygiene standards

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) to be competent in this competency standard:

A person who demonstrates competency in this unit must be able to provide evidence of the ability to maintain professionalism in the workplace .The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Evidence of the following is essential:

- clarify and affirm work values/ethics/concepts consistently in the workplace;
- comply with required working times;
- conduct work practices satisfactorily and consistently, in compliance with work ethical standards, organizational policy and guidelines;
- Develop suitable hygiene
- Keep adequate distance while interacting with colleagues and clients.



11.12.8 Organize schedules

Overview: This unit describes the skills and knowledge required to manage appointments and diaries for personnel within an organization, using manual and electronic diaries, schedules and other appointment systems. It applies to individuals employed in a range of work environments who provide administrative support to teams and individuals.

Unit of Competency	Performance Criteria
1. Establish schedule requirements	P1 Identify organizational requirements and protocols for diaries and staff planning tools P2 Identify organizational procedures for different types of appointments P3 Determine personal requirements for diary and schedule items for individual personnel P4 Establish appointment priorities and clarify in discussion with individual personnel
2. Manage schedules	P1 Identify recurring appointments and deadlines, and schedule these in accordance with individual and organizational requirements P2 Establish availability of attendees, and schedule new appointments in accordance with required timelines and diary commitments P3 Negotiate alternative arrangements and confirm when established appointments are changed P4 Record appointments and manage schedules in accordance with organizational policy and procedures

Knowledge & Understanding

- K1: identify the key provisions of relevant legislation, standards and codes that affect aspects of business operations or the achievement of team goals
- K2: describe organizational requirements for managing appointments for personnel within the organization
- K3: summarize the range of appointment systems that could be used
- K4: outline important considerations when managing the schedules of others.

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) to be competent in this competency standard:



A person who demonstrates competency in this unit must be able to provide evidence of the ability to organize schedules. The evidence should integrate employability skills with workplace tasks and job roles and verify competency is able to be transferred to other circumstances and environments.

Performance requirements

This competency is to be assessed using standard and authorized work practices, safety requirements and environmental constraints. Demonstrated evidence is required of the ability to:

- Appropriately manage the schedules of various individuals through a process of careful planning and negotiation.



11.13. Highway Material Testing

11.13.1 Determine the physical properties of the road metal

Overview: This competency standard covers the skills and knowledge required to determine the physical properties of road metals.

Competency Units	Performance Criteria
CU1. Prepare Samples for Petrography	P1 Select the quarry Site P2 Classify the quarry site as guided P3 Sketch a paper map of the quarry site P4 Collect the fresh sample from the quarry site P5 Transport the sample to the laboratory P6 Prepare the Fresh Samples as per standard guidelines P7 Handover the Samples for preparation of Thin Section Slides P8 Ensure the safety of the samples
CU2. Perform Flaky & Elongated Particles test of Road Metal	P1 Prepare the test samples P2 Select the apparatus to be used P3 Apply PPEs P4 Ensure the workability of the apparatus P5 Conduct the test as per standard specifications of ASTM D-4791-95 P6 Compute the results of the test
CU3. Compute the Specific Gravity and water absorption Road Metal	P1. Prepare the test samples P2. Select the apparatus to be used P3. Apply PPEs P4. Ensure the workability of the apparatus P5. Conduct the test as per standard specifications of ASTM C127 P6. Compute the results of the test P7. Prepare the test record sheet
CU4. Maintain a safe work environment	P1. Use defined safe work practices and personal protective equipment to ensure personal safety and that of others. P2. Clean all equipment, containers and work area according to workplace procedures P3. Collect and/or dispose of all waste in accordance with environmental requirements and workplace procedures



	P4. Clean and care all equipment and check serviceability of equipment before storage
--	--

Knowledge & Understanding

The candidate must be able to demonstrate the underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

- K1.** Define the Base and Sub-base
- K2.** Explain the flaky and elongated particles
- K3.** What is flakiness and elongation index?
- K4.** Explain the purpose to perform the Flaky and elongated particles Test
- K5.** Explain the flaky and elongated particle test as per standard specifications of ASTM D-4791-95
- K6.** Explain the procedure to generate the report.
- K7.** Explain Compute the Specific Gravity and water absorption of road Metal
- K8.** Explain the purpose to perform the Specific Gravity and water absorption Test
- K9.** Explain the Specific Gravity and water absorption test as per standard specifications of ASTM C127

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Prepare the samples for the thin section slides
- Compute Unit Weight, Specific Gravity and Water absorption
- Perform the Flaky and elongated Particles test
- Prepare flow diagram to perform Specific Gravity and Water absorption test

Tools and Equipment:

Following tools and equipment are required to fulfill the execution needs of the tasks under this competency standard.

- NHA Specifications Manual 1998, American Association of State Highways and Transportation Officials (AASHTO) Manual M, R & ASTM Manuals
- Sieve Set
- PPEs
- File
- Shovel
- Rubber Hammer



- Tempering Rod
- Oven
- Proportional Caliper Device
- Flakiness Gauge
- Funnel
- Scale
- Graduated Cylinder



11.13.2 Determine the Basic Properties of Road Metal

Overview: This competency standard covers the skills and knowledge required to Determine the basic Properties of Road Metal.

Competency Units	Performance Criteria
CU1. Prepare Samples for Petrography	P1 Select the quarry Site P2 Classify the quarry site as guided P3 Sketch a paper map of the quarry site P4 Collect the fresh sample from the quarry site P5 Transport the sample to the laboratory P6 Prepare the Fresh Samples as per standard guidelines P7 Handover the Samples for preparation of Thin Section Slides P8 Ensure the safety of the samples
CU2. Perform the Gradation Test	P1 Prepare the Samples as per standard guidelines P2 Select the appropriate Sieve Set as per requirements P3 Apply PPEs P4 Carry out the sieving procedure as per standard guidelines of AASHTO T-27 or ASTM C 136 P5 Compute the results of the test P6 Prepare the test record sheet
CU3. Compute the Bulk Density and Void ratio of the Road Metal	P1 Prepare the test samples P2 Select the apparatus to be used P3 Apply PPEs P4 Ensure the workability of the apparatus P5 Conduct the test as per standard specifications/ guidelines of ASTM C 29/C29M P6 Compute the results of the test P7 Prepare the test record sheet
CU4. Maintain a safe work environment	P1. Use defined safe work practices and personal protective equipment to ensure personal safety and that of others. P2. Clean all equipment, containers and work area according to workplace procedures P3. Collect and/or dispose of all waste in accordance with environmental requirements and workplace procedures P4. Clean and care all equipment and check serviceability of



	equipment before storage
--	--------------------------

Knowledge & Understanding

The candidate must be able to demonstrate the underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

- K1. Define the gradation of road metal
- K2. Explain the significance of the Gradation test
- K3. Explain the Procedure of Gradation tests as per the guidelines of AASHTO T-27 or ASTM C 136
- K4. Explain the Test result pertaining to Gradation test
- K5. Explain the Bulk density and Void ratio of the road metal
- K6. Explain the importance to perform Bulk density and void ratio test
- K7. Explain the procedure of Bulk density and Void ratio test as per guidelines of ASTM C 29/C29M
- K8. Explain the result pertaining to Bulk density and Void ratio test.
- K9. Explain the importance of blending process of coarse aggregates
- K10. Explain the importance to maintain the safe environment while performing the Tests

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Prepare the samples for the thin section slides
- Perform the Gradation Test
- Perform bulk density and void ratio Test
- Prepare the Process flow diagram related to Gradation test
- Prepare process flow diagram related to bulk density and void ratio test.

Tools and Equipment:

Following tools and equipment are required to fulfill the execution needs of the tasks under this competency standard.

- NHA Specifications Manual 1998, American Association of State Highways and Transportation Officials (AASHTO) Manual M, R & ASTM Manuals
- Sieve
- PPEs
- File
- Shovel



- Rubber Hammer
- Temping Rod
- Water tight Graduated Cylinder/Container
- Void Content Apparatus
- Balance
- Glass Plate
- Funnel
- Scale



11.13.3 Determine Strength Properties of road Metal

Overview: This competency standard covers the skills and knowledge required to determine the Strength Properties of road metal.

Competency Units	Performance Criteria
CU1. Prepare Samples for Petrography	P1 Select the quarry Site P2 Classify the quarry site as guided P3 Sketch a paper map of the quarry site P4 Collect the fresh sample from the quarry site P5 Transport the sample to the laboratory P6 Prepare the Fresh Samples as per standard guidelines P7 Handover the Samples for preparation of Thin Section Slides P8 Ensure the safety of the samples
CU2. Perform the Los Angeles Abrasion Test for road metal	P1 Prepare the test samples P2 Select the apparatus to be used P3 Apply PPEs P4 Ensure the workability of the apparatus P5 Conduct the test as per standard specifications of AASHTO T-96 or ASTM C 131 P6 Compute the results of the test P7 Prepare the test record sheet
CU3. Perform the Impact Value Test for road metal	P1 Prepare the test samples P2 Select the apparatus to be used P3 Apply PPEs P4 Ensure the workability of the apparatus P5 Conduct the test as per standard specifications of ASTM C-131/C-131M P6 Compute the results of the test P7 Prepare the test record sheet
CU4. Execute the Crushing Value Test for road metal	P1 Prepare the test samples P2 Select the apparatus to be used P3 Apply PPEs P4 Ensure the workability of the apparatus P5 Conduct the test as per standard specifications of IS- 2386-4 P6 Compute the results of the test



	P7 Prepare the test record sheet
CU5. Maintain a safe work environment	P1 Use defined safe work practices and personal protective equipment to ensure personal safety and that of others. P2 Clean all equipment, containers and work area according to workplace procedures P3 Collect and/or dispose of all waste in accordance with environmental requirements and workplace procedures P4 Clean and care all equipment and check serviceability of equipment before storage

Knowledge & Understanding

The candidate must be able to demonstrate the underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

- K1.** Define abrasion, Impact value and Crushing value of the road Metal
- K2.** Explain the importance of Los Angeles Abrasion Test
- K3.** Explain the importance of Impact Value Test
- K4.** Explain the importance of Crushing Value
- K5.** Explain the procedure of Los Angeles Abrasion test as per standard specifications of AASHTO T-96 or ASTM C 131
- K6.** Explain the procedure of Impact value test as per standard specifications of ASTM C-131/C-131M
- K7.** Explain the procedure of Crushing value test as per standard specifications of IS- 2386-4
- K8.** Explain the procedures of Petrography and its importance
- K9.** Explain the importance to maintain safe work environment.
- K10.** Explain the importance of blending process of coarse aggregates

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Prepare the samples for the thin section slides
- Perform the Los Angeles Abrasion Test
- Perform Aggregate Impact Value Test
- Perform Aggregate Crushing Value Test
- Prepare Process flow Diagram for each test



Tools and Equipment:

Following tools and equipment are required to fulfill the execution needs of the tasks under this competency standard.

- NHA Specifications Manual 1998, American Association of State Highways and Transportation Officials (AASHTO) Manual M, R & ASTM Manuals
- Sieve Set
- PPEs
- File
- Shovel
- Rubber Hammer
- Temping Rod
- Los Angeles Abrasion Machine
- Funnel
- Scale
- Graduated Cylinder



11.13.4 Determine California bearing ratio of Road Base and Sub-Base

Overview: This competency standard covers the skills and knowledge required to determine California bearing ratio of Road Metal (Base and Sub-Base)

Competency Units	Performance Criteria
CU1. Prepare Samples for Petrography	P1 Select the quarry Site P2 Classify the quarry site as guided P3 Sketch a paper map of the quarry site P4 Collect the fresh sample from the quarry site P5 Transport the sample to the laboratory P6 Prepare the Fresh Samples as per standard guidelines P7 Handover the Samples for preparation of Thin Section Slides P8 Ensure the safety of the samples
CU2. Perform the Test to Determine CBR for road base, sub-base.	P1 Prepare the Samples as per standard guidelines P2 Select the appropriate Sieve Set as per requirements P3 Apply PPEs P4 Carry out the sieving procedure as per standard guidelines of AASHTO T 193 P5 Compute the results of the test P6 Prepare the test record sheet
CU3. Maintain a safe work environment	P1 Use defined safe work practices and personal protective equipment to ensure personal safety and that of others. P2 Clean all equipment, containers and work area according to workplace procedures P3 Collect and/or dispose of all waste in accordance with environmental requirements and workplace procedures P4 Clean and care all equipment and check serviceability of equipment before storage

Knowledge & Understanding

The candidate must be able to demonstrate the underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

- K1.** Explain the procedures of Petrography and its importance
- K2.** Explain the California bearing ratio
- K3.** Explain the importance of California bearing ratio



- K4. Explain the procedure of CBR test.
- K5. Explain the AASHTO T 193 standards.
- K6. Explain the result of CBR test
- K7. Explain the Importance to maintain a safe work environment related to CBR test
- K8. Explain the importance of blending process of coarse aggregates

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Prepare the samples for the thin section slides
- Perform the CBR Test
- Perform Process flow diagram pertaining to CBR

Tools and Equipment:

Following tools and equipment are required to fulfill the execution needs of the tasks under this competency standard.

- NHA Specifications Manual 1998, American Association of State Highways and Transportation Officials (AASHTO) Manual M, R & ASTM Manuals
- PPEs
- File
- Shovel
- Rubber Hammer
- Temping Rod
- CBR apparatus
- Funnel
- Scale
- Graduated Cylinder



11.13.5 Measure basic properties of bitumen

Overview: This competency standard covers the skills and knowledge required to measure and determine basic properties of bitumen to be used in road construction. Specifically, consistency, ductility, softening point, flash and fire point viscosity and specific gravity of bituminous material is measured/determined.

Competency Units	Performance Criteria
CU1. Determine consistency of bituminous material	P1. Identify penetrometer P2. Prepare sample for test P3. Examine, clean and fix the needle P4. Place the sample in assembly and perform test P5. Record the reading from dial gauge P6. Calculate the mean penetration value.
CU2. Measure the ductility of Bitumen	P1. Assemble the standard briquette. P2. Prepare sample for test and place in water bath P3. Remove the sample from mould and fix in testing machine. P4. Operate the testing machine P5. Measure the distance covered during test P6. Record the reading from dial gauge P7. Calculate the average ductility value of bitumen.
CU3. Determine the softening point of bitumen	P1. Identify Ring and Ball apparatus P2. Prepare sample for test P3. Assemble the apparatus to perform test P4. Record temperature at which balls touch the bottom of cylinder P5. Calculate the average temperature of softening of bitumen.
CU4. Determine Flash and Fire point test for bitumen / cutback	P1. Assemble the apparatus P2. Heat the bitumen sample and stir the bitumen to maintain uniform temperature in sample P3. Apply test flame to sample P4. Record the temperature for flash point P5. Record the temperature for fire point
CU5. Determine the viscosity of bitumen	P1. Identify the equipment and calibrate P2. Prepare sample for test P3. Pour the hot bitumen in the viscometer. P4. Place the viscometer in test bath and establish a vacuum of



	mercury P5. Note the reading. P6. Determine the average absolute viscosity.
CU6. Determine the specific gravity of bituman	P1. Identify specific gravity bottle. P2. Prepare bottle for test P3. Assemble sample in apparatus according to specifications P4. Pour the bitumen in bottle as per specification. P5. Fill the bottle with water P6. Determine the average specific gravity of bitumen

Knowledge & Understanding

The candidate must be able to develop understanding to draw structural components of flexible pavement, determine ductility of bitumen, determine softening point of bitumen, Determine the specific gravity, viscosity and consistency and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- K1.** Explain the component of road i.e. wearing course
- K2.** Introduction of binders for road metals.
- K3.** Explain consistency of bituminous material
- K4.** Explain the Importance to determine the consistency of bituminous material
- K5.** Explain the procedure to collect the sample and to perform the test as per specifications of ASTM D5/D5M.
- K6.** Explain the procedure to Calculate the mean penetration value.
- K7.** Enlist the apparatus to use for the test
- K8.** Explain Ductility of bituminous material
- K9.** Explain the Importance to measure the ductility of bituminous material
- K10.** Explain the procedure to collect the sample and to perform the test as per specifications of ASTM D113 - 99 Standard Test Method for Ductility of Bitumen Material.
- K11.** Explain the procedure to Calculate the mean ductility value.
- K12.** Enlist the apparatus to use for the test.
- K13.** Explain softening point of bituminous material
- K14.** Explain the Importance to measure the softening point of bituminous material,
- K15.** Explain the procedure to collect the sample and to perform the test as per specifications of ASTM D36 - 06 Standard Test Method for Softening Point of Bitumen Material.
- K16.** Explain the procedure to Calculate the average temperature of softening of bitumen.
- K17.** Enlist the apparatus to use for the test.



- K18.** Explain Flash and fire Point of bitumen / Cutback.
- K19.** Explain the Importance to Determine Flash and Fire point test for bitumen / cutback.
- K20.** Explain the procedure to collect the sample and to perform the test as per specifications of ASTM D3143 / D3143M Standard Test Method for Flash Point of Cutback with Tag Open-Cup Apparatus.
- K21.** Explain the procedure to record the temperature for flash point.
- K22.** Enlist the apparatus to use for the test
- K23.** Explain the viscosity of bitumen.
- K24.** Explain the Importance to determine the viscosity of bitumen.
- K25.** Explain the procedure to collect the sample and to perform the test as per specifications of ASTM D2170 / D2170M Standard Test Method to Determine the average absolute viscosity.
- K26.** Explain the procedure to Determine the average absolute viscosity.
- K27.** Enlist the apparatus to use for the test
- K28.** Explain the specific gravity of bitumen.
- K29.** Explain the Importance to determine the specific gravity of bitumen.
- K30.** Explain the procedure to collect the sample and to perform the test as per specifications of ASTM D70 - 97 Standard Test Method to Determine the specific gravity of bitumen.
- K31.** Explain the procedure to Determine the average specific gravity of bitumen
- K32.** Enlist the apparatus to use for the test

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Measure consistency/Grade of bitumen
- Determine ductility value of bitumen
- Temperature of bitumen for softening
- Specific gravity of bituminous material
- Viscosity of bituminous material
- Temperature of bitumen for Flash and Fire point

Tools and Equipment

1. **Penetrometer** calibrated to give accurate results in one-tenth of a millimeter allows the needle to penetrate without much friction. The penetrometer has leveling screws and spirit level to make the base horizontal. The needle is secured in a vertical position and the total weight of



needle assembly is 100 grams. A knob is used to release or lock the needle assembly. The needle penetration is measured on a dial graduated in one-tenth of a millimeter. An automatic type penetrometer is provided with an electric timer that releases the needle exactly for 5 seconds.

2. **Container** is a flat bottomed cylindrical metallic dish 55 mm in diameter and 35 mm in depth. If the penetration is of the order of 25 mm or more, a deeper dish of 70 mm diameter and 45 mm depth is used.
3. **Needle** consists of a straight, highly polished, cylindrical hard steel rod.
4. **Water bath** maintained at 25 degrees Celsius ± 0.1 degree Celsius containing not less than 10 liters of water, the sample is immersed to a depth not less than 100 mm from the top and supported on a perforated shelf not less than 50 mm from the bottom of the bath.
5. **Bath thermometer** of range 0 to 44 degrees Celsius with 0.2 degree Celsius graduations.
6. **Time measuring device** with an accuracy of ± 0.1 seconds.
7. **Transfer dish or Tray** for supporting the container and should not rock the container. It should be of such capacity as to completely immerse into the container during the test.
8. **Briquette mold:**

It is made up of brass. The circular holes are provided in the clips to grip the fixed and moveable ends of the testing machine. The molds when properly assembled form a briquette specimen of the following dimensions:

Total length	75.0 $\pm$ 0,5 mm
Distance between clips	30.0 $\pm$ 0.3 mm
Width of mount of slip	20.0 $\pm$ 0.2 mm
Width at minimum cross-section (half way between clips).	10.0 $\pm$ 0.1 mm
Thickness throughout	10.0 $\pm$ 0.1 mm

Water bath: A bath maintained within $27.0^{\circ} \pm 0.1^{\circ}\text{C}$ of the specified temperature, containing not less than 10 liters of water. The specimen being submerged to a depth of not less than 10 cm and supported on a perforated shelf and less than 5cm from the bottom of the bath.

Testing machine: For pulling the briquette of bituminous material apart, any apparatus may be used which is so constructed that the specimen will be continuously submerged in water while the two clips are being pulled apart horizontally at a uniform speed of 50 ± 2.5 mm per minute.

9. **Thermometer:** Range 0-44°C and readable up to 0.2°C
10. **Knife.**
11. **Heater.**
12. **Glycerin**
13. **Ring** — A brass shouldered ring.
14. **Ball**— A steel ball, 9.53 mm (**3/8"**) in diameter, weighing between 3.45 and 3.55 grams.



- 15. Ball Centering Guide** — A guide for centering the ball and made of brass.
- 16. Ring Holder** — the rings shall be supported on a brass ring holder. Rings shall be supported in a horizontal position with the bottoms of the rings 25 mm above the upper surface of the bottom plate and a distance of at least 13 mm and not more than 19 mm between the bottom plate and the bottom of the bath. the thermometer shall be suspended so that the bottom of the bulb is level with the bottom of the rings and within 13 mm of the rings but not touching them.
- 17. Brass Pouring Plate** — a flat, smooth brass plate approximately 75 by 50 mm that has been treated to prevent the bituminous material from adhering to it. A suitable treatment is to coat the plate just before use with a thin layer of a mixture of glycerin and dextrin, talc, or china clay.
- 18. Water Bath** — A glass vessel, capable of being heated, not less than 85 mm in diameter and not less than 120 mm in depth from the bottom of the flare.
- 19. Thermometers** — having a range from -2 to +80°C.
- 20. Constant Temperature Bath** – A suitable bath for immersion of at least 6 vacuum capillary viscometer tubes with a digital temperature controller. The accuracy of the temperature in the bath should be +/- 0.1 C throughout the bath.
- 21. Silicone Bath Oil** suitable up to 150 C
- 22. Vacuum System** – Capable of maintaining a vacuum within +/- 0.05 cm of the desired level up to and including 30 cm of mercury. The system shall consist of vacuum pump, moisture trap, vacuum regulator, manometer with electronic controller, bleed valve, all interconnecting tubing/piping, and any other accessories as needed to complete the vacuum system.
- 23. Thermometer for Bath** – Mercury in glass, range 37.8 to 82 C, and graduations of 0.2 C.
- 24. Timing Device** – A stop watch or stop clock capable of reading up to ½ second.
- 25. Cannon-Manning Vacuum Viscometers**– With manufacturers' calibration certificate, viscometer holder and silicone cork. Size 12 and Size 13 (one each) [Size 12 is suitable for testing VG-10 and Size 13 is suitable for testing VG-20, VG-30, and VG-40 bitumen.]
- 26. Viscometer Stand** – for holding 6 viscometers.
- 27. Cleveland Cup Apparatus:** It consists of test cup, heating plate, test flame applicator, heater, thermometer support and heating plate support, all conforming to the following requirements.
- Test Cup** — It is made of brass. The cup may be equipped with a handle.
 - Heating Plate** — A brass, cast iron, wrought iron, or steel plate with a center hole surrounded by an area of plane depression, and a sheet of hard asbestos board which covers the metal plate except over the area of plane depression in which the test cup is supported. The metal plate may be square instead of round and have suitable extension for mounting the test flame applicator device and the thermometer support. The metal bead is mounted on the plate so that it extends through and slightly above a small hole in the asbestos board. Fire Point



- c. **Test Flame Applicator** — The device for applying the test flame may be of any suitable design, but the tip shall be 1.6 to 5.0 mm in diameter at the end and the orifice shall have an approximate diameter of 0.8 mm. The device for applying the test flame shall be so mounted to permit automatic duplication of the sweep of the test flame, the radius of swing being not less than 150 mm and the center of the orifice moving' in a plane not more than 2.5 mm above the cup. A bead having a diameter of 3.8 to 5.4 mm may be mounted in a convenient position on the apparatus so the size of the test flame can be compared to it. Fire Point
- d. **Heater** — Heat may be supplied from any convenient source. The use of a gas burner or alcohol lamp is permitted, but under no circumstances are products of combustion or free flame to be allowed to come up around the cup. An electric heater controlled by a variable voltage transformer is preferred. The source of heat shall be centered under the opening of the heating plate with no local superheating.
- e. **Thermometer Support** — A device which will hold the thermometer in the specified position during a test and permits easy removal of the thermometer from the test cup upon completion of a test.
- f. **Heating Plate Support** — Any convenient support which will hold the heating plate level and steady may be employed. Fire Point



11.13.6 Determine the bituminous content in a pavement sample

Overview: This competency standard covers the skills and knowledge required for quantitative determination bitumen in hot mixed paving mixture and pavement samples. By performing this test, a substantial saving in the cost of bitumen can be had by ensuring that the optimum quantity of bitumen is used. The results of the test are an indication regarding the quantity of bitumen that has been used in a bituminous mix.

Competency Units	Performance Criteria
CU-1. Check test equipment before use	P1. Set up test equipment in accordance with test method P2. Perform pre-use and safety checks in accordance with workplace procedures P3. Identify faulty equipment and report to appropriate personnel P4. Check calibration status of instruments.
CU-2. Prepare the sample	P1. Identify the apparatus P2. Assemble the standard briquette mold on a brass plate P3. Heat and pour the bitumen in the mold P4. Cool the filled mold at specified temperature P5. Cut off the excess bitumen
CU-3. Extract quantity of bitumen from bituminous paving	P1. Identify centrifuge apparatus P2. Prepare sample for test P3. Assemble sample in apparatus according to specifications P4. Add solvent to disintegrate materials P5. Extract bitumen from sample P6. Determine the amount of bitumen
CU-4 Process and interpret data	P1. Check data for accuracy and completeness P2. Perform required calculations and ensure results are consistent with expected values for the sample type P3. Interpret trends in data and/or results P4. Record and report results

Knowledge & Understanding

The candidate must be able to develop understanding to draw structural components of flexible pavement, and extract quantitative bitumen from bituminous paving and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

K1. Describe structural components of flexible pavement with sketches.



- K2.** Define wearing course
- K3.** Describe the bituminous materials
- K4.** Explain the construction procedure of bituminous roads.
- K5.** Explain the construction detail of surfacing cold and hot process bituminous macadam, premix asphalt macadam, bituminous concrete pavements and sheet asphalt pavement.
- K6.** Enlist the Equipment and check the accuracy/calibration prior to use for test of Pavement.
- K7.** Explain the importance of test for bitumen pavement
- K8.** Explain the procedure to assemble the apparatus prior to use.
- K9.** Explain the procedure to get sample as per the standard method specified in the relevant ASTM standard and code.
- K10.** Explain the procedure of test to extract the Quantity of bitumen as per the relevant ASTM standard and codes.
- K11.** Explain the procedure to compute the test result and its interpretation.

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Clean and check the equipment prior to use for test of bitumen pavement.
- Drawing of flexible pavement
- Assembling the apparatus
- sample as per the standard.
- Test to extract the Quantity of bitumen from bituminous paving as per the specified standards.
- Log of expected result data VS test result data

Tools and Equipment

1. Centrifuge extractor
2. Filter ring of paper or felt to fit the rim of bowl
3. Balance of capacity 500 grams and sensitivity 0.01grams.
4. Thermostatically controlled oven with capacity up to 2500 C.
5. Beaker for collecting extracted material.
6. Stainless steel fork or spoon approximately 300mm long
7. Aluminum or stainless-steel pan approximately 330x230x60 mm



11.13.7 Determine the Mix Design by Marshall Method

Overview: This competency standard covers the skills and knowledge required to determine the optimum binder content of the bituminous mix by Marshall method of mix design and also to determine the Marshall stability of bituminous mixture.

Competency Units	Performance Criteria
CU-1. Check test equipment before use	P1. Set up test equipment in accordance with test method P2. Perform pre-use and safety checks in accordance with workplace procedures P3. Identify faulty equipment and report to appropriate personnel P4. Check calibration status of instruments.
CU-2. Prepare the sample	P1. Identify the apparatus P2. Assemble the standard briquette mold on a brass plate P3. Heat and pour the bitumen in the mold P4. Cool the filled mold at specified temperature P5. Cut off the excess bitumen
CU3. Perform Marshal stability test for bituminous mixture	P1. Identify the equipment P2. Prepare sample for test P3. Place the mould in Marshal test setup P4. Load the mold in Marshal test setup P5. Note the reading for vertical deformation of specimen P6. Vary the bitumen content for next trial P7. Compile data in tabular form P8. Compute required parameters P9. Plot the graph using the predetermined parameters P10. Determine optimum bitumen content
CU-4 Process and interpret data	P1. Check data for accuracy and completeness P2. Perform required calculations and ensure results are consistent with expected values for the sample type P3. Interpret trends in data and/or results P4. Record and report results

Knowledge & Understanding

The candidate must be able to develop understanding to draw structural components of flexible pavement, perform Marshal Stability test for bituminous mixture design and determine Marshall



Stability of bituminous mixture and understanding required to carry out tasks covered in this competency standard. This includes the knowledge of:

- K1.** Describe structural components of roads and airports pavements.
- K2.** Explain the types of Marshall mix designs.
- K3.** Explain Marshall Stability and flow.
- K4.** Describe the Marshall Stability Correction
- K5.** Enlist the Equipment and check the accuracy/calibration prior to use.
- K6.** Explain the importance of Marshal stability test for bituminous mixture
- K7.** Explain the procedure to assemble the apparatus prior to use.
- K8.** Explain the procedure to get sample as per the standard method specified in the relevant ASTM standard and code.
- K9.** Explain the procedure to Perform Marshal stability test for bituminous mixture as per the relevant ASTM standard and codes.
- K10.** Explain the procedure to compute the test result and its interpretation.
- K11.** Explain the construction detail of surfacing cold and hot process bituminous macadam, premix asphalt macadam, bituminous concrete pavements and sheet asphalt pavement.

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Clean and check the equipment prior to use for test
- Assemble the apparatus
- Perform the sample as per the standard.
- Theoretical specific gravity (G_t) of test specimen.
- Bulk specific gravity of mix (G_m)
- Air voids (V_v) in test specimen.
- Volume of bitumen (V_b) in test mix.
- Voids in mineral aggregates (V_{ma}) of the mix.
- Voids in mineral aggregates (V_{fb}) filled with bitumen.
- Determination of Marshall stability and flow
- Apply stability correction
- Prepare graphs to Determine optimum bitumen content

Tools and Equipment

1. Marshall Load frame of 50 KN capacity.
2. Proving ring of 30 KN capacity fitted with the dial gauge of least count of 0.002 mm



3. Stability breaking head
4. Flow measuring dial gauge of least count 0.01 mm
5. Specimen extractor or ejector
6. Compaction pedestal
7. Compaction hammer with 4.53 kg mass and 457 mm fall
8. Specimen molds of 100 mm diameter
9. Thermometer of range 200°C



11.13.8 Evaluate the Job Mix Formula for Asphaltic Concrete

Overview: This competency standard covers the skills and knowledge required to design and evaluate trial batches of Asphalt Concrete.

Competency Units	Performance Criteria
CU-1 Perform quality tests over coarse aggregate	P1. Prepare the test samples P2. Select the apparatus to be used P3. Arrange Apparatus as per requirements P4. Apply PPEs P5. Ensure the workability of the apparatuses P6. Conduct the test as per standard specifications of AASHTO, ASTM P7. Compute the results of the test P8. Prepare the test record sheet
CU-2 Perform the quality tests over fine aggregates	P1. Prepare the test samples P2. Select the apparatus to be used P3. Arrange Apparatus as per requirements P4. Apply PPEs P5. Ensure the workability of the apparatuses P6. Conduct the test as per standard specifications of AASHTO, ASTM P7. Compute the results of the test P8. Prepare the test record sheets
CU-3 Perform the quality tests over Bitumen	P1. Prepare the test samples P2. Select the apparatus to be used P3. Arrange Apparatus as per requirements P4. Apply PPEs P5. Ensure the workability of the apparatuses P6. Conduct the test as per standard specifications of AASHTO, ASTM P7. Compute the results of the test P8. Prepare the test record sheets
CU-4 Prepare Trial batch of Job mix Formula for Asphalt Configures	P1. Arrange the materials as per the Batching summary sheet P2. Weigh the desired amounts of materials P3. Perform test run on the mixture machine P4. Ensure the workability of the mixer machine



	P5. Ensure the standard specifications during mixing procedure P6. Compute the test results P7. Fill up the Job mix formula's summary sheet P8. Prepare the test record sheets P9. Submit the record sheets for approval
--	--

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out tasks covered in this competency standard. This includes the knowledge to,

- K1.** Explain the importance of Quality test of coarse aggregates.
- K2.** Explain the procedure to prepare the sample of Coarse aggregates
- K3.** Enlist the apparatus required to perform the sample and test.
- K4.** Explain the importance of the workability and calibration of apparatus.
- K5.** Explain the procedure to perform Quality test of coarse aggregates as per AASHTO, ASTM standards
- K6.** Explain the importance of Quality test of fine aggregates.
- K7.** Explain the procedure to prepare the sample of Fine aggregates
- K8.** Enlist the apparatus required to perform the sample and test.
- K9.** Explain the importance of the workability and calibration of apparatus.
- K10.** Explain the procedure to perform Quality test of fine aggregates as per AASHTO, ASTM standards.
- K11.** Explain the importance of Quality test of Bitumen.
- K12.** Explain the procedure to prepare the sample of Bitumen
- K13.** Enlist the apparatus required to perform the sample and test.
- K14.** Explain the importance of the workability and calibration of apparatus.
- K15.** Explain the procedure to perform Quality test of bitumen as per AASHTO, ASTM standards.
- K16.** Explain the importance to Prepare Trial batch of Job mix Formula for Asphalt Configures.
- K17.** Define batching.
- K18.** Enlist the apparatus required to Prepare Trial batch of Job mix Formula for Asphalt Configures.
- K19.** Explain Trial batch of Job mix Formula for Asphalt Configures as per ASTM and AASHTO standards.
- K20.** Explain to compute results and keeping records as per standards..



Critical Evidence(s) required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Cleaning and Checking the apparatus
- Quality test of bitumen, coarse and fine aggregates as per standards.
- The job mix formula for asphaltic concrete
- Process flow diagram pertaining to the procedure of Trial batch of Job mix Formula for Asphalt Configures
- Job mix formula for asphaltic concrete.

Tools and Equipment

- PPEs
- Multimeter
- Circuit Diagrams for Plants
- Digital Balance
- Digital Thermometer
- GI Tray
- Spatula
- Knife edge
- Test equipment
- Digital Stop Watch



11.14. Masonry Material Testing

11.14.1 Perform Physical Test for Brick & Block

Overview: This competency standard covers the skills and knowledge required to perform different physical test for bricks, blocks. These tests are required for better construction results. These tests ensure that the material specified and bought is the same required specifications and delivered to you or the job site for construction.

Competency Units	Performance Criteria
CU-1. Carry out initial preparatory activities.	P1. Access relevant job instructions from Laboratory Information Management System (LIMS) P2. Interpret test request to confirm samples to be tested, the test method and equipment involved P3. Identify hazards to take sample P4. Prepare workplace for task P5. Collect required equipment and materials P6. Plan task sequences for optimum efficiency
CU-2. Perform (Porosity) Absorption & Moisture Contents	P1. Identify sample. P2. Weight the Sample P3. Dip sample in water for specified time P4. Differentiate sample weight. P5. Apply formula P6. Calculate percentage of absorption P7. Record test data in register.
CU-3. Perform Sound Test	P1. Identify sample. P2. Strike sample as per standard. P3. Observe strike sound of sample. P4. Mention result as per rule (S.O.P) P5. Maintain record in register.
CU-4. Perform durability test	P1. Identify sample. P2. Drop sample from specified height on hard surface P3. Differentiate sample. P4. Apply formula



	P5. Calculate average for samples P6. Maintain record in register.
CU-5. Perform Attrition / abrasion test	P1. Identify samples in required numbers and weight. P2. Put sample in drum in specified numbers P3. Lock the Drum. P4. Check angle of inclination for drum P5. Rotate drum for specified revolutions and time. P6. Open Drum Safely P7. Clean & Weigh the samples P8. Apply formula P9. Compute result percentage. P10. Maintain Test record in register.
CU-6 Maintain a safe work environment	P1. Use PPEs and apply safe work practices P2. Rehabilitate sampling site and Minimize generation of wastes P3. Collect waste material P4. Dispose waste Material in accordance with environmental / quarantine requirements and workplace procedures P5. Clean the equipment P6. Check serviceability of equipment before storage

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:-

- K1. Types of physical test.
- K2. Operations of physical tests.
- K3. Importance of physical tests.
- K4. Techniques of physical test.
- K5. Types of bricks and their properties.
- K6. Capacity of physical test equipment.
- K7. Measuring tools and techniques
- K8. Sizes and uses of bricks in samples
- K9. Capacity of trolley / table
- K10. Weighing and dip techniques
- K11. Specifications as per requirements



- K12. Loading capacity of bricks / blocks in equipment.
- K13. Differentiate between bricks and blocks
- K14. Define soundness test
- K15. Importance of abrasion test for materials
- K16. Type of different blocks and its properties
- K17. Type of different bricks and its properties
- K18. Define Porosity

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Load Brick and Blocks.
- Balance the samples in equipment.
- Unload and Load the materials safely
- Load techniques of materials
- Adjust brick on trolley
- Adjust for standard
- Fasten brick in clamp
- Putting the sample in drum
- Size and Revolution of drum
- Maintain safe work environment
- Maintaining the equipment after Tests

Important points

- Operate various types of bricks in Machines.
- Ensure personal, co-workers and machine safety.
- Understand Capacity of trolley.
- Understand Loading capacity of trolley
- Understand Operations brick for different test
- Understand Operations stones for different test
- Understand Operations blocks for different test
- Techniques of dipping the samples.
- Balancing and weighing the samples for safe handling



LIST OF TOOLS AND EQUIPMENT

List of Machines and Tools	
Sr. #	Description
1.	Hand Trolley
2.	Spade
3.	Capping
4.	Measurement tape
5.	G. I. Tray
6.	File set
7.	Brick Hammer
8.	Chisel
9.	Tester
10.	Water pump
11.	Wrench set
12.	Grip pliers
13.	Hammer set
14.	Screw driver set
15.	Pick axe
16.	Plumb bob
17.	Wheel barrow
18.	Hoe
19.	Abrasion Drum



11.14.2 Perform Chemical Test for Brick & Block

Overview: This competency standard covers the skills and knowledge required to perform Chemical test for bricks and blocks. It helps the builders and site owners identify potential problems before committing resources to the project. **Testing** is also essential for keeping the structure in line with applicable legal requirements.

Competency Units	Performance Criteria
CU-1. Carry out initial preparatory activities.	P1. Access relevant job instructions from laboratory information management system (LIMS) P2. Interpret test request to confirm samples to be tested, the test method and equipment involved P3. Identify hazards to take sample P4. Prepare and workplace for task P5. Assemble / collect all required equipment and materials P6. Plan task / work sequences for optimum efficiency
CU-2. Perform Chemical / Efflorescence test for bricks and blocks (Soluble Salt Test)	P1. Select sample. P2. Dip the brick / block in water for specified time. P3. Dry the sample in shade for specified time. P4. Check the color and surface after specified time P5. Check Randomly different samples P6. Maintain record in register.
CU-3. Perform Acid Test for bricks and blocks	P1. Select sample. P2. Dip sample 5% Sulphuric Acid Solution for the specified time. P3. Dry the sample P4. Check stone sample sharpness P5. Check Randomly different samples P6. Maintain record in register.
CU-4. Perform Crystallization Test for bricks and blocks	P1. Select sample. P2. Weight and dry the sample. P3. Dry the sample P4. Dip sample in 14% solution of Sodium Sulfate (Na₂SO₄) for specified time P5. Dry sample for specified temperature & weight P6. Repeat test on sample for specified time



	P7. Apply formula P8. Compute result percentage P9. Maintain record as per S.O.P.
CU-5 Maintain a safe work environment	P1. Use PPEs P2. Apply safe work practices P3. Rehabilitate sampling site P4. Minimize generation of wastes P5. Collect and dispose all waste P6. Clean and care all equipment. P7. Check serviceability of equipment before storage.

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:-

- K1. Introduction to Salt / Efflorescence test for bricks and blocks.
- K2. Operations of Salt tests.
- K3. Importance of Salt / Efflorescence tests.
- K4. Techniques of Salt / Efflorescence test.
- K5. Types of under burnt and over burnt bricks properties.
- K6. Capacity of Salt / Efflorescence test.
- K7. Sizes and uses of bricks in samples
- K8. Weighing of brick sample techniques.
- K9. Specifications as per requirements
- K10. Differentiate between Acid and Crystallization test of bricks and blocks
- K11. Importance of Crystallization test for bricks and blocks
- K12. Importance of Acid test for bricks and blocks
- K13. Define PH value.

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Check Brick for in Salt / Efflorescence test.
- Balance the brick in equipment.
- Load and Unload the materials safely from the trolley
- Adjust for standard for Salt / Efflorescence test
- Fasten brick in clamp / Jaws and dip in water



- Care to keep sample in solution

Important points

- Operate various types of bricks in Machines.
- Ensure personal, co-workers and machine safety.
- Understand PPEs
- Understand Operations for brick test
- Techniques of brick dipping in water
- Balancing and weighing the bricks for safe handling
- Fixing of brick in Jaws safely
- Unloading the brick from jaws
- Unloading stones from chemical solution

LIST OF TOOLS AND EQUIPMENT

List of Machines and Tools	
Sr. #	Description
1.	Hand Trolley
2.	Spade
3.	Capping
4.	Measurement tape
5.	G. I. Tray
6.	File set
7.	Brick Hammer
8.	Chisel
9.	Tester
10.	Water pump
11.	Wrench set
12.	Grip pliers
13.	Hammer set
14.	Screw driver set
15.	Pick axe
16.	Plumb bob
17.	Wheel barrow
18.	Hoe



11.14.3 Perform Strength Test for Bricks & Blocks

Overview: This competency standard covers the skills and knowledge required to perform Crushing / Compressive Strength test for bricks and Blocks. These tests are helpful to estimate material behavior when it is subjected to a force or combination of different forces. A material's strength in a given application depends on many factors, including its resistance to deformation and cracking.

Competency Units	Performance Criteria
CU-1. Carry out initial preparatory activities.	P1. Access relevant job instructions from laboratory information management system (LIMS) P2. Interpret test request to confirm samples to be tested, the test method and equipment involved P3. Identify hazards to take sample P4. Prepare and workplace for task P5. Assemble / collect all required equipment and materials P6. Plan task / work sequences for optimum efficiency
CU-2. Perform Crushing Strength / Impact for (bricks, blocks)	P1. Select sample. P2. Fill the Frog / Holes with prerequisite materials. P3. Dry the brick for specified time and temperature. P4. Apply Capping P5. Fix the brick in Compressive testing machine P6. Apply load at convenient rate on fixed sample. P7. Check crushing strength on gauge. P8. Maintain record in register.
CU-3. Perform Transverse strength test (Modulus of Rupture) for Bricks and Blocks	P1. Select sample / specified specimen. P2. Fix sample wedge-shaped supports near its ends in the machine. P3. Apply load until failure at convenient specified rate. P4. Apply formula P5. Find out “Modulus of Rupture”. P6. Maintain record in register.
CU-4. Perform Hardness test for bricks and blocks.	P1. Select & weigh the sample. P2. Fix the sample on testing machine



	P3. Apply load at convenient rate on fixed sample. P4. Rotate machine for specified revolution and time. P5. Weigh the sample P6. Apply formula P7. Check co-officiant of hardness P8. Maintain record in register.
CU-5. Maintain a safe work environments	P1. Use PPEs definitely P2. Apply safe work practices P3. Rehabilitate sampling site and Minimize generation of wastes P4. Collect and dispose waste in accordance with environmental / quarantine requirements and workplace procedures P5. Clean all equipment P6. Check serviceability of equipment before storage

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

- K1. Introduction to Compressive / Crushing Strength test for samples.
- K2. Operations of Compressive / impact tests.
- K3. Importance of Compressive / impact tests.
- K4. Techniques of Compressive / impact tests.
- K5. Types of bricks and their properties.
- K6. Capacity of Crushing equipment / machine.
- K7. Measuring tools and techniques
- K8. Sizes and uses of bricks in samples
- K9. Capacity of Frog Filling
- K10. Weighing of brick sample techniques.
- K11. Specifications as per requirements
- K12. Loading capacity of bricks in equipment.
- K13. Define co-officiant
- K14. Differentiate between Hardness and Crushing strength



K15. Define different type of blocks

K16. Different bricks properties

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Load Brick in testing machine.
- Balance the brick in equipment.
- Unload the sample safely from the testing machine
- Adjust the sample in testing machine.
- Adjust for standard
- Fasten brick in clamp / Jaws
- Frog Filling Materials Techniques
- Capping method
- Modulus of Rupture
- Serviceability of equipment

Important points

- Operate various sample in testing Machines.
- Ensure personal, co-workers and machine safety.
- Understand Loading capacity of machine
- Understand Operations for brick test
- Techniques of brick frog filling
- Balancing and weighing the bricks for safe handling
- Fixing of brick in Jaws safely
- Importance of Capping
- Prepare yourself for “PPEs”
- Maintaining record procedure
- Re-filling of extinguishers.



LIST OF TOOLS AND EQUIPMENT

List of Machines and Tools	
Sr. #	Description
1.	Compression Testing Machine
2.	Hand Trolley
3.	Spade
4.	Capping
5.	Spatula
6.	Measurement tape
7.	G. I. Tray
8.	File set
9.	Brick Hammer
10.	Chisel
11.	Tester
12.	Float
13.	Grip pliers
14.	Hammer set
15.	Screw driver set
16.	Pick axe
17.	Plumb bob
18.	Hydraulic Jack
19.	Puller
20.	Plumb rule
21.	Spanner set
22.	Torque Wrench
23.	Pipe Wrench
24.	Adjustable Wrench
25.	Safety glasses
26.	Trowel
31.	Wheel barrow
32.	Hoe
34.	P.C. (Attached with U.T.M.)



35. Modulus of Rupture apparatus

List of Consumables

Sr. #	Description
1.	Sand
2.	Cement
3.	Lubricating oil
4.	Water
5.	Cloths
6.	Grease
7.	Kerosene oil
8.	Sand Paper
9.	Brushes
10.	Nuts and Bolts.
12.	Stones
13.	Bricks
14.	Blocks
15.	14% solution of Sodium Sulfate (Na_2SO_4)
16.	5% Sulphuric Acid Solution

List of Personal Protective Equipment

Sr. No	Description
1.	First Aid Box
2.	Fire Blanket
3.	Fire Bucket
4.	Safety Gloves
5.	Ear Protector
6.	Safety Goggles
7.	Safety Helmet
8.	Safety Mask
9.	Safety Shoes



10.	Safety Belt
11.	Sanitizer
12.	Formal Uniform for Work

List of Stationary

Sr. #	Description
1.	Handbooks / white papers / white charts
2.	File cover and files
3.	Pencils with color pencils
4.	Rubber
5.	Sharpeners
6.	Paper Cutter & Seizers
7.	White board with white board markers
8.	Multimedia



11.14.4 Perform Physical Test for Lime

Overview: This competency standard covers the skills and knowledge required to perform different physical test for lime. These tests are required for better construction results. These tests ensure that the material specified and bought is the same required specifications and delivered to you or the job site for construction.

Competency Units	Performance Criteria
CU-1. Carry out initial preparatory activities.	P1. Interpret test request to confirm samples to be tested, the test method and equipment involved P2. Identify hazards associates with the sample preparation, test methods, reagents and equipment. P3. Collect required equipment and materials P4. Identify faulty or unsafe components and equipment and report to appropriate personnel P5. Check calibration status of instruments and report any out-of-calibration items to appropriate personnel. P6. Plan task sequences for optimum efficiency
CU-2. Perform visual examination	P1 Select sample. P2 Observe the color and taste of sample. P3 Identify the smell. P4 Identify the presence of lumps P5 Record observations in lab sheet and prepare test report in the specified lab format .
CU-3. Perform soundness test of lime sample	P1. Prepare the test mix according to standards P2. Fill the mix in the cylinder of Le-chatelier apparatus P3. Cover the cylinder by a glass plate and kept for one hour P4. Measure distance between the ends of the two indicators. P5. Place the apparatus for 48 hours in a damp air and then kept for 3 hours in steam P6. Cool down the sample at room temperature. P7. Measure distance between the ends of the two indicators P8. Compute the results of the test



	P9. Record the test result in lab sheet and prepare test report in the specified lab format
CU-4. Perform consistency test of lime samples	P1. Identify samples in required numbers and weight. P2. Place it in water for 24 hours. P3. Mix the soaked material thoroughly with the help of a mixer. P4. Place the paste in the mould of the flow table.. P5. Determine the average spread of the material by measuring three diameters at approximately 60° apart. P6. Add water If the consistency is too stiff P7. Add material if too wet for a short period on a clean absorbent surface. P9. Compute result percentage. P10. Maintain Test record in register.
CU-5 Find out Initial and final setting time	P1. Weigh lime sample P2. Prepare paste of lime P3. Measure the time. P4. Fill the molds P5. Put the mold under vicat apparatus. P6. Drop the needle and note reading till final value is attained. P7. Record initial setting time. P1. Replace the needle with the needle having circular attachment P8. Note the time when needle leave the impression only. P9. Record final setting time
CU-6 Perform fineness test of lime	P1 . Select sample. P2 . Arrange sieves in such a way that the coarser sieves are placed at the top. P3 Wash the hydrated lime with the help of a moderate jet of water, not more than 30 minutes. P4 Dry up the residue on each of the sieve. P5 Calculate the percentage of hydrated lime. P6 Record data and observations in lab sheets in accordance



	with workplace procedures
CU-7 Carry out ball test	P1. Prepare the sample P2. Place the sample in the basin for 6 hours P3. Observe the disintegration P4. Observe the expansion with cracks P5. Observe any kind of adverse effect P6. Ascertain the class of the lime
CU-8 Perform Plasticity test	P1. Prepare the Sample P2. Dip sample in water for overnight P3. Place the sample over a blotting paper P4. Determine the plasticity of lime
CU-9 Maintain a safe work environments	P1 Select, wear and use appropriate personal protective equipment (PPE). P2 Follow workplace procedures when carrying out work tasks. P3 Keep all work areas clean and free from obstacles P4 Safely store, transport and dispose of hazardous materials and dangerous goods in accordance with environmental procedures. P5 Care for and store equipment, used test pieces and back-up samples in accordance with workplace procedures. P6 Check serviceability of equipment before storage.

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:-

- K1. Types of physical test
- K2. Importance of physical tests
- K3. Techniques of physical test
- K4. Types of lime and their properties.



- K5. Capacity of physical test equipment
- K6. Measuring tools and techniques
- K7. Capacity of trolley / table
- K8. Weighing and dip techniques
- K9. Specifications as per requirements
- K10. Loading capacity of lime in equipment
- K11. Define different type of lime
- K12. Define soundness test
- K13. Importance of consistency test for materials
- K14. Type of different lime and its properties
- K15. Define Porosity
- K16. Define fineness.
- K17. Define setting time.
- K18. Mixing properties of lime
- K19. Importance of plasticity of lime
- K20. Define expansion and disintegration

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Balance the samples in equipment.
- Maintain Mix in le-chatlier apparatus
- Maintain the temperature and humidity
- Adjust lime on trolley
- Adjust for standard
- Maintain the mix in flow table
- Use of blotting paper
- Putting the sample in basin
- Putting the sample for overnight
- Maintain safe work environment
- Maintaining the equipment after Tests

List of Machines and Tools

Sr. #	Description
-------	-------------



1	Hand Trolley
2	Spade
3	Steam boiler
4	Spatula
5	Measurement tape
6	G. I. Tray
7	File set
8	Glass plate
9	Cylinder
10	Water pump
11	Wrench set
12	Hammer set
13	Screw driver set
14	Pick axe
15	Blotting paper
16	Torque Wrench
17	Pipe Wrench
18	Adjustable Wrench
19	Safety glasses
20	Trowel
21	Wheel barrow
22	Hoe
23	Le-Chatelier apparatus
24	Balance
25	Oven (300°C)
26	Vicat apparatus
27	Absorbant surface
28	Enamel tray



11.14.5 Perform Chemical Test of lime

Overview: This competency standard covers the skills and knowledge required to perform Chemical test for lime. It helps the builders and site owners identify potential problems before committing resources to the project. **Testing** is also essential for keeping the structure in line with applicable legal requirements.

Competency Units	Performance Criteria
CU-1. Carry out initial preparatory activities.	P1. Access relevant job instructions from laboratory information management system (LIMS) P2. Interpret test request to confirm samples to be tested, the test method and equipment involved P3. Identify hazards to take sample P4. Prepare and workplace for task P5. Assemble / collect all required equipment and materials P6. Plan task / work sequences for optimum efficiency
CU-2. Perform sugar test on lime samples	P1. Select sample. P2 Put 2.50 g of lime into a 250 ml flask, add 35–45 ml of CO ₂ -free water and boil for 3 minutes. P3 Cool to room temperature. P4 Mix 20 g of sucrose (sugar) in 20 ml of water (= 50% solution) P5 Add this solution to the lime in the flask and shake for 30 minutes. Add more water up to the 250 ml mark. P6 Filter through a No.1 Whatman paper. Discard the first 15–30 ml of filtrate. Pipette 25 ml into a flask. P7 Add 5 drops of phenolphthalein. P8 Titrate with 0.357N sulphuric acid. P9 Calculate cao amount (as CaO, = ml of 0.357N acid, on the burette, x 4) P19. Maintain record in register.
CU-3. Carry out hydraulic acid test.	P1. Identify the sample P2. Prepare the sample P3. Place the sample of specific quantity in the test-tube



	P4. Observe the efflorescence by adding HCL for 24 hours P5. Observe the bubbling action of the reaction P6. Check the thick gel after 24 hours P7. Observe the flowing and non-flowing capability of gel P8. Identify the class of the lime
CU-4. Perform Impurity test	P1. Prepare the sample P2. Extract the residue from the solution P3. Observe the residue to dry under the sun for 8 hours P4. Observe the percentage of the residue left P5. Identify the class of the lime
CU-6. Maintain a safe work environment	P1. Use PPEs P2. Apply safe work practices P3. Rehabilitate sampling site P4. Minimize generation of wastes P5. Collect and dispose all waste P6. Clean and care all equipment. P7. Check serviceability of equipment before storage.

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:-

- K1. Introduction to lime / Impurity test for lime
- K2. Operations of Lime tests
- K3. Importance of Lime
- K4. Techniques for lime tests
- K5. Properties of lime
- K6. Classes of lime
- K7. Specifications as per requirements
- K8. Differentiate between different classes of lime
- K9. Importance of Acid test for lime
- K10. Define Bubbling action

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:



- Check lime test for efflorescence
- Care to keep sample in solution
- Mixing of material safely
- Volume of water
- Thickness of gel
- Maintain safe work environment
- Maintaining the equipment after Tests

List of Machines and Tools	
Sr. #	Description
1.	Hand Trolley
2	Spade
3	Steam boiler
4	Spatula
5	Test tube
6	Beaker
7	Knife
8	Basin
9	Water pump
10	Pipe Wrench
11	Adjustable Wrench
12	Safety glasses
13	Trowel
14	Wheel barrow
15	Balance
16	Oven (300°C)
17	Pipette



11.14.6 Perform Strength Test for lime

Overview: This competency standard covers the skills and knowledge required to perform Crushing / Compressive Strength test for lime. These tests are helpful to estimate material behavior when it is subjected to a force or combination of different forces. A material's strength in a given application depends on many factors, including its resistance to deformation and cracking.

Competency Units	Performance Criteria
CU-1. Carry out initial preparatory activities.	P1. Access relevant job instructions from laboratory information management system (LIMS) P2. Interpret test request to confirm samples to be tested, the test method and equipment involved P3. Identify hazards to take sample P4. Prepare and workplace for task P5. Assemble / collect all required equipment and materials P6. Plan task / work sequences for optimum efficiency
CU-2. Perform transverse strength test for lime	P1. Prepare sample: 25 x 25 x 100 mm mortar specimens P2 Mix: standard lime to sand at 1:3 ratio P3. Cure for 28 days with the mold with the help of a contained at 90 % relative humidity and a temperature of 27°C. P4. Remove the mold at the end of the 28 days and cure the specimen is cured in water for 30 minutes. P5. Test the specimen on a transverse testing machine, placing over 2 rollers placed at a space of 80mm. P6. Apply The concentrated load at the center uniformly at a rate of 150+_15N per minute till the specimen breaks. P7. Calculate The modulus of rupture or the transverse strength at 28 days. P8. Maintain record in register.
CU-3. Perform compressive strength for lime	P1. Prepare Twelve cubes with side 5 cm from standard lime-sand mortar using metallic moulds. P2. Fill the moulds is filled by hand, the mortar being pressed in with the thumb, lightly tamped, smoothed off with 2 or 3 strokes of the trowel.



	P3. Store these cubes undisturbed in a container for a period of 72 hours in an atmosphere of at least 90 percent relative humidity and at a temperature of $27 \pm 2^{\circ}\text{C}$.for 72 hours. P4. Take out specimens and place in the air in laboratory for 4 days. P5. Immerse the samples in clean water and left there until just prior to testing for its strength in the testing machine. P6. Take out the cubes wiped surface-dry and test for compressive strength in a compression testing machine. The load is increased at a rate of 15kg/min. P7. Apply formula P8. Find out compressive strength P9. Maintain record in register.
CU-4. Maintain a safe work environment	P1. Use PPEs definitely P2. Apply safe work practices P3. Rehabilitate sampling site and Minimize generation of wastes P4. Collect and dispose waste in accordance with environmental/quarantine requirements and workplace procedures P5. Clean all equipment P6. Check serviceability of equipment before storage

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

- K1. Introduction to Compressive / Crushing Strength test for samples.
- K2. Operations of Compressive / impact tests.
- K3. Importance of Compressive / impact tests.
- K4. Techniques of Compressive / impact tests.
- K5. Types of lime and their properties.
- K6. Capacity of Crushing equipment / machine.
- K7. Measuring tools and techniques
- K8. Use of lime in construction
- K9. Difference between quicklime and hydrated lime



- K10. Specifications as per requirements
- K11. Modulus of rupture
- K12. Define co-efficient
- K13. Differentiate between transverse and compressive strength

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Load lime in testing machine.
- Balance the lime in equipment jaw
- Unload the sample safely from the testing machine
- Adjust the sample in testing machine.
- Adjust for standard
- Fasten stone in clamp / Jaws
- Modulus of Rupture
- Serviceability of equipment

List of Machines and Tools	
Sr. #	Description
1.	Compression Testing Machine
2.	Hand Trolley
3.	Spade
4.	Spatula
5	Wrench set
6	Hammer set
7	Screw driver set
8	Pick axe
9	Spanner set
10	Torque Wrench
11	Pipe Wrench
12	Adjustable Wrench
13	Safety glasses
14	Trowel
15	Wheel barrow
16	Hoe
17	P.C. (Attached with U.T.M.)
18	Compression testing machine
19	Enamel tray

List of Consumables	
Sr. #	Description
1.	Sand
2.	Water
3.	Cloths
4.	Cement



5.	Phenepthelene
6.	Sand Paper
7.	Brushes
8.	Sulphuric acid
9.	Sugar

List of Personal Protective Equipment	
Sr. No	Description
1.	First Aid Box
2.	Fire Blanket
3.	Fire Bucket
4.	Safety Gloves
5.	Ear Protector
6.	Safety Goggles
7.	Safety Helmet
8.	Safety Mask
9.	Safety Shoes
10.	Safety Belt
11.	Sanitizer
12.	Formal Uniform for Work

List of Stationary	
Sr. #	Description
1.	Handbooks / white papers / white charts
2.	File cover and files
3.	Pencils with color pencils
4.	Rubber
5.	Sharpeners
6.	Paper Cutter & Seizers
7.	White board with white board markers
8.	Multimedia



11.14.7 Perform Physical Test for Stones

Overview: This competency standard covers the skills and knowledge required to perform different physical test for stones. These tests are required for better construction results. These tests ensure that the material specified and bought is the same required specifications and delivered to you or the job site for construction.

Competency Units	Performance Criteria
CU-1. Carry out initial preparatory activities.	P1. Access relevant job instructions from Laboratory Information Management System (LIMS) P2. Interpret test request to confirm samples to be tested, the test method and equipment involved P3. Identify hazards to take sample P4. Prepare workplace for task P5. Collect required equipment and materials P6. Plan task sequences for optimum efficiency
CU-2. Perform (Porosity) Absorption & Moisture Content for stone samples	P1. Identify sample. P2. Weight the Sample P3. Dip sample in water for specified time P4. Differentiate sample weight. P5. Apply formula P6. Calculate percentage of absorption P7. Record test data in register.
CU-3. Perform durability test for stone samples	P1. Identify sample. P2. Drop sample from specified height on hard surface P3. Differentiate sample. P4. Apply formula P5. Calculate average for samples P6. Maintain record in register.
CU-4. Perform Attrition /abrasion test for stone samples	P1. Identify samples in required numbers and weight. P2. Put sample in drum in specified numbers P3. Lock the Drum. P4. Check angle of inclination for drum P5. Rotate drum for specified revolutions and time.



	P6. Open Drum Safely P7. Clean &Weigh the samples P8. Apply formula P9. Compute result percentage. P10.Maintain Test record in register.
CU-5 Skid Resistance test for Stones	P1. Select specimen P2. Prepare specimen testor P3. Adjust the specimen in the mould P4. Polish the specimen in machine P5. Place the sample in the skid resistance tester P6. Operate the tester P7. Compute the readings P8. Maintain Test record in note pad
CU-6 Maintain a safe work environments	P1. Use PPEs and apply safe work practices P2. Rehabilitate sampling site and Minimize generation of wastes P3. Collect waste material P4. Dispose waste Material in accordance with environmental/quarantine requirements and workplace procedures P5. Clean the equipment P6. Check serviceability of equipment before storage

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:-

- K1. Types of physical test.
- K2. Operations of physical tests.
- K3. Importance of physical tests.
- K4. Techniques of physical test.
- K5. Types of bricks and their properties.
- K6. Capacity of physical test equipment.
- K7. Measuring tools and techniques



- K8. Sizes and uses stones in samples
- K9. Capacity of trolley / table
- K10. Weighing and dip techniques
- K11. Specifications as per requirements
- K12. Loading capacity of stones in equipment.
- K13. Define different type of stones
- K14. Define soundness test
- K15. Importance of abrasion test for materials
- K16. Type of different Stones and its properties
- K17. Define Porosity
- K18. Define Skid Resistance

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Perform **Attrition** /abrasion test for stone samples
- Balance the samples in equipment.
- Skid Resistance test for Stones
- Load techniques of materials
- Absorption test of stones
- Durability test of stones

Important points

- Operate various types of stones in Machines.
- Ensure personal, co-workers and machine safety.
- Understand Capacity of trolley.
- Understand Loading capacity of trolley
- Understand Operations stones for different test
- Techniques of dipping the samples.
- Balancing and weighing the samples for safe handling



List of Machines and Tools	
Sr. #	Description
1.	Hand Trolley
2.	Spade
3.	Skid Resistance tester
4.	Spatula
5.	Measurement tape
6.	G. I. Tray
7.	File set
8.	Brick Hammer
9.	Chisel
10.	Tester
11.	Leveling Screws
12.	Water Container
13.	Water pump
14.	Adjustable Wrench
15.	Hammer set
16.	Screw driver set
17.	Pick axe
18.	Plumb bob
19.	Hydraulic Jack
20.	Puller
21.	Trowel
22.	Wheel barrow
23.	Hoe
24.	Abrasion Drum



11.14.8 Perform Chemical Test of stones

Overview: This competency standard covers the skills and knowledge required to perform Chemical test for bricks, blocks and stones. It helps the builders and site owners identify potential problems before committing resources to the project. **Testing** is also essential for keeping the structure in line with applicable legal requirements.

Competency Units	Performance Criteria
CU-1. Carry out initial preparatory activities.	P1. Access relevant job instructions from laboratory information management system (LIMS) P2. Interpret test request to confirm samples to be tested, the test method and equipment involved P3. Identify hazards to take sample P4. Prepare and workplace for task P5. Assemble / collect all required equipment and materials P6. Plan task / work sequences for optimum efficiency
CU-2. Perform Chemical / Efflorescence test for bricks and blocks (Soluble Salt Test)	P1. Select sample. P2. Dip the brick / block in water for specified time. P3. Dry the sample in shade for specified time. P4. Check the color and surface after specified time P5. Check Randomly different samples P6. Maintain record in register.
CU-3. Perform Acid Test for Stones	P1. Select sample. P2. Dip sample 5% Sulphuric Acid Solution for the specified time. P3. Dry the sample P4. Check stone sample sharpness P5. Check Randomly different samples P6. Maintain record in register.
CU-4. Perform Crystallization Test for Stones	P1. Select sample. P2. Weight and dry the sample. P3. Dry the sample P4. Dip sample in 14% solution of Sodium Sulfate (Na₂SO₄) for specified time P5. Dry sample for specified temperature & weight



	P6. Repeat test on sample for specified time P7. Apply formula P8. Compute result percentage P9. Maintain record as per S.O.P.
CU-5 Perform freezing and thawing test for stones (Weathering Test)	P1. Identify samples from different sources P2. Weigh the samples. P3. Immerse the samples in water P4. Store the immersed sample in freezer P5. Dry sample in the drying chamber P6. Observe the change in weight P7. Observe the change in length P8. Compute the results P9. Maintain record as per S.O.P.
CU-6 Perform microscopic test for stones	P1. Select sample. P2. Clean the sample. P3. Adjust sample under microscope P4. Observe the stone properties (<i>Average size of grain, Reality of pores, cavity, fissures, veins and shakes, Mineral constituents, Nature of cementing material, Presence of any harmful substance, Texture of stones etc</i>) P5. Maintain record as per S.O.P.
CU-6 Perform smith test for stones	P1. Select sample. P2. Clean the sample. P3. Place a few chips / pieces of stone in a test tube. P4. Fill the test tube with water P5. Stir / shake the test tube vigorously P6. Observe sample after specified time P7. Observe Presence of earthy matter. P8. Maintain record as per S.O.P.
CU-8 Maintain a safe work environment	P1. Use PPEs P2. Apply safe work practices P3. Rehabilitate sampling site P4. Minimize generation of wastes P5. Collect and dispose all waste



	P6. Clean and care all equipment. P7. Check serviceability of equipment before storage.
--	---

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:-

- K1. Introduction to Salt / Efflorescence test for bricks and blocks.
- K2. Operations of Salt tests.
- K3. Importance of Salt / Efflorescence tests.
- K4. Techniques of Salt / Efflorescence test.
- K5. Types of under burnt and over burnt bricks properties.
- K6. Capacity of Salt / Efflorescence test.
- K7. Sizes and uses of bricks in samples
- K8. Weighing of stone sample techniques.
- K9. Specifications as per requirements
- K10. Differentiate between Acid and Crystallization test of stones
- K11. Importance of Crystallization test for stones
- K12. Importance of Acid test for stones
- K13. Define PH value.
- K14. Define Freezing and Thawing
- K15. Define impurities in stone
- K16. Importance of smith test
- K17. Difference between soluble and insoluble matter
- K18. Use of microscope
- K19. Define stone properties (Average size of grain, Reality of pores, cavity, fissures, veins and shakes, Mineral constituents, Nature of cementing material, Presence of any harmful substance, Texture of stones etc)

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Check stones for in Salt / Efflorescence test.
- Adjust stone in equipment.



- Load and Unload the materials safely from the trolley
- Adjust for standard for Salt / Efflorescence test
- Fasten stone sample in clamp / Jaws and dip in water
- Care to keep sample in solution
- Observe the change in sample
- Adjust the stone in microscope
- Putting sample in test tube

Important points

- Operate various types of bricks in Machines.
- Ensure personal, co-workers and machine safety.
- Understand PPEs
- Understand Operations for brick test
- Techniques of brick dipping in water
- Balancing and weighing the bricks for safe handling
- Fixing of brick in Jaws safely
- Unloading the brick from jaws
- Unloading stones from chemical solution

List of Machines and Tools

Sr. #	Description
1.	Chisel
2.	Hand Trolley
3.	Spade
4.	Adjustable Wrench
5.	Spatula
6.	Measurement tape
7.	G. I. Tray
8.	File set
9.	Brick Hammer
10.	Water Container
11.	Freezing Machine
12.	Water pump



13.	Wrench set
14.	Grip pliers
15.	Pick axe
16.	Plumb bob
17.	Hydraulic Jack
18.	Puller
19.	Microscope
20.	Test tube
21.	Trowel
22.	Wheel barrow
23.	Hoe



11.14.9 Perform Strength Test for stones

Overview: This competency standard covers the skills and knowledge required to perform Crushing / Compressive Strength test for bricks, Blocks and Stones. These tests are helpful to estimate material behavior when it is subjected to a force or combination of different forces. A material's strength in a given application depends on many factors, including its resistance to deformation and cracking.

Competency Units	Performance Criteria
CU-1. Carry out initial preparatory activities.	P1. Access relevant job instructions from laboratory information management system (LIMS) P2. Interpret test request to confirm samples to be tested, the test method and equipment involved P3. Identify hazards to take sample P4. Prepare and workplace for task P5. Assemble / collect all required equipment and materials P6. Plan task / work sequences for optimum efficiency
CU-2. Perform Crushing Strength test for stones)	P1. Select sample. P2. Fill the Frog / Holes with prerequisite materials. P3. Dry the brick for specified time and temperature. P4. Apply Capping P5. Fix the brick in Compressive testing machine P6. Apply load at convenient rate on fixed sample. P7. Check crushing strength on gauge. P8. Maintain record in register.
CU-3. Perform Transverse strength test (Modulus of Rupture) for stones	P1. Select sample / specified specimen. P2. Fix sample wedge-shaped supports near its ends in the machine. P3. Apply load until failure at convenient specified rate. P4. Apply formula P5. Find out "Modulus of Rupture". P6. Maintain record in register.
CU-4. Perform Hardness test for stones.	P1. Select & weigh the sample. P2. Fix the sample on testing machine P3. Apply load at convenient rate on fixed sample. P4. Rotate machine for specified revolution and time.



	P5. Weigh the sample P6. Apply formula P7. Check co-officiant of hardness P8. Maintain record in register.
CU-5. Maintain a safe work environment	P1. Use PPEs definitely P2. Apply safe work practices P3. Rehabilitate sampling site and Minimize generation of wastes P4. Collect and dispose waste in accordance with environmental/quarantine requirements and workplace procedures P5. Clean all equipment P6. Check serviceability of equipment before storage

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

- K1. Introduction to Compressive / Crushing Strength test for samples.
- K2. Operations of Compressive / impact tests.
- K3. Importance of Compressive / impact tests.
- K4. Techniques of Compressive / impact tests.
- K5. Types of bricks and their properties.
- K6. Capacity of Crushing equipment / machine.
- K7. Measuring tools and techniques
- K8. Sizes and uses of stones in samples
- K9. Weighing of stone sample techniques.
- K11. Specifications as per requirements
- K12. Loading capacity of stones in equipment.
- K13. Define co-officiant
- K14. Differentiate between Hardness and Crushing strength
- K15. Define different type of stones
- K16. Different stone properties

Critical Evidence(s) Required



The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Load stones in testing machine.
- Balance the stones in equipment jaw
- Unload the sample safely from the testing machine
- Adjust the sample in testing machine.
- Adjust for standard
- Fasten stone in clamp / Jaws
- Modulus of Rupture
- Serviceability of equipment

Important points

- Operate various sample in testing Machines.
- Ensure personal, co-workers and machine safety.
- Understand Loading capacity of machine
- Understand Operations for brick test
- Techniques of brick frog filling
- Balancing and weighing the bricks for safe handling
- Fixing of brick in Jaws safely
- Prepare yourself for “PPEs”
- Maintaining record procedure
- Re-filling of fire extinguishers.

List of Machines and Tools

Sr. #	Description
1.	Compression Testing Machine
2.	Hand Trolley
3.	Spade
4.	Skid Resistance tester
5.	Spatula
6.	Measurement tape
7.	G. I. Tray
8.	File set
9.	Brick Hammer



10.	Chisel
11.	Tester
12.	Capping
13.	Water Container
14.	P.C. (Attached with U.T.M.)
15.	Water pump
16.	Wrench set
17.	Grip pliers
18.	Hammer set
19.	Spanner set
20.	Puller
21.	Hydraulic Jack
22.	Hoe
23.	Trowel
24.	Wheel barrow

List of Consumables

Sr. #	Description
1.	Lubricating oil
2.	Water
3.	Cloths
4.	Grease
5.	Kerosene oil
6.	Sand Paper
7.	Brushes
8.	Nuts and Bolts.
9.	Stones
10.	14% solution of Sodium Sulfate (Na_2SO_4)
11.	5% Sulphuric Acid Solution



11.15. Testing Properties of Timber

11.15.1 Perform Strength Test on wood

Overview: This competency standard covers the skills and knowledge required to perform Crushing / Compressive Strength test for wood. These tests are helpful to estimate wood behavior when it is subjected to a force or combination of different forces. A material's strength in a given application depends on many factors, including its resistance to deformation and cracking.

Competency Units	Performance Criteria
CU-1. Carry out initial preparatory activities.	P1. Access relevant job instructions from laboratory information management system (LIMS) P2. Interpret test request to confirm samples to be tested, the test method and equipment involved P3. Identify hazards to take sample P4. Prepare and workplace for task P5. Assemble / collect all required equipment and materials P6. Plan task / work sequences for optimum efficiency
CU-2. Perform compressive strength test on wood	P1. Select samples. P2. Clean wood sample. P3. Fix the wood sample in Compressive testing machine 1- samples parallel to grain, 2- samples perpendicular to grain P4. Apply load at convenient rate on fixed sample. P5. Check crushing strength on gauge. P6. Plot stress strain curve P7. Check the failure mode P8 Maintain record in register
CU-3. Perform tensile strength test on wood	P1. Select and clean samples. P2. Identify equipment's for test. P3. Fix the wood sample in universal testing machine 1 - samples parallel to grain, 2 - samples perpendicular to grain) P4. Apply load at convenient rate on fixed sample. P5. Check tensile strength on gauge.



	P6. Plot stress strain curve P7. Check the failure mode P8 Maintain record in register
CU-4. Perform flexural test on wood	P1. Select and clean samples. P2. Identify equipment's for test. P3. Fix the wood sample in machine P4. Apply load at convenient rate on fixed sample. P5. Calculate flexural strength P6. Maintain record
CU-5. Maintain a safe work environment	P1. Use PPEs and apply safe work practices P2. Rehabilitate sampling site and Minimize generation of wastes P3. Collect waste material P4. Dispose waste Material in accordance with environmental / quarantine requirements and workplace procedures P5. Clean the equipment P6. Check serviceability of equipment before storage

Knowledge & Understanding

The candidate must be able to demonstrate underpinning knowledge and understanding required to carry out the tasks covered in this competency standard. This includes the knowledge of:

- K1** Introduction to Compressive / Crushing Strength test for samples.
- K2** Operations of Compressive tests.
- K3** Importance of Compressive, tensile and flexural tests.
- K4** Types of wood and their properties.
- K5** Capacity of Crushing equipment / machine.
- K6** Measuring tools and techniques
- K7** Sizes and uses of wood in samples
- K8** Weighing of wood sample techniques.
- K9** Specifications as per requirements
- K10** Define tensile, compressive and flexural strength.

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:



- Load wood in testing machine.
- Balance the wood in equipment.
- Unload the sample safely from the testing machine
- Adjust the sample in testing machine.
- Adjust for standard
- Fasten wood in clamp / Jaws
- Serviceability of equipment

Important points

- Operate various sample in testing Machines.
- Ensure personal, co-workers and machine safety.
- Understand Loading capacity of machine
- Understand Operations for wood test
- Balancing and weighing the wood for safe handling
- Fixing of wood in Jaws safely
- Prepare yourself for “PPEs”
- Maintaining record procedure
- Re-filling of extinguishers.

List of Machines and Tools

Sr. #	Description
1	Hand Trolley
2	Cutter
3	Saw
4	Compressive Testing Machine
5	Measurement tape
6	Gauge
7	File set
8	Universal Testing Machine
9	3-Point Bending Apparatus



11.15.2 Determine hardness and impact timber

Overview: This competency standard covers the skills and knowledge required to identify type of timber, determine specific gravity of timber, find out moisture content of timber and determine compressive strength of timber

Competency Units	Performance Criteria
CU1. Carry out initial preparatory activities.	P1. Access relevant job instructions from laboratory information management system (LIMS) P2. Interpret test request to confirm samples to be tested, the test method and equipment involved P3. Identify hazards to take sample P4. Prepare and workplace for task P5. Assemble / collect all required equipment and materials P6. Plan task / work sequences for optimum efficiency
CU2.Determine hardness of timber	P1. Identify tools and equipment P2. Clean the sample P3. Measure dimensions of sample P4. Calibrate the apparatus. P5. Fix the timber sample in apparatus. P6. Adjust the jack so that surface touches the indenter. P7. Apply load at constant rate with help of apparatus. P8. Repeat the procedure for radial surface. P9. Calculate hardness of timber by taking average.
CU3.Perform impact test on timber (charpy impact test)	P1. Identify tools and equipment. P2. Weigh sample P3. Measure the sample with vernier caliper P4. Set the latching mechanism in upper position P5. Record the air friction and friction at bearing P6. Fix the sample in apparatus. P7. Horizontally across supports P8. Vertically across supports P9. Slide the pointer to its maximum energy on scale. P10. Raise the pendulum arm until it is firmly supported by machine. P11. Release pendulum arm. P12. Apply hand brake.



	P13. Record the reading on charpy scale. P14. Calculate impact strength.
CU4. maintain safe environment	P1. Use PPEs and apply safe work practices P2. Rehabilitate sampling site and Minimize generation of wastes P3. Collect waste material P4. Dispose waste Material in accordance with environmental / quarantine requirements and workplace procedures P5. Clean the equipment P6. Check serviceability of equipment before storage

Knowledge & Understanding

The candidate must be able to develop skills and understanding identify type of timber, determine specific gravity of timber, find out moisture content of timber and determine compressive strength of timber required to carry out tasks covered in this competency standard. This includes the knowledge of:

- K1. Define wood
- K2. Explain Constructional wood (timber) with sketch
- K3. Explain structure and growth of timber.
- K4. wood types and Uses of various wooden products
- K5. Felling and conversion of timber.
- K6. Defects and decay of timber.
- K7. Qualities-characteristics, section of timber
- K8. Define hardness and impact resistance of timber
- K9. Explain the importance of impact resistance.

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Report on hardness of timber
- Report on impact test of timber

Tools and Equipment



1. Digital weighing balance
2. Laboratory oven
3. Vernier caliper
4. Pendulum type single blow impact testing machine
5. Janka ball indenter with dial gauge
6. PPEs
7. File with record sheet
8. Cleaning tools



11.15.3 Determine properties and types of locally manufactured timber

Overview: This competency standard covers the skills and knowledge required to identify type of timber, determine specific gravity of timber, find out moisture content of timber and determine compressive strength of timber

Competency Units	Performance Criteria
CU1. Identify type of timber	P1. Recognize color and odor of locally produced timber P2. Prepare a list of locally produced timber in accordance with color and odor P3. Identify type of given timber sample
CU2. Determine specific gravity of timber	P1. Identify tools and equipment P2. Measure dimensions of sample P3. Weigh sample P4. Calculate specific gravity of timber by computing density
CU3. Find out moisture content of timber	P1. Identify tools and equipment P2. Weigh sample before oven drying P3. Weigh sample after drying sample P4. Calculate moisture content
CU4. Determine compressive strength of timber	P1. Identify tools and equipment P2. Assemble sample in equipment by placing sample perpendicular to grain P3. Find out compressive strength according to specification P4. Repeat process by placing sample parallel to grain P5. Interpret compressive strength

Knowledge & Understanding

The candidate must be able to develop skills and understanding identify type of timber, determine specific gravity of timber, find out moisture content of timber and determine compressive strength of timber required to carry out tasks covered in this competency standard. This includes the knowledge of:

- K1.** Define wood
- K2.** Explain Constructional wood (timber) with sketch
- K3.** Explain structure and growth of timber.
- K4.** wood types and Uses of various wooden products
- K5.** Felling and conversion of timber.



- K6. Defects and decay of timber.
- K7. Qualities-characteristics, section of timber
- K8. Explain the procedure of specific gravity test.
- K9. Define seasoning and its types.
- K10. Explain importance of seasoning.
- K11. Define moisture content and OMC of timbe
- K12. Describe the Specifications for the compression test.

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Report on specific gravity of timber
- Report on moisture content of timber
- Report on compressive strength of timber

Tools and Equipment

- Compression testing machine
- Ply wood
- Vernier caliper
- Digital weighing balance
- PPEs
- File with record sheet
- Brush /cleaning tool
- Digital weighing balance
- Laboratory oven
- Container
- Digital moisture meter



11.15.4 Make simple calculations of timber

Overview: This competency standard covers the skills and knowledge required to prepare a drawing of product and estimate timber quantity

Competency Units	Performance Criteria
CU1. Prepare a drawing of product	P1. Identify drawing tools P2. Perform basics of drawing P3. Draw plan, cross section and elevation of product
CU2. Estimate timber quantity	P1. Identify components of product P2. Recognize timber requirement for specific components of product P3. Calculate quantities of timber

Knowledge & Understanding

The candidate must be able to develop skills and understanding to prepare a drawing of product and estimate timber quantity required to carry out tasks covered in this competency standard. This includes the knowledge of:

- K1. Measuring of wood square and board
- K2. Measuring of Log
- K3. Description and use of drawing tools

Critical Evidence(s) Required

The candidate needs to produce following critical evidence(s) in order to be competent in this competency standard:

- Use of tools
- Compliance to OHS requirement

Tools and Equipment

1. Drafting table
2. Drafting tools
3. Drawing sheet
4. PPEs
5. File with record sheet
6. Measuring tape



Complete List of Equipments

List of Machines and Tools	
Sr. #	Description
1.	Compression Testing Machine
2.	Hand Trolley
3.	Spade
4.	Skid Resistance tester
5.	Spatula
6.	Measurement tape
7.	G. I. Tray
8.	File set
9.	Brick Hammer
10.	Chisel
11.	Tester
12.	Leveling Screws
13.	Water Container
14.	Freezing Machine
15.	Water pump
16.	Wrench set
17.	Grip pliers
18.	Hammer set
19.	Screw driver set
20.	Pick axe
21.	Plumb bob
22.	Hydraulic Jack
23.	Puller
24.	Plumb rule
25.	Spanner set
26.	Torque Wrench
27.	Pipe Wrench
28.	Adjustable Wrench
29.	Safety glasses
30.	Trowel



31.	Wheel barrow
32.	Hoe
33.	Abrasion Drum
34.	P.C. (Attached with U.T.M.)
35.	Test tube
36.	Microscope

List of Consumables

Sr. #	Description
1.	Lubricating oil
2.	Water
3.	Cloths
4.	Grease
5.	Kerosene oil
6.	Sand Paper
7.	Brushes
8.	Nuts and Bolts.
9.	Stones
10.	14% solution of Sodium Sulfate (Na_2SO_4)
11.	5% Sulphuric Acid Solution

List of Personal Protective Equipment

Sr. No	Description
1.	First Aid Box
2.	Fire Blanket
3.	Fire Bucket
4.	Safety Gloves
5.	Ear Protector
6.	Safety Goggles
7.	Safety Helmet
8.	Safety Mask
9.	Safety Shoes
10.	Safety Belt



11.	Sanitizer
12.	Formal Uniform for Work

List of Stationary

Sr. #	Description
1.	Handbooks / white papers / white charts
2.	File cover and files
3.	Pencils with color pencils
4.	Rubber
5.	Sharpeners
6.	Paper Cutter & Seizers
7.	White board with white board markers
8.	Multimedia