



REPUBLIC OF KENYA  
MINISTRY OF ROADS AND TRANSPORT

# RDM 3.2

## Road Design Manual

**Volume 3: Materials and Pavement Design for New Roads**

Part 2: Materials Field and Laboratory Testing

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## Foreword

This manual was developed by the Ministry pursuant to The Fourth Schedule of the Constitution which assigns to the National Government the functions and powers of setting standards for the construction and maintenance of all public roads including those under the County Governments.

It is part of a series of manuals that replace the first generation of road manuals developed in the first and second decades after independence. This second generation of the road manuals were developed to cover the entire road project cycle covering planning, appraisal, design, contracts, construction, maintenance, operations and monitoring. The series incorporates best practices, climate change considerations, and recent technologies to enable the provision of road infrastructure that is safe, secure, and efficient.

Under the Kenya Vision 2030 long term plan, infrastructure expansion and modernisation are some of the foundations for the realisation of economic, social and political transformation of Kenya into a rapidly industrialising middle-income country. The plan envisages an integrated, safe and efficient transport and communication infrastructure network consisting of roads, railways, ports, airports, waterways, and telecommunications infrastructure.

The strategies to be pursued under the Vision 2030 plan to improve infrastructure services and to maximise the economic and social impacts of infrastructure development and management include: Strengthening of the institutional framework for infrastructure development and maintenance; Raising efficiency and quality of infrastructure projects; Enhancing local content of identified infrastructure projects to minimise import content; Benchmarking infrastructure facilities and services provision with globally acceptable performance standards; and, Implementing infrastructure projects that will stimulate demand in hitherto marginalised areas.

The first three 5-year Medium Term Plans (MTP) under the Vision 2030 from 2008 to 2022 targeted construction of 1,950 km, 5,500 km and 10,000 km of new paved roads under MTP I, II and III, respectively, totalling 17,450 km. This was a massive infrastructure development program intended to double the paved road network in 10 years compared to 8,600 km developed from independence in 1963 to 2008.

Implementation of MTP I to III resulted in the construction of 14,000 km of paved roads, which extended the paved road coverage to Arid and Semi-Arid regions, that had been previously neglected. However, some key milestones of the Vision 2030 goals have not been realised. This has been due to internal and external challenges. External challenges included: climate change – prolonged droughts; the emergence of COVID-19 pandemic; global supply chain disruptions; exchange rate volatility; and rising interest rates in the leading economies.

The internal challenges included: inadequate road maintenance equipment; pavement overloading by heavy goods vehicles; huge maintenance backlog of the road network; low contracting and supervision capacity particularly in the Counties; poor quality control and assurance of works; congestion in urban areas; encroachment on road reserves; high costs and delays in payments of land acquisition; lack of harmonisation of cross-border transport regulation and operational procedures; rapid urbanisation; increased traffic volume with exponential growth of motorcycle traffic; high cost/delays in relocation of utilities and services along and across road reserves; inadequate funding of projects and programs; and, delay or default in payments for goods, services and works.

The implementation of MTP III came to an end on 30th June 2023, ushering in the implementation of the Fourth Medium Term Plan (MTP IV), which has been aligned to the aspirations of the Kenya Vision 2030 and the Kenya Kwanza Government's Bottom-Up Economic Transformation Agenda (BETA) planning approach and its key priorities.

BETA is the Government's transformation agenda geared towards economic turnaround through a value chain approach. BETA has targeted sectors with the highest impact to drive economic recovery and growth. This will be achieved through bringing down the cost of living; eradicating hunger; creating jobs; expanding the tax base; improving foreign exchange balances; and inclusive growth. BETA ensures rational resource allocation by eliminating wastage of resources occasioned by duplication, overlaps, fragmentation and ineffective coordination in the implementation of programmes and projects.

The Fourth Medium Term Plan key priorities are clustered under five key sectors, namely: Finance and Production; Infrastructure; Social; Environment and Natural Resources; and Governance and Public Administration. The infrastructure sector seeks to: enhance transport connectivity by constructing 6,000 km of new roads, maintaining rural and urban roads, rail, air and seaport facilities and services; expand communication and broadcasting systems; and promote the development of energy generation and distribution by increasing investments in green energy (geothermal, wind, solar and hydro). The infrastructure gap is expected to be bridged by promoting economic participation of the private sector through public private partnerships in the financing, construction, development, operation, and maintenance of infrastructure.

The plan entails a shift of focus to fundamentals in project planning and implementation which include: respect for technical input, regulations and standard practices; adherence to project life cycle i.e., planning, feasibility studies and design before procurement of works; public and stakeholder consultation; procurement within budgetary ceilings; shifting focus during project implementation from the finished product 'black top' to the construction of the foundation; building local capacity particularly MSMEs by ensuring prompt payments; and capacity building at all levels to enable internalisation of policies and processes.

The first generation of the road manuals were used for 35 to 45 years. It is my sincere hope that the second generation of the road standards which have been developed in alignment with the Government's strategy will provide guidance in solving most of the above challenges and those expected to emerge in the next 50 years. Implementation of the manuals will enable achievement of the Government aspirations which include inclusive growth; creation of sustainable employment; building of MSMEs; climate change adaptation and realisation of the UN SDGs; enhanced efficiency in management of infrastructure and transport system; and, laying the foundation for the next national long-term plan at the end of the Vision 2030.

On behalf of the Government of Kenya, I would wish to thank the European Union for financing the development of the first drafts of the manuals in 2009 and the African Development Bank for the financial support in the review and updating of the manuals. I would also like to thank the members of the National Steering Committee and the Technical Task Force for their input. The Technical Administrators, and the Kenya National Highways Authority (KeNHA) for the procurement and able administration of the consultancy Contract. I also thank the Consultant, TRL Limited for their role in providing technical expertise that was essential for the success of the manuals updating exercise. I also wish to express my deepest appreciation to our stakeholders and all those who have contributed to this process and the staff of the Ministry for their continued input.

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**Hon. Davis K. Chirchir, E.G.H**

Cabinet Secretary, Ministry of Roads and Transport

## Preface

A good understanding of material properties and their variability is necessary for the reliable design of new roads. Part 2 of Volume 3 provides the test standards and test methods to be followed for conducting field and laboratory tests at the design stage.

Field tests conducted for the determination of the soil profiles, and indication of material strength where applicable, such as the dynamic cone penetration tests and test pit excavation, have been described and reference made to the relevant test standards. Geotechnical tests for strength properties of soils and rocks, and compressibility properties of soils have also been included. Furthermore, tests to determine material properties for soils, gravels, aggregates, hydraulically modified and hydraulically bound materials, concrete pavements, bituminous binders, and mixtures, steel, water, road marking, paints for structures, geosynthetics and bridge components are provided.

The title of the test standards referenced within the manual have been provided in the appendix to this Part. Following the standards and best practices provided herein will ensure agreement and acceptance of results between laboratories and designers without the need for further testing. This will also ensure that the tests are repeatable in the case of a dispute or if there is a need for conducting the test on a modified sample or redoing the test later.

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**Eng. Joseph M. Mbugua, CBS**

Principal Secretary, State Department for Roads

# Document Management

## Document Status

This document has the status of a Manual. Users shall apply the contents there-in to fully satisfy the requirements set out. The content of the manual is based on current practice in Kenya and latest practices in the road sector, both regionally and internationally.

## Sources of the Document

Copies of the document can be obtained from:

**The Principal Secretary**, State Department for Roads, Ministry of Roads and Transport, Works Building, Ngong Road, P.O. Box 30260 - 00100, NAIROBI Email: ps@road.go.ke

A secured PDF copy maybe downloaded from: [www.roads.go.ke/downloads](http://www.roads.go.ke/downloads)

## Notification of Errors and Requests for Amendments

While all care and consideration has been applied in the compilation of this document, the Ministry accepts no responsibility for failure in any way related to the application of this manual or any reference documents cited in it.

Requests for edits and corrections can be freely sent to the following address:

**The Principal Secretary**, State Department for Roads, Ministry of Roads and Transport, Works Building, Ngong Road, P.O. Box 30260 - 00100, NAIROBI Email: ps@road.go.ke

## Amendments Request Form

Request No.	Name	Organisation	Chapter	Page	Section/ Clause	Ref. to: Figure/ Table/	Type of request:	Request

Type of request: General – G; Editorial – E; Technical - T

## Amendments to Date

Amendment No.	Description	Amendment Effective Date	Amendment Approved by

## Acknowledgements

This Manual was prepared by the Ministry of Roads and Transport, State Department for Roads, with the kind assistance of the African Development Bank.

A National Steering Committee was set up and chaired by the Permanent Secretary, Ministry of Roads and Transport, with the following membership: Principal Secretary for Devolution, Office of the Deputy President; Chief Executive Officer, Inter-Governmental Relations Technical Committee; Chief Executive Officer, Council of Governors; Managing Director and Council Secretary, Kenya Bureau of Standards; Director, National Transport and Safety Authority; Director General, Kenya Roads Board; Director General, Kenya Wildlife Services; Chief Executive Officer, Engineers Board of Kenya; Director General, Kenya Rural Roads Authority; Director General, Kenya Urban Roads Authority; President, Institution of Engineers Kenya; Director Policy, Strategy and Compliance; Kenya National Highways Authority; Chief Engineer, Roads Division, State Department for Roads; Chief Engineer, Materials Testing and Research Division, State Department for Roads.

The technical work was undertaken under the guidance of a Technical Task Force, chaired by Eng. David Maganda, with the following gazetted members: Francis Gichaga (Prof.) (Eng.), Andrew Gitonga (Eng.), Timothy Nyomboi (Dr.) (Eng.), Rosemary Kungu (Eng.), Charles Obuon (Eng.), Sylvester Abuodha (Prof.) (Eng.), Samuel Kathindai (Eng.), Nicholas Musuni (Eng.), Charles Muriuki (Eng.), Tom Opiyo (Eng.), John Maina (Eng.), Fidelis Sakwa (Eng.), Daniel Cherono (Eng.), Maurice Ndeda (Eng.), Theo Uwamba (Eng.).

The Consultant for the review and updating of the manuals and specification for road and Bridge Construction was TRL Limited (UK), in partnership with Consulting Engineers Group Ltd, India and Norken International Limited, Kenya. The Consultant's team composed of the Team Leader, Charles T. Bopoto (Eng.), Pavements Lead Expert, Andrew Otto (Eng.), Author, Angella Lekea (Eng.), and Project Manager, Warsame Mohamed.

Technical Administration was provided by James Kung'u (Eng.), Joachim Mbarua (Eng.) and Stephen K. Kogi (Eng.), assisted by the project secretariat Esther E.O. Amimo (Eng.), Monicah Wangare (Eng.) and Catherine K. Ndinda (Eng.)

Project coordination was provided by the KeNHA team led by Kungu Ndungu (Eng.) and J. N. Gatitu (Eng.), supported by Victoria Okumu (Dr.), (Eng.), Isaiah Onsongo (Eng.), Clarence Karot (Eng.), Howard Ashihundu (Eng.), Naomi Njoki Nthiga (Eng.), Shiphras Mibey (Eng.), Mateelong Moses (Eng.) and Rose Rahabwanjohi (Eng.).

## Abbreviations

<b>AASHTO</b>	American Association of State Highway and Transportation Officials	<b>IBI</b>	Immediate bearing index
<b>AAV</b>	Aggregate abrasion value	<b>ICL</b>	Initial consumption of lime
<b>ACV</b>	Aggregate crushing value	<b>ISO</b>	International Standard Organisation
<b>AGPT/T</b>	Australian general practice training/ test no.	<b>KeNHA</b>	Kenya National Highways Authority
<b>AIV</b>	Aggregate impact value	<b>KS</b>	Kenya Standard
<b>ALD</b>	Average least dimension	<b>LL</b>	Liquid limit
<b>ASTM</b>	American Society for Testing and Materials	<b>MC</b>	Moisture content
<b>BS</b>	British Standard	<b>MDD</b>	Maximum dry density
<b>BS EN</b>	British Standards European Norms	<b>NDG</b>	Nuclear density gauge
<b>CBR</b>	California bearing ratio	<b>NDT</b>	Non-destructive tests
<b>CPT</b>	Cone penetration test	<b>OMC</b>	Optimum moisture content
<b>CQS</b>	Cationic quick setting	<b>PI</b>	Plasticity index
<b>DMRB</b>	Design Manual for Roads and Bridges	<b>PL</b>	Plastic limit
<b>DCP</b>	Dynamic cone penetration	<b>PSV</b>	Polished stone value
<b>DPL</b>	Dynamic probing light	<b>SG</b>	Specific gravity
<b>DSR</b>	Dynamic shear rheometer	<b>SPT</b>	Standard penetration test
<b>FACT</b>	Fine aggregate crushing test	<b>SSS</b>	Sodium Sulphate soundness
<b>FI</b>	Flakiness index	<b>TFV</b>	Ten percent fines value
<b>GPS</b>	Global positioning system	<b>TRL</b>	Transport Research Laboratory
<b>HBM</b>	Hydraulically bound materials	<b>UCS</b>	Unconfined compressive strength
<b>HF</b>	Hubbard - Field	<b>VH</b>	Vibrating hammer
		<b>RDM</b>	Road Design Manual
		<b>Vol</b>	Volume



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# 1 Introduction

## 1.1 General

This Manual was prepared by the Ministry as part of a series of manuals that cover the entire project cycle. The series incorporate best practices, climate change considerations, and recent technologies to enable the provision of road infrastructure that is safe, secure, and efficient.

The Kenya road manual series is as follows:

Project Cycle Stage	Manual: Volume or Part/Chapter	Code
<b>A. General</b>	<b>Procedures and Standards Manual</b>	<b>PSM</b>
	1. General	
	2. Policies	
	3. Procedures Guidance	
	4. Codes of Practice	
	5. Guidelines	
<b>B. Planning</b>	<b>Network and Project Planning Manual</b>	<b>NPM</b>
	1. Road Classification	
	2. Route/Corridor Planning	
	3. Route/Corridor Planning	
	4. Highway Capacity	
<b>C. Appraisal</b>	<b>Project Appraisal Manual</b>	<b>PAM</b>
	1. Environmental Impact Assessment and Audit	
	2. Social Impact Assessment	
	3. Traffic Impact Assessment	
	4. Road Safety Audits	
	5. Project Appraisal	
<b>D. Design</b>	<b>Road Design Manual</b>	<b>RDM</b>
	1. Geometric Design	
	2. Hydrology and Drainage Design	
	3. Materials and Pavement Design for New Roads	
	4. Bridges and Retaining Structures Design	
	5. Pavement Maintenance, Rehabilitation and Overlay Design	
	6. Traffic Control Facilities and Communication Systems Design	
	7. Road Lighting Design	
<b>E. Contracts</b>	<b>Works and Services Contracts Manual</b>	<b>WSCM</b>
	1. Forms of contracts	
	2. Standard Specification for Road and Bridge Construction	
	3. Bills of Quantities	
<b>F. Construction</b>	<b>Road Construction Manual</b>	<b>RCM</b>
	1. Construction Management	
	2. Project Management	
	3. Site Supervision	
	4. Quality Assurance	
	5. Quality Control	

This table continues onto the next page...

Project Cycle Stage	Manual: Volume or Part/Chapter	Code
<b>G. Maintenance</b>	<b>Road Asset Management Manual</b>	<b>RAAM</b>
	1. Maintenance Management	
	2. General Maintenance	
	3. Pavement Maintenance	
	4. Bridges and Structures Maintenance	
<b>H. Operations</b>	<b>Road Operation Manual</b>	<b>ROM</b>
	1. Traffic Management	
	2. Vehicle Load Control	
	3. Emergency Services	
	4. Tolling	
<b>I. Monitoring &amp; Evaluation</b>	<b>Road Design Manual</b>	<b>MEM</b>
	1. Performance Monitoring Manual	
	2. Technical Audits	
	3. Poverty, Gender Equality and Social Inclusion Monitoring	

This Road Design Manual, Volume 3, Part 2 – Materials Field and Laboratory Testing is part of the Roads Design Manual made up of a series of volumes and shown below:

**Table 1.1** Road Design Manual (RDM) Coding Structure

Vol.	Manual Title	Part Name	Code
<b>1</b>	<b>Road Design Manual: Vol. 1</b> Geometric Design	<b>Part 1</b> - Topographic Survey	RDM 1.1
		<b>Part 2</b> – Traffic Surveys	RDM 1.2
		<b>Part 3</b> – Geometric Design of Highways, Rural and Urban Roads	RDM 1.3
<b>2</b>	<b>Road Design Manual: Vol. 2</b> Hydrology & Drainage Design	<b>Part 1</b> – Hydrological Surveys	RDM 2.1
		<b>Part 2</b> – Drainage Design	RDM 2.2
<b>3</b>	<b>Road Design Manual: Vol. 3</b> Materials & Pavement Design for New Roads	<b>Part 1</b> – Ground Investigations and Material Prospecting	RDM 3.1
		<b>Part 2</b> – Materials Field and Laboratory Testing	RDM 3.2
		<b>Part 3</b> – Pavement Foundation and Materials Design	RDM 3.3
		<b>Part 4</b> – Flexible Pavement Design	RDM 3.4
		<b>Part 5</b> – Rigid Pavement Design	RDM 3.5
<b>4</b>	<b>Road Design Manual: Vol. 4</b> Bridges & Retaining Structures Design	<b>Part 1</b> – Geotechnical Investigation and Design	RDM 4.1
		<b>Part 2</b> – Bridge and Culvert Design	RDM 4.2
		<b>Part 3</b> – Retaining Structures Design	RDM 4.3
		<b>Part 4</b> – Reinforced Fill Structures Design	RDM 4.4
		<b>Part 5</b> – Bridges and Structures Condition Survey	RDM 4.5
		<b>Part 6</b> – Bridge Maintenance Design	RDM 4.6
<b>5</b>	<b>Road Design Manual: Vol. 5</b> Pavement Maintenance, Rehabilitation & Overlay Design	<b>Part 1</b> – Pavement Condition Survey	RDM 5.1
		<b>Part 2</b> – Pavement Maintenance, Rehabilitation and Overlay Design	RDM 5.2
<b>6</b>	<b>Road Design Manual: Vol. 6</b> Traffic Control Facilities & Communication Systems Design	<b>Part 1</b> – Road Marking	RDM 6.1
		<b>Part 2</b> – Traffic Signs	RDM 6.2
		<b>Part 3</b> – Traffic Signals and Communication System	RDM 6.3
		<b>Part 4</b> – Other Traffic Control Devices	RDM 6.4
<b>7</b>	<b>Road Design Manual: Vol. 7</b> Road Lighting Design	<b>Part 1</b> – Grid-connected Road Lighting	RDM 7.1
		<b>Part 2</b> – Solar Road Lighting	RDM 7.2

This manual must be applied sensibly and flexibly in conjunction with the skill and judgement of the designer. Compliance with the guidance given in the manual does not relieve designers of the responsibility for establishing that their design is suitable, appropriate, safe and adequate for the purpose stated in the project requirements.

## 1.2 Objectives of this Part

Test standards have been provided in this Part, to ensure agreement between test results from different laboratories. This will also ensure that tests are repeatable. Consequently, more reliable, and cost-effective designs for new roads can be undertaken.

## 1.3 Scope of this Part

This part provides the test standards for sampling and testing materials such as soils, gravels, aggregates, hydraulic road binders, lime, bituminous binders, bitumen stabilised and bitumen bound materials used in road construction. Test standards for other materials such as cement, concrete, and steel used for construction of structural elements and rigid pavements are also provided. Standards for conducting field ground tests and tests for laboratory geotechnical investigations are also provided.

## 1.4 Organisation of the Manual

This Part comprises twenty chapters. The first chapter is an introductory chapter and includes the scope and objectives of this part. Issues pertinent to the laboratory such as health, safety and environment, calibration, data management and reporting are discussed in Chapter two. Chapter three provides a list of test standards for conducting field ground tests. Chapters four to twenty cover testing standards for determining strength and material properties for geotechnical design; soils and gravels; aggregates; hydraulic road binders; lime; cement; bituminous binders; steel; hydraulically modified and hydraulically bound materials; concrete pavements; water; bitumen stabilised materials; bitumen bound materials; road marking and signs; paints for structures, geosynthetics and bridge components, respectively. The titles of the test standards referenced in the manual are provided in the appendix.

The procedure to follow for prospecting material sources and alignment investigations at the feasibility and preliminary design stage as well as the detailed design stage is provided in RDM 3.1. Material properties for classification and strength obtained following the test methods in this part shall be used to feed into the pavement design procedure in RDM 3.3. Test standards for steel and geosynthetics to be used in structural design as detailed in parts of RDM 4 are also provided herein.

## 1.5 Departure from Standards

Where the designer departs from a standard, written approval must be obtained from the Chief Engineer for Roads.

In seeking approval of a departure from standards, a designer should submit the following information according to the standard format prescribed in the preliminaries to this manual:

1. The number, name, and description of the road section;
2. The design parameter for which a Departure from Standards is desired;
3. A description of the standard, including normal value, and the value of the Departure from Standards;
4. The reason for the Departure from Standards;
5. Any mitigation to be applied in the interests of safety; and
6. Justification for the departure.

The approval of departures by the Chief Engineer for Roads may involve a consultative process in accordance with the guidance in the procedures and guidelines manual, or statutes governing public consultations.





## 2 Preliminary Considerations

### 2.1 General

This chapter covers major considerations for operating a laboratory. Some of the necessary health, safety and the environment considerations are included. These are to be followed in combination with the necessary statutory requirements. The need for calibration and proper record keeping is addressed.

The different test standards followed in this Part are provided and the reporting requirements which shall be according to the standard referenced for the respective test.

### 2.2 Health, Safety and the Environment

Appropriate occupational, health and safety practices shall be put in place for each activity in the field and the laboratory. The right personal protective equipment shall always be worn when required. The workspaces in the laboratory must be as ergonomic as possible.

Every laboratory shall be equipped with a serviced and functioning fire extinguisher. Workers shall be made aware of the location of the safety zone in case of a fire. This shall be free from any obstructions and easily accessible. Training staff as to the proper use of fire extinguishers is essential to minimising fire outbreaks.

The environmental impact assessment for laboratory set-up shall include the likely waste materials, their quantities and impacts on the environment. Proper waste disposal shall be ensured. Waste sites shall be suitably located and easily accessible. Necessary measures shall be put in place to prevent and/or control pollution. The relevant environmental statutory requirements shall be adhered to.

### 2.3 Calibration

Laboratory equipment shall have yearly certification of calibration provided by the Kenya Accreditation Service (KENAS) or any of its accredited service provider.

Routine laboratory calibration may be done in-house by suitably qualified and experienced personnel according to the standard procedures set out for each item. The relevant standards shall be referred to for the methodology and frequency of calibration.

The precision of the test standard shall be one order higher than that of the equipment to be calibrated. Equipment should be re-calibrated at regular intervals. Up to date calibration data should be readily available for reference. Calibration records shall contain information on:

- Identification number of the instrument.
- Date Calibrated.
- By whom it was calibrated.
- Due date of the next calibration.

Ideally this information should be displayed on the instrument or within its sight.

## 2.4 Data Management

The sample number and sample description shall be correctly recorded on each test form. Any special testing instructions should also be included. Figures and calculations shall be checked, and the test results approved, preferably by different personnel.

Laboratory test samples from which specimens are picked shall be properly stored and disposed of once it is confirmed no further information is required for testing. Proper record keeping for field and laboratory forms shall be ensured. Both electronic and hardcopy files shall be kept in a good condition and well labelled for ease of reference and tracing.

## 2.5 Test Standards

Test standards such as American Association of State Highway and Transportation (AASHTO), American Society for Testing and Materials (ASTM), British Standards (BS) and British Standards European Norm (BS EN) have been referenced.

Manufactured products such as cement, lime, and hydraulic road binders etc shall be tested according to the relevant Kenya standard. Where a Kenya Standard is not available, an international standard has been provided.

Where reference is made to a test standard, the year has not been included and the latest edition of the referenced document (including any amendments) applies. For references to clauses in a test standard, the year has been included to account for changes that may occur in subsequent revisions to the standard.

For contracting purposes, the current and active test standard at twenty eight (28) days before the closing date of the tender shall be applicable. [Appendix 1](#) provides a list of the titles of the various test standards referred to in this manual.

## 2.6 Reporting

The reporting requirements of each standard test procedure shall be adhered to. Additional information to include in the test report has also been provided in this manual.

## 3 Field Ground Tests

### 3.1 General

This chapter provides the test standards for field tests conducted in the design of road alignments. Any deviations from the standard test procedure should be included in the test report.

### 3.2 Standard Methods of Testing

Test standards for conducting field ground tests are provided in Table 3.1.

**Table 3.1** Testing Standards for Field Ground Tests

S/No.	Test Description	Test Standard
1.	Field Density – Sand Replacement method ( <i>Small pouring cylinder</i> )	BS 1377-9:1990, Cl. 2.1
2.	Field Density – Sand Replacement method ( <i>Large pouring cylinder</i> )	BS 1377-9:1990, Cl. 2.2
3.	Field Density – Nuclear method	BS 1377-9:1990, Cl. 2.5
4.	In-situ California Bearing Ratio ( <i>CBR</i> ) Test	BS 1377-9: 1990, Cl. 4.3
5.	Plate Loading Test	BS 1377-9: 1990, Cl. 4.1
6.	Field Density – Water Replacement Test method	BS 1377-9:1990, Cl. 2.3
7.	Field Density – Core Cutter Test method	BS 1377-9:1990, Cl. 2.4
8.	Field Density – Electrical method	Manufacturer's guidance
9.	In-situ Penetration Test ( <i>Static Cone Penetration Test, SCPT</i> )	ISO 22476-1 for electrical CPT BS EN 22476-12 for mechanical CPT
10.	In-situ Penetration Test ( <i>Dynamic Probing, DP</i> )	ISO 22476-2
11.	In-situ Penetration Test ( <i>Standard Penetration Test, SPT</i> )	ISO 22476-3
12.	In-situ Corrosivity Test ( <i>Apparent Resistivity of Soil</i> )	BS 1377-9: 1990, Cl. 5.1
13.	In-situ Corrosivity Test ( <i>Redox Potential of Soil</i> )	BS 1377-9: 1990, Cl. 5.2
14.	In-situ Vane Shear Strength Test	ISO 22476-9

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Field Ground Tests

## 4 Geotechnical Tests

### 4.1 General

Most of the tests used in the stability analysis of cut slopes, embankment fill, retaining walls and reinforced earth walls are covered under geotechnical tests. These shall include tests for shear strength, consolidation/compressibility, permeability and specific gravity. Undisturbed samples obtained using a rotary core or samples taken by pushing thin-walled tubes into the ground under steady pressure should be used for strength and compressibility testing. Minimum disturbance should be ensured during sample extrusion.

### 4.2 Undisturbed Soil Sampling

Soil samples may be categorised into five types from Category A to Category E with increasing level of disturbance. Laboratory tests for strength, compressibility and stiffness shall be conducted on samples categorised as A. Tests for permeability, porosity and density of fine soils may be conducted on category B samples. Test pits may be used for obtaining samples. Alternatively, samples may be obtained using an open sampler, core sampler, auger sampler or a piston sampler. Samples can be obtained using samplers in combination with drilling. Detailed information for choice of sampling method is provided in ISO 22475-1.

### 4.3 Rock Sampling

Much like soils, rock samples are categorised into five from Category A to Category E. Category A and Category B samples may be used for the determination of strength and deformation properties. Samples may be obtained by core drilling or rotary open hole drilling as described in ISO 22475-1.

### 4.4 Earlier Uses and State of Site

Test standards for conducting geotechnical tests on soil and rock samples are provided in Table 4.1.

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Geotechnical Tests

Table 4.1 Geotechnical Test Standards for Soils and Rocks

S/No.	Test Description	Test Standard
<b>FIELD TESTS</b>		
1	Sampling of soil, rock and groundwater	ISO 22475-1
2	Electric Cone Penetration Test	ISO 22476-1
3	Mechanical Cone Penetration Test	ISO 22476-12
4	Dynamic Probing	ISO 22476-2
5	Standard Penetration Test, SPT	ISO 22476-3
6	Plate Bearing Test	ISO 22476-13
7	Geohydraulic Tests	ISO 22282-1
8	Field Density	BS 1377-9
9	Flat Dilatometer Test	ISO 22476-11
10	Field Vane Shear Test	ISO 22476-9
11	Menard Pressuremeter Test	ISO 22476-4
12	In-situ Stress Measurement Tests	BS 5930
13	Redox potential	ISO 11271
14	Measuring while drilling	ISO 22476-15
<b>LABORATORY TESTS</b>		
15	Water content	ISO 17892-1
16	Bulk density	ISO 17892-2
17	Particle density	ISO 17892-3
18	Particle size distribution	ISO 17892-4
19	Atterberg Limits	ISO 17892-12
20	Organic content	BS 1377-3, CI 4
21	Carbonate content	BS 1377-3, CI 8
22	Sulfate content	BS 1377-3, CI 7
23	pH value	BS 1377-3, CI 12
24	Chloride content	BS 1377-3, CI 9
25	Unconfined compression test	ISO 17892-7
26	Unconsolidated undrained triaxial compression test	ISO 17892-8
27	Consolidated triaxial compression test	ISO 17892-9
28	Compressibility and deformation	ISO 17892-5
29	Direct Shear Test	ISO 17892-10
30	Strength index tests	ISO 17892-6
31	Permeability and erodibility	ISO 17892-11
32	Compaction	BS 1377-4
33	Uniaxial compression	ASTM D7012
34	Indirect tensile test	ASTM D3967
35	Point load test	ASTM D5731

## 5 Soils and Gravels

### 5.1 General

This chapter covers the standard procedures to be followed for the sampling of soils and gravels. Tests to determine their engineering properties and thus their suitability for use as pavement materials are included.

### 5.2 Standard Methods of Testing

Test standards for conducting laboratory tests on disturbed samples for soils and gravels are provided in Table 5.1.

**Table 5.1** Test Standards for Disturbed Samples of Soils and Gravels

S/No.	Test Description	Source Standard
1	Sampling and preparation	BS 1377-1
2	Water content	BS 1377-2:2022, CI 4.1
3	Liquid limit	BS 1377-2:2022, CI 5
4	Plastic limit	BS 1377-2:2022, CI 6
5	Linear shrinkage	BS 1377-2:2022, CI 7
6	Particle size distribution	ISO 17892-4
7	Sedimentation test	ISO 17892-4
8	Organic matter content	BS 1377-3:2018, CI 4 & CI 6 for peat and organic sands
9	Density-moisture content relationship ( <i>2.5 kg rammer</i> )	AASHTO T99
10	Density-moisture content relationship ( <i>4.5 kg rammer</i> )	AASHTO T180
11	California bearing ratio	AASHTO T193 (ASTM D1883)
12	Total Sulphate ratio	BS 1377-3:2018, CI 7
13	pH value	BS 1377-3:2018, CI 12
14	Density-moisture content relationship vibrating hammer	BS 1377-2:2022, CI 11.7
15	Initial Consumption of Lime, ICL	BS 1924-2:2018, CI. 10.3

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Soils and Gravels



## 6 Aggregates

### 6.1 General

Standard test methods for determining the engineering properties of aggregates, natural sands and fillers for use in pavement layers including surfacing and concrete works are provided in this chapter.

Sampling and sample preparation shall be carried out according to BS EN 932-1. Necessary measures shall be taken to minimise segregation by following the correct procedures and using the right equipment for sampling. Aggregate in storage shall also be checked for segregation prior to sampling.

Sampling forms shall be placed both on the container/sack with the sample and inside the sample. These shall be protected from damage during transportation and storage of the sample.

### 6.2 Standard Methods of Testing

Standard test methods for aggregates used in concrete, unbound pavement layers, hydraulically bound pavement layers, bituminous mixes, and surface dressing are provided in the sections that follow.

#### 6.2.1 Aggregates for Concrete

Tests on aggregates for use in concrete are presented in Table 6.1. These shall be conducted when required, according to the standards presented.

Table 6.1 Test Standards for Aggregates for Concrete

S/No.	Test Name/Property	Test Standard
1	Sampling and sample preparation	BS EN 932-1
2	Water content	BS EN 1097-5
3	Particle density and water absorption	BS EN 1097-6
4	Water soluble chloride content	BS EN 1744-1:1998, cl 7
5	Water soluble sulphate content	BS EN 1744-1
<b>Coarse Aggregates</b>		
6	Particle size distribution ( <i>PSD</i> )	BS EN 933-1
7	Flakiness index for coarse aggregates	BS EN 933-3
8	Aggregate impact value ( <i>AIV</i> )	BS EN 1097-2:2020, CI 6
9	Loose bulk density and voids	BS EN 1097-3
10	Shape index for coarse aggregates	BS EN 933-4
11	Los Angeles Abrasion For coarse aggregates < 37.5 mm For coarse aggregates > 20 mm	AASHTO T96 ASTM C131 ASTM C535
12	Aggregate soundness	AASHTO T104/ASTM C88
13	Aggregate abrasion value	BS EN 1097-8:1999, Appendix A
14	Shell content for coarse aggregates	BS EN 933-7
15	Drying shrinkage	BS EN 1367-4
16	Polished stone value ( <i>PSV</i> )	BS EN 1097-8
<b>Fine Aggregates</b>		
17	Fines quality ( <i>sand equivalent</i> )	BS EN 933-8
18	Organic impurities in sand	AASHTO T21 (ASTM C40)
19	Fines content ( <i>sieving method</i> )	BS EN 933-1
20	PSD for filler aggregates ( <i>air jet sieving</i> )	BS EN 933-10

## 6.2.2 Aggregates for Graded Crushed Stone (GCS)

Test on aggregates, sand and filler for use in hydraulically/bitumen treated GCS shall be carried out in accordance with the standards given in Table 6.2.

**Table 6.2** Test Standards for Aggregates for GCS

S/No.	Test Name/Property	Test Standard
1	Sampling and sample preparation	BS EN 932-1
2	Particle density and water absorption	BS EN 1097-6
3	Particle size distribution	BS EN 933-1
4	Fines content	BS EN 933-1
5	Flakiness index	BS EN 933-3
6	Aggregate crushing value	BS 812-110
7	Ten percent fines value ( <i>TFV</i> ) or 10 % Fine Aggregate Crushing Test ( <i>10 % FACT</i> ).	BS EN 1097-2
8	Los Angeles Abrasion For coarse aggregates < 37.5 mm For coarse aggregates > 20 mm	AASHTO T96 ASTM C131 ASTM C535
9	Aggregate soundness	AASHTO T104/ASTM C88
10	Fines quality using sand equivalent test	BS EN 933-8
11	Shell content	BS EN 933-7
12	Water soluble chloride content	BS EN 1744-1:1998, cl 7
13	Water soluble sulphate content	BS EN 1744-1
14	Atterberg Limits	BS 1924-2:2018, Clause 4.2

### 6.2.3 Aggregates for Bituminous Mixes

Test on aggregates, sand and filler for use in bituminous mixes shall be carried out in accordance with the standards given in Table 6.3.

Table 6.3 Test Standards for Aggregates for Bituminous Mixes

S/No.	Test Name/Property	Test Standard
1	Sampling and sample preparation	BS EN 932-1
<b>Coarse Aggregates</b>		
2	Bulk specific gravity	ASTM C127/AASHTO T85
3	Apparent Specific gravity	ASTM C127/AASHTO T85
4	Water absorption	ASTM C127/AASHTO T85
5	Grading	ASTM C136/AASHTO T27
6	Flakiness Index	BS 812-105
7	Flat and Elongated Particles	ASTM D4791
8	Aggregate Crushing Value	BS 812-110
9	Los Angeles Abrasion test	ASTM C131/AASHTO T96
10	Aggregate Soundness	ASTM C88/AASHTO T104
11	Loose Unit Weight	AASHTO T19
12	Rodded Unit Weight	AASHTO T19
13	Bitumen affinity ( <i>Static immersion test</i> )	AASHTO T182
<b>Fine Aggregates</b>		
14	Fines quality ( <i>sand equivalent</i> )	BS EN 933-8
15	Organic impurities in sand	AASHTO T21 (ASTM C40)
16	Fines content ( <i>sieving method</i> )	BS EN 933-1
17	PSD for filler aggregates ( <i>air jet sieving</i> )	BS EN 933-10
18	Loose Unit Weight	AASHTO T19
19	Rodded Unit Weight	AASHTO T19
20	Sand Equivalent	AASHTO T176
21	Fine Aggregate Angularity	AASHTO T304
<b>Mineral Filler</b>		
22	Specific gravity	AASHTO T100
23	Plasticity Index	AASHTO T90

### 6.2.4 Aggregates for Surface Dressing

Test on aggregates, sand and filler for use in asphalt concrete shall be carried out in accordance with the standards given in Table 6.4.

Table 6.4 Test Standards for Aggregates for Surface Dressing

S/No.	Test Name/Property	Test Standard
1	Sampling and sample preparation	BS EN 932-1
<b>Coarse Aggregates</b>		
2	Bulk specific gravity	ASTM C127/AASHTO T85
3	Apparent Specific gravity	ASTM C127/AASHTO T85
4	Water absorption	ASTM C127/AASHTO T85
5	Grading	ASTM C136/AASHTO T27
6	Flakiness Index	BS 812-105
7	Aggregate Crushing Value	BS 812-110
8	Los Angeles Abrasion test	ASTM C131/AASHTO T96
9	Aggregate Soundness	ASTM C88/AASHTO T104
10	Loose Unit Weight	AASHTO T19
11	Rodded Unit Weight	AASHTO T19
12	Bitumen affinity ( <i>Static immersion test</i> )	AASHTO T182
13	Average Least Dimension Test	AS 1141.20 Part 1, 2 or 3
<b>Fine Aggregates</b>		
14	Bulk specific gravity	ASTM C128/AASHTO T84
15	Apparent Specific gravity	ASTM C128/AASHTO T84
16	Water absorption	ASTM C128/AASHTO T84
17	Grading	ASTM C136/AASHTO T27
18	Loose Unit Weight	AASHTO T19
19	Rodded Unit Weight	AASHTO T19
20	Sand Equivalent	AASHTO T176
<b>Mineral Filler</b>		
21	Specific gravity	AASHTO T100
22	Grading	ASTM C117/AASHTO T11
23	Plasticity Index	AASHTO T90

# 7 Hydraulic Road Binders

## 7.1 General

Hydraulic road binders shall conform to BS EN 13282-1 for mechanical, physical and chemical requirements. All common cements conforming to KS EAS 18-1 with standard strength Class 32.5 shall also be classified as hydraulic road binders.

## 7.2 Standard Methods of Testing

Tests to determine the physical and chemical properties of hydraulic road binders shall be conducted according to standards in Table 7.1.

Table 7.1 Test Standards for Rapid Hardening Hydraulic Road Binders

S/No.	Test Name/Property	Test Standard
1	Sampling and sample preparation	BS EN 13282-1/BS EN 13282-2
2	Compressive strength	BS EN 196-1
3	Fineness	BS EN 196-6
4	Initial setting time	BS EN 196-3
5	Soundness	BS EN 196-3
6	Sulphate content	BS EN 196-2
7	Composition	BS EN 13282-1/BS EN 13282-2

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Hydraulic Road Binders

## 8 Lime

### 8.1 General

Lime shall meet the specifications and conformity criteria set out in KS 1780. Samples for quicklime, hydrated lime, lime slurry and lime putty shall be obtained and prepared according to KS 1755-1.1 prior to testing.

### 8.2 Standard Methods of Testing

Tests to determine the physical and chemical properties of lime shall be conducted according to the standards in Table 8.1.

**Table 8.1** Test Standards for Lime

S/No.	Test Name/Property	Test Standard
1	Soundness ( <i>Le Chatelier</i> )	KS 1755-4.2
2	Sample preparation for lime	KS 1755-1.1
3	Fineness	KS 1755-2.1
4	Slaking ( <i>Dewar Flask</i> )	KS 1755-3.1
5	Soundness ( <i>Autoclave</i> )	KS 1755-4.3
6	Chemical composition	KS 1755-5.1
7	Lime index – Available lime	KS 1755-6.1
8	Loss on ignition	KS 1755-7.1
9	Free moisture	KS 1755-8.1

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Lime

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Lime



## 9 Cement

### 9.1 General

Cement shall be common cements meeting the specifications set out in KS EAS 18-1. Blended hydraulic cements shall comply with the requirements of KS EAS 18-1. All common cements conforming to KS EAS 18-1 with standard strength Class 32.5 shall also be classified as hydraulic road binders. Hydraulic road binders (HRB) shall conform to BS EN 13282-1.

### 9.2 Standard Methods of Testing

Tests for physical and chemical properties of cement shall be conducted according to the standards in Table 9.1.

**Table 9.1** Test Standards for Physical and Chemical Properties of Cement

S/No.	Property	Kenya Standard
1	Sample preparation	KS EAS 148-7
2	Fineness	KS EAS 148-6
3	Cement strength	KS EAS 148-1
4	Setting times and soundness	KS EAS 148-3
5	Chemical analysis	KS EAS 148-2
6	Quantitative determination of constituents	KS EAS 148-4
7	Pozzolanicity test for pozzolanic cements	KS EAS 148-5
8	Heat of hydration – solution method	KS EAS 148-8

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Cement

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Cement

## 10 Bituminous Binders

### 10.1 General

Test standards for bituminous binders are provided in this chapter. Kenya Standards have been referenced where applicable. Where these are not available, the equivalent AASHTO/ASTM or British Standard has been referenced.

### 10.2 Standard Methods of Testing

Standard test methods for straight-run bitumen, cutback bitumen, bitumen emulsion, performance graded bitumen and modified bituminous binder types are provided in the sections that follow.

#### 10.2.1 Straight-run Bitumen

Tests on straight-run bitumen shall be carried out according to the test standards presented in Table 10.1.

**Table 10.1** Test standards for Straight-run Bitumen as per ASTM D946

S/No.	Test Name	Test Standard
1	Sampling and sample preparation	ASTM D140
2	Specific Gravity at 25 °C	AASHTO T228 (ASTM D70)
3	Penetration at 25 °C, 100 g, 5 Sec (0.1 mm)	AASHTO T49/ASTM D5
4	Softening point (0°C) – Ring and Ball test	AASHTO T53
5	Retained penetration after TFOT, %, Minc	AASHTO T49/ASTM D5
6	Kinematic Viscosity at 135 °C	ASTM D2170
7	Ductility at 25 °C (Min)	ASTM D113
8	Loss on heating, Max	ASTM D6
9	Solubility in Trichloroethylene, %	ASTM D2042
10	Flash Point (C.O.C), Min	AASHTO T48/ASTM D92
11	Ductility after TFOT (cm), Min	ASTM D113
12	Water	AASHTO T55/ASTM D95
13	Thin film oven test	AASHTO T179/ASTM D1754

#### 10.2.2 Cut-back Bitumen

Tests on cut-back bitumen shall be carried out according to the Test standards presented in Table 10.2.

**Table 10.2** Standard Test Methods for Cut-back Bitumen

S/No.	Test Name	Test Standard
1	Sampling and sample preparation	ASTM D140
2	Flash point (T.O.C) °C, Min	ASTM D3143
3	Kinematic Viscosity at 60 °C	ASTM D2170
<b>Distillate Test</b>		
4	Distillate, volume % of total distillate to 360 °C	
	• To 225 °C (Max)	ASTM D402
	• To 260 °C	ASTM D402
	• To 316 °C	ASTM D402
5	Residue from distillation to 360 °C, % Vol by difference, Min	ASTM D402
<b>Tests on Residue from Distillation</b>		
6	Specific Gravity at 15 °C	AASHTO T228 (ASTM D70)
7	Penetration at 25 °C, 100g, 5 Sec	ASTM D5
8	Ductility at 25 °C, Min	ASTM D113
9	Solubility in Trichloroethylene, %, Min	ASTM D2042
10	Water, %, Max	ASTM D95

### 10.2.3 Bitumen Emulsion

Bitumen emulsion is classified as anionic or cationic. Sampling for anionic bitumen emulsion shall be done according to KS EAS 982-3. For cationic bitumen emulsion, the sampling shall be done following KS EAS 982-4. Tests on anionic emulsions shall be done according to BS 434 or the test standards provided in Table 10.3.

The following tests shall be conducted according to BS 434.

1. Residue on 0.710 mm sieve.
2. Residue on 0.150 mm sieve.
3. Binder content.
4. Engler viscosity.
5. Redwood II viscosity.
6. Storage stability (short period).
7. Storage stability (long period).
8. Particle charge.
9. Stability to mixing with coarse aggregate.
10. Stability to mixing with cement.

**Table 10.3** Test Standards for Cationic Emulsions per ASTM D2397M-13

S/No.	Test Name	Test Standard
1	Sampling and sample preparation	ASTM D140
2	Viscosity, Saybolt Furol at 25 °C, SFS	ASTM D7496
3	Viscosity, Saybolt Furol at 50 °C, SFS	ASTM D7496
4	Storage stability test, 24 h, %,Max	ASTM D6930
5	Demulsibility, 35mL, 0.8% diocetyl sodium sulfosuccinate, %, Min	ASTM D6936
<b>Coating Ability and Water Resistance</b>		
6	Coating dry aggregate	ASTM D244
7	Coating after spraying	ASTM D244
8	Coating, wet aggregate	ASTM D244
9	Coating after spraying	ASTM D244
10	Particle charge test	ASTM D7402
11	Sieve test, %	ASTM D6933
12	Cement Mixing Test, %	ASTM D6935
<b>Distillation</b>		
13	Oil Distillate, by volume of emulsion, %	ASTM D6997
14	Residue, %	ASTM D6997
<b>Tests on Residue from Distillation Test</b>		
15	Penetration at 25 °C, 100g, 5 Sec	ASTM D5
16	Ductility at 25 °C, Min	ASTM D113
17	Solubility in Trichloroethylene, %, Min	ASTM D2042

**Note 1:** Cationic Quick Setting, CQS – 1h emulsions shall meet the requirements outlined in ASTM D3910 standard practices for Design, Testing and Construction of Slurry Seal

**Note 2:** CQS- 1h is used for quick set Slurry Seal systems

For anionic road emulsions, the test standards in Table 10.4 shall be followed.

**Table 10.4** Test Standards for Anionic Emulsions per BS 434

S/No.	Test Name	Test Standard
1	Sampling	BS 434-1: 2011 Annex A
2	Sample preparation	BS 434-1: 2011 Annex B
3	Storage stability ( <i>short period test</i> ) ( <i>inversions to clear sediment, Max</i> )	BS EN 1429
4	Storage stability ( <i>long period test</i> ) ( <i>% water content difference, Max</i> )	BS EN 1429
5	Particle charge	BS EN 1430
6	Residue on 500 µm BS sieve ( <i>% (m/m, max)</i> )	BS EN 1429
7	Residue on 160 µm BS sieve ( <i>per 100 mL, max</i> )	BS EN 1429
8	Stability to mixing with Cement ( <i>% coagulation</i> )	BS EN 12848
9	Stability to mixing with coarse aggregate ( <i>% coagulation</i> )	BS 434-1: 2011 Annex C
10	Binder content ( <i>% m/m</i> ), min	BS EN 1428
11	Viscosity ( <i>degrees Engler °E at 20 °C</i> )	BS 434-1: 2011 Annex D
12	Coagulation of emulsion at low temperature	BS 434-1: Annex E

#### 10.2.4 Performance Graded Bitumen

Sampling for performance graded bitumen shall be done according to KS EAS 982-5.

The following tests shall be conducted on performance graded bitumen according to the test standards in Table 10.5.

**Table 10.5** Test Standards for Performance Graded Bitumen

S/No.	Test Name	Test Standard
1	Sampling and sample preparation	ASTM D140
<b>Tests on Original Binder</b>		
2	Flash point	AASHTO T48
3	Softening point	AASHTO T53
4	Solubility	AASHTO T44
5	Rotational Viscosity	AASHTO T316
6	Dynamic Shear Rheometer	AASHTO T315
7	Separation Test	ASTM D7173
<b>Rolling Thin Film Oven Test Residue (AASHTO T240)</b>		
8	Rolling Thin Film Oven	AASHTO T240
9	Multi Stress Creep Recovery, Jnr, 3.2	AASHTO T350
<b>Pressure Ageing Vessel Residue AASHTO R28</b>		
10	Dynamic Shear Rheometer	AASHTO T315

#### 10.2.5 Modified Bituminous Binders

A manufacturer's test certificate shall be provided with information for the type, and penetration grade of the original bituminous binder. Where modified bituminous binders are to be used, a record of its proven performance shall be provided.

##### Polymer Modified Bitumen

A Method Statement for the preparation of polymer modified bitumen blending including the type of polymer intended for use shall be submitted for the Engineer's approval. The modified bitumen shall be tested for compatibility with the polymer modifier to BS EN13632.

Polymer modified bitumen shall meet the requirements of BS EN14023. The following tests (Table 10.6) shall be conducted for polymer modified bitumen.

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Bituminous Binders

Table 10.6 Standard Test Methods for Polymer Modified Bitumen

S/No.	Test Name	Test Standard
1	Sampling and sample preparation	ASTM D140
<b>Before Ageing</b>		
2	Flash and fire point test ( <i>Cleveland open cup</i> )	BS EN 2592
3	Softening point (ring and ball)	BS EN1427
4	Penetration	BS EN1426
5	Dynamic viscosity at 165 °C	BS EN13302
6	Storage stability at 180 °C	BS EN13399
7	Elastic recovery at 15 °C	BS EN13398
<b>After Ageing (RTFOT) BS EN12607-1</b>		
8	Softening point	BS EN1427
9	Penetration	BS EN1426
10	Elastic recovery at 15 °C	BS EN13398
11	Dynamic shear rheometer	BS EN14770
12	Multiple stress creep and recovery @ 60 °C	prEN 16659

### Rubber Modified Bitumen

Rubber modified bitumen shall meet the specifications of ASTM D6114. Other applicable tests are as specified in Table 10.7.

Table 10.7 Standard Test Methods for Rubber Modified Bitumen

S/No.	Test Name	Test Standard
1	Sampling and sample preparation	ASTM D140
2	Flash and fire point test ( <i>Cleveland open cup</i> )	ASSHTO T48 (ASTM D92)
3	Penetration at 25 °C and 4 °C	AASHTO T49 (ASTM D5)
4	Softening point by Ring and Ball apparatus	AASHTO T53
5	Apparent viscosity	ASTM D4402 or ASTM D7741
6	Thin-film oven test residue	AASHTO T179 (ASTM D1754)
7	Multiple Stress Creep Recovery	AASHTO T350
8	Resilience	ASTM D5329

### Chemical Additives

The most common chemical modification of bitumen is the addition resins, the most popular of which is epoxy resin. The applicable tests are as shown in Table 10.8.

Table 10.8 Standard Test Methods for Chemically Modified Bitumen

S/No.	Test Name	Test Standard
1	Sampling and sample preparation	ASTM D140
2	Flash and fire point test ( <i>Cleveland open cup</i> )	ASSHTO T48 (ASTM D92)
3	Penetration at 25 °C	AASHTO T49 (ASTM D5)
4	Softening point by Ring and Ball apparatus	AASHTO T53
5	Ductility	ASTM D113
6	Brookfield viscosity at 135 °C	AASHTO T316 (ASTM D4402)
7	RTFO Mass loss, max %	AASHTO T240
8	Dynamic shear before RTFOT	AASHTO T315
9	Dynamic shear after RTFOT	AASHTO T315
10	Elastic recovery after RTFOT	AASHTO T301 (ASTM D6084)
11	Bending Beam Rheometer	AASHTO T313 (ASTM D3497)
12	Direct tension	AASHTO T314

# 11 Steel

## 11.1 General

Test standards for reinforcing steel used in rigid pavements and structures, prestressing steel, and steel for guardrails are covered in this chapter.

## 11.2 Standard Methods of Testing

### 11.2.1 Reinforcing Steel

Structural steel shall comply with the following requirements: KS EAS 412 PART 1-3, KS EAS 134, KS ISO 6934 PART 1-3. Reinforcing steel for use in structures such as bridges shall be tested according to the test standards in Table 11.1.

**Table 11.1** Test Standards for Steel Reinforcement for Structures

S/No.	Test Name	Test Standard
1	Sampling	ISO 15630-1
2	Tensile Test	ISO 15630-1 (KS EAS 193) ISO 6892-1 (KS ISO 6892-1)
3	Bend Test	ISO 15630-1, ISO 7438
4	Rebend Test	ISO 15630-1
5	Chemical Analysis	ISO 15630-1
6	Measurement of geometrical characteristics	ISO 15630-1
7	Determination of the relative rib or indentation area	ISO 15630-1
8	Determination of deviation from nominal mass per meter	ISO 15630-1
9	Welding	ISO 17660
10	Arc stud welding of metallic materials	ISO 14555
11	Studs and ceramic ferrules for arc stud welding	ISO 13918

### 11.2.2 Prestressing Steel

Prestressing steel shall be tested according to the test standards in Table 11.2.

**Table 11.2** Test Standards for Prestressing Steel

S/No.	Test Name	Test Standard
1	Sampling	ISO 15630-3
2	Tensile Test	ISO 15630-3, ISO 6892-1
3	Bend Test	ISO 15630-3, ISO 7438
4	Reverse Bend Test	ISO 15630-3
5	Isothermal stress relaxation test	ISO 15630-3
6	Stress corrosion test in a solution of thiocyanate	ISO 15630-3
7	Deflected tensile test	ISO 15630-3
8	Chemical analysis	ISO 15630-3
9	Measurement of the geometrical characteristics	ISO 15630-3
10	Determination of the relative rib area	ISO 15630-3
11	Determination of deviation from nominal mass per metre	ISO 15630-3
12	Prestressing steel bars	EN 10138 Part 1 and 4

### 11.2.3 Guardrails

Steel for guardrails shall be tested according to the test standards in Table 11.2.

Steel for guardrails (including beams, terminals, transitions, plates, and fasteners) shall conform to the various parts of BS EN 1317. BS EN 1317-5 shall be used with reference to the other parts of BS EN 1317 to establish the performance characteristics of the steel guardrail system.

The various steel components of guardrails shall be tested according to the test standards in Table 11.3.

**Table 11.3** Test Standards for Steel Guardrails

S/No.	Test Name	Test Standard
1	Sampling	ISO 6892-1
2	Tensile strength	ISO 6892-1
3	Yield point	ISO 6892-1
4	Percentage elongation	ISO 6892-1
5	Measurement of thickness of beam	BS EN 10051

Tests for structural components of guardrails shall be conducted according to the test standards in Table 11.4.

**Table 11.4** Test Standards for Structural Components of Guardrails

S/No.	Test Name	Test Standard
1	Dimensions - Guardrails and end wings	AASHTO M180
2	Galvanising of guardrails	ASTM A653
3	Guardrail steel posts and steel spacers	AASHTO M270
4	Galvanising of steel posts and steel spacers	AASHTO M111
5	Dimensions - Guardrail steel posts	As per drawings
6	Guardrail timber posts <ul style="list-style-type: none"> <li>• Dimensions</li> <li>• Design</li> <li>• Treatment method</li> <li>• Creosote</li> </ul>	As per drawings BS 5268-2 BS 5268-5 SANS 616
7	Fittings, bolts, nuts, washers and accessories	AASHTO M180
8	Galvanising of materials above	AASHTO M232
9	Bolts and nuts	ASTM A307, AASHTO M291
10	High strength bolts	AASHTO M164, ASTM A449



## 12 Hydraulically Modified and Hydraulically Bound Materials

### 12.1 General

Test standards for determining the mechanical properties and performance of improved and/or stabilised materials are provided in this chapter.

Following the mix design of HBM, the selected binder content shall allow for the method of mixing, type of mixer, expected site conditions (such as material variability and moisture content). The assumptions made in selecting the binder content should be included in the test report.

### 12.2 Standard Methods of Testing

Tests to determine the properties of hydraulically modified and hydraulically bound materials shall be conducted according to the standards in Table 12.1.

**Table 12.1** Test Standards for Hydraulically Modified and Hydraulically Bound Materials

S/No.	Test Name/Property	Test Standard
1	Sampling and sample preparation	BS 1924-2
2	Plasticity index of modified/improved materials	BS 1924-2
3	California bearing ratio	BS EN 13286-47
4	Water content	BS 1924-2
5	Initial consumption of lime	BS 1924-2
6	Compaction relationships	AASHTO T180
7	Unconfined compressive strength	BS 1924-2
8	Indirect tensile strength	BS EN 13286-42
9	Effect of immersion in water on compressive strength	BS 1924-2
10	Modulus of elasticity in compression	BS EN 13286-43

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Hydraulically Modified and Hydraulically Bound Materials

## 13 Concrete for Pavements

### 13.1 General

Test standards for concrete constituents, fresh concrete and hardened concrete for use in concrete works, and rigid pavements are included in this chapter.

Sampling fresh concrete shall be done according to BS EN 12350-1. Care shall be taken to ensure segregation is avoided.

### 13.2 Standard Methods of Testing

#### 13.2.1 Tests on Fresh Concrete

Properties of fresh concrete such as slump, compacting factor, compaction test, air content shall be determined according to the standards provided in Table 13.1.

Table 13.1 Test Standards for Fresh Concrete

S/No.	Test Name/Property	Test Standard
1	Sampling	BS EN 12350-1
2	Slump test	BS EN 12350-2
3	Degree of compactability	BS EN 12350-4
4	Vebe Test	BS EN 12350-3
5	Flow table test	BS EN 12350-5
6	Density	BS EN 12350-6
7	Air content Pressure methods	BS EN 12350-7
8	Self-compacting concrete – Slump-flow test	BS EN 12350-8
9	Self-compacting concrete V funnel test	BS EN 12350-9

A note on what the slump looks like i.e., true, shear or collapse shall be included in the report.

The air content test shall be conducted for air entrained concrete. The test includes two methods – Method A with a graduated cylinder and Method B with a pressure meter, for measuring air content. For method A, the personnel should check that the equipment is calibrated before conducting the test.

Method B, on the other hand, is easier and faster to use but is prone to leakage from the valves. As such caution should be taken during testing to ensure leakages are fixed and variations in dial gauge readings are corrected.

The concrete on which the tests have been conducted should be discarded and not used for any other test.

Properties for fresh concrete should always be conducted before concrete cubes for compressive strength tests are made. Only fresh concrete meeting the design requirements shall be used for preparing the cubes.

### 13.2.2 Tests for Hardened Concrete

Tests on hardened concrete shall be according to the standards provided in Table 13.2. Where mechanical compaction is used for preparing the samples, over compaction should be avoided as it may lead to segregation. Vibration shall be done until no more bubbles are visible on the surface of the layer.

The shape, dimensions and other requirements for specimens and moulds are specified in BS EN 12390-1.

A log of the daily curing tank temperature should be kept at the laboratory to ensure that the required environmental conditions are maintained.

Concrete cubes shall be tested on a face perpendicular to the casting face. A comment on if the failure shape in the compressive strength test was satisfactory or unsatisfactory shall be included in the report.

Table 13.2 Test Standards for Cured Concrete Samples

S/No.	Test Name/Property	Test Standard
1	Sample preparation	BS EN 12390-1
2	Compressive strength of test specimens	BS EN 12390-3
3	Tensile splitting strength of test specimens	BS EN 12390-6
4	Flexural strength of test specimens	BS EN 12390-5
5	Density of hardened concrete	BS EN 12390-7
6	Making and curing specimens for strength tests	BS EN 12390-2
7	Depth of penetration of water under pressure	BS EN 12390-8
8	Determination of the carbonation resistance of concrete at atmospheric levels of carbon dioxide	BS EN 12390-10
9	Determination of the carbonation resistance of concrete Accelerated carbonation method	BS EN 12390-12
10	Determination of the chloride resistance of concrete, unidirectional diffusion	BS EN 12390-11
11	Determination of secant modulus of elasticity in compression	BS EN 12390-13
12	Semi-adiabatic method for the determination of heat released by concrete during its hardening process	BS EN 12390-14
13	Adiabatic method for the determination of heat released by concrete during its hardening process	BS EN 12390-15
14	Determination of the shrinkage of concrete	BS EN 12390-16
15	Determination of creep of concrete in compression	BS EN 12390-17
16	Determination of the chloride migration coefficient	BS EN 12390-18
17	Determination of electrical resistivity	BS EN 12390-19

### 13.2.3 Coring

Concrete cores shall be taken to determine the in-situ compressive strength of hardened concrete works. The sampling, preparation and testing of concrete cores shall be done according to BS EN 12504-1.

Cores should be taken when the concrete cube strength does not meet the specified design strength. The number of cores required shall be at the Resident Engineer's discretion.

Remedial work and the method statement must be approved prior to any coring works.

The diameter of the cores shall be specified before coring but it should be more than 3 times the maximum aggregate size. 100 mm diameter cores should be drilled for 20 mm aggregate concrete and 150 mm diameter cores for 40 mm concrete. Smaller diameter cores less than 100mm however should be avoided as these produce variable results.

Immediately after drilling, the location and orientation of each core shall be clearly labelled. Drilling through steel reinforcement shall be avoided and the drilled core shall contain no reinforcement.

### 13.2.4 Tests for Concrete Pavements

Strength tests on concrete pavements shall be conducted on cores that have been drilled from the full depth of the slab. The test standards for tests on concrete pavements are provided in Table 13.3.

Table 13.3 Test Standards for Concrete Pavements

S/No.	Test Name/Property	Test Standard
1	Splitting tensile strength of concrete on cylindrical discs	BS EN 13863-6
2	Thickness of a concrete pavement by survey method	BS EN 13863-1
3	Bond between two concrete layers	BS EN 13863-2
4	Thickness of a concrete pavement from cores	BS EN 13863-3
5	Bond stress of dowels to be used in concrete pavements	BS EN 13863-5

### 13.2.5 Non-destructive Tests

Non-destructive tests (NDT) for concrete shall be conducted according to the test standards in Table 13.4.

Table 13.4 Test Standards for Non-destructive Tests on Concrete

S/No.	Test Name/Property	Test Standard
1	Rebound hammer	BS EN 12504-2
2	Pull out test	BS EN 12504-3
3	Ultrasonic pulse velocity	BS EN 12504-4

### 13.2.6 Tests for Paving Blocks and Kerbs

Concrete paving blocks and kerbs shall be tested for total water absorption, breaking strength and breaking load, abrasion resistance (Wide wheel) and Slip resistance according to the test standards in Table 13.4.

Table 13.5 Test Standards for Concrete Paving Blocks and Kerbs

S/No.	Test Name/Property	Test Standard
1	Concrete paving blocks	BS EN 1338
2	Kerbs	BS EN 1340

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13.2.7 Tests for Precast Concrete Products

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Tests for precast concrete products such as retaining wall elements, bridge elements, box culverts etc shall be conducted according to the test standards in Table 13.6.

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Table 13.6 Test Standards for Precast Concrete Products

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S/No.	Test Name/Property	Test Standard
1	Common rules	EN 13369
2	Retaining wall elements	EN 15258
3	Bridge elements	EN 15050
4	Foundation elements	EN 14991
5	Box culverts	EN 14844
6	Linear structural elements	EN 13225
7	Street furniture	EN 13198
8	Masts and poles	EN 12843
9	Foundation piles	EN 12794
10	Precast concrete pipes and fittings	EN 1916

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# 14 Water for Construction

## 14.1 General

Water is important in construction for preparation of mortar, mixing of cement concrete, curing and compaction work. The quality of water used is especially important in attaining design strength of cement concrete and mortar.

## 14.2 Standard Methods of Testing

Tests to determine the physical and chemical properties of water for construction shall be conducted according to standards in Table 14.1.

Table 14.1 Test Standards for Determining Water Quality

S/No.	Test Name/Property	Test Standard
1	Sampling	BS 6068-6
2	pH Value	BS 6068-2.50
3	Alkalinity	ASTM D1067
4	Total suspended solids	BS EN 872
5	Chloride content	BS 6068-2.37
6	Sulphate content	BS 6068-2.39
7	Turbidity	BS 6068-2-2.13

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Water for Construction



# 15 Bitumen Stabilised Materials

## 15.1 General

Soils and gravels may be stabilised using bitumen. The two commonly used bitumen stabilised materials are emulsified bitumen and foamed bitumen. Cement may be added to enhance strength or provide early curing.

## 15.2 Standard Methods of Testing

Tests on bitumen emulsion and foamed bitumen stabilised materials shall be carried out in accordance with the test standards provided in Table 15.1.

Table 15.1 Test Standards for Bitumen Stabilised Materials

S/No.	Test Name/Property	Test Standard
1	Sampling	ASTM D979 (BS EN 12697-27)
2	Modified Lottman ( <i>Indirect Tensile Test</i> )	AASHTO T283 (ASTM D4867M) (BS EN 12697-23)
3	Resilient modulus of asphalt mixtures	ASTM D4123
4	Gyratory compaction procedure	AASHTO T312 (BS EN 12697-31)
5	Foaming characteristics of bitumen	AGPT/T301
6	Gyratory compaction	ASTM D6925
7	Proctor compaction	ASTM D1557/AASHTO T180 (BS EN 12697-5)
8	California Bearing Ratio	ASTM D1883
9	Unconfined Compressive Strength	ASTM D1074
10	Binder Content	ASTM D2172/AASHTO T164 (BS EN 12697-1)
11	Particle size distribution	AASHTO T27/ ASTM C136 (BS EN 12697-2)

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Bitumen Stabilised Materials

## 16 Bitumen Bound Materials

### 16.1 General

Test standards for bituminous mixtures are provided in this chapter. These have been based on AASHTO/ASTM or British Standards.

Sampling of bituminous mixes shall be done according to AASHTO T168 (ASTM D979).

### 16.2 Standard Methods of Testing

#### 16.2.1 Tests on Bituminous Mixtures (AC and DBM)

Tests on bituminous mixtures in general shall be carried out in accordance with the test standards provided in Table 16.1.

Table 16.1 Test Standards for Bituminous Mixtures (AC and DBM)

S/No.	Test Name/Property	Test Standard
1	Sampling	ASTM D979
2	Moisture and volatile distillates	AASHTO T110/ASTM D1461)
3	Quantitative extraction and recovery of asphalt binder from asphalt mixtures	AASHTO T319, AASHTO T164
4	Specific gravity of compacted mixture	AASHTO T166 (ASTM D1188 and ASTM D2726)
5	Recovery of bitumen from solution	AASHTO R59 (ASTM D1856)
6	Degree of particle coating	AASHTO T195 (ASTM D2489)
7	Coating and stripping	AASHTO T182 (ASTM D1664)
8	Coating and stripping with adhesion agent	ASTM D2727
9	Maximum specific gravity	AASHTO T209 (ASTM D2041)
10	Degree of pavement compaction	AASHTO T230
11	Marshall stability	AASHTO T245 (ASTM D1559)
12	Hubbard-Field stability	ASTM D1138
13	Modified Lottman ( <i>Indirect Tensile Test</i> )	AASHTO T283 (ASTM D4867M)
14	Resilient modulus of asphalt mixtures	ASTM D4123
15	Gyratory compaction procedure	AASHTO T312
16	Refusal density by vibrating hammer	BS EN 12697-32
17	Compaction using a slab compactor	BS EN 12697-33
18	Wheel tracking test ( <i>Hamburg Wheel</i> )	AASHTO T324
19	Particle size distribution	AASHTO T30
20	Field density - Nuclear Method	ASTM D2950

#### 16.2.2 Modified Bituminous Mixtures

Modified bituminous mixtures shall be subjected to the tests in Table 16.2, with emphasis on performance tests.

Table continues on the next page...

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Bitumen Bound Materials

Table 16.2 Test Standards for Modified Bituminous Mixtures

S/No.	Test Name/Property	Test Standard
1	Sampling	ASTM D979
2	Quantitative extraction and recovery of asphalt binder from asphalt mixtures	AASHTO T319
3	Specific gravity of compacted mixture	AASHTO T166 (ASTM D1188 and ASTM D2726)
4	Recovery of bitumen from solution	AASHTO R59 (ASTM D1856)
5	Degree of particle coating	AASHTO T195 (ASTM D2489)
6	Coating and stripping	AASHTO T182 (ASTM D1664)
7	Coating and stripping with adhesion agent	ASTM D2727
8	Maximum specific gravity	AASHTO T209 (ASTM D2041)
9	Degree of pavement compaction	AASHTO T230
10	Modified Lottman ( <i>Indirect Tensile Test</i> )	AASHTO T283 (ASTM D4867M)
11	Resilient modulus of asphalt mixtures	ASTM D4123
12	Wheel tracking test ( <i>Hamburg Wheel</i> )	AASHTO T324
13	Beam fatigue test	AASHTO T321
14	Dynamic modulus	AASHTO TP62
15	Gyratory compaction procedure	AASHTO T312
16	Field density - Nuclear Method	ASTM D2950

### 16.2.3 Enrobé à Module Élevé (EME – High Modulus Asphalt)

In addition to general bituminous mixture tests outlined in section 16.2.1, performance tests on EME shall be carried out in accordance with the test standards provided in Table 16.3.

Table 16.3 Test Standards for EME-high Modulus Asphalt

S/No.	Test Name/Property	Test Standard
1	Sampling	ASTM D979
2	Gyratory compaction procedure	AASHTO T312
3	Beam fatigue test	AASHTO T321
4	Dynamic modulus	AASHTO TP62
5	Wheel tracking test ( <i>Hamburg Wheel</i> )	AASHTO T324
6	Modified Lottman ( <i>Indirect Tensile Test</i> )	AASHTO T283 (ASTM D4867M)
7	Field density - Nuclear Method	ASTM D2950

### 16.2.4 Stone Mastic Asphalt

Tests on stone mastic asphalt shall be carried out in accordance with the test standards provided in Table 16.4.

Table 16.4 Test Standards for Stone Mastic Asphalt

S/No.	Test Name/Property	Test Standard
1	Sampling	ASTM D979
2	Moisture and volatile distillates	AASHTO T110 (ASTM D1461)
3	Quantitative extraction and recovery of asphalt binder from asphalt mixtures	AASHTO T319
4	Specific gravity of compacted mixture	AASHTO T166 (ASTM D1188 and ASTM D2726)
5	Degree of particle coating	AASHTO T195 (ASTM D2489)
6	Coating and stripping	AASHTO T182 (ASTM D1664)
7	Coating and stripping with adhesion agent	ASTM D2727
8	Maximum specific gravity	AASHTO T209 (ASTM D2041)
9	Degree of pavement compaction	AASHTO T230
10	Wheel tracking test ( <i>Hamburg Wheel</i> )	AASHTO T324
11	Modified Lottman ( <i>Indirect Tensile Test</i> )	AASHTO T283
12	Field density - Nuclear Method	ASTM D2950

## 17 Road Marking and Signs

### 17.1 General

Test standards for road marking are provided in this chapter.

### 17.2 Standard Methods of Testing

#### 17.2.1 Road Marking

Tests on road marking shall be carried out in accordance with the test standards provided in Table 17.1.

Table 17.1 Test Standards for Road Marking

S/No.	Test Description	Test Standard
1	Sampling	ASTM D7307/ BS EN 13459
2	Test for Traffic Paint	ASTM D2205 (KS EAS 927)
3	Test for Cold Applied Plastic Paint	DS/EN 1871
4	Test for Thermoplastic Marking	BS EN1871 (KS EAS 928-2)
5	Test for Preformed Adhesive Tape	ASTM D3330 (KS 2563)
6	Test for Skid Resistance of Adhesive Tapes	ASTM E 303
7	Test for Retro Reflectivity of Marking	BS EN1436
8	Test for Road Studs	BS EN1463 Part 2

#### 17.2.2 Road Signs

Tests on road signs shall be carried out in accordance with the test standards provided in Table 17.2.

Table 17.2 Test Standards for Road Signs

S/No.	Test Description	Test Standard
1	Test for Retro reflectivity of Aluminium Sheeting	ASTM E810
2	Test for Aluminium Composite Material ( <i>Drum Peel Test</i> )	ASTM D903
3	Tests for Fibre Reinforced Plastic	ISO 527
	Tensile test	ASTM D3039
	Impact test	ASTM D 256
	Flexure test	ASTM D 790

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Road Marking and Signs

## 18 Paints for Structures

### 18.1 General

Test standards for paints for structures are provided in this chapter.

### 18.2 Standard Methods of Testing

#### 18.2.1 Paints for Steel Work

Paints for steel shall tested according to the test standards in Table 18.1.

Table 18.1 Test Standards for Paints for Steel Work

S/No.	Test Description	Test Standard
1	Determination of dry-film thickness	ISO 12944-6, ISO 2808
2	Determination of scratch resistance	ISO 1518-1, ISO 1518-2

#### 18.2.2 Galvanised Coatings on Iron and Steel

Galvanised coatings on iron and steel shall be tested according to the test standards in Table 18.2.

Table 18.2 Test Standards for Galvanised Coatings on Iron and Steel

S/No.	Test Description	Test Standard
1	Determination of thickness of hot dip galvanised coatings	ISO 1461, ISO 2178, ISO 1460

#### 18.2.3 Paints for Road Signs, Posts and Fittings

Paints for steel shall tested according to the test standards in Table 18.3.

Table 18.3 Test Standards for Paints for Road Signs, Posts and Fittings

S/No.	Test Description	Test Standard
1	Paints for road signs, posts and fittings	ASTM D823

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Paints for Structures



## 19 Geosynthetics

### 19.1 General

Test standards for geosynthetics such as geotextiles, geogrids for reinforcing granular layers, geobelts, asphalt reinforcement grids and geocells are provided in this chapter.

### 19.2 Standard Methods of Testing

#### 19.2.1 Geotextiles

Tests on geotextiles shall be carried out in accordance with the test standards provided in Table 19.1.

Table 19.1 Test Standards for Geotextiles

S/No.	Test Description	Test Standard
1	Sampling	ASTM D4354
2	Density	ASTM D1505
3	Interface shear strength	ASTM D5321
4	Tensile strength	ASTM D4595
5	Pullout resistance	ASTM D6706
6	Flexural rigidity	ASTM D7748
7	Grab strength	ASTM D4632
8	Puncture strength	ASTM D4833
9	Burst strength	ASTM D3786
10	Trapezoid tear	ASTM D4533
11	Apparent opening size	ASTM D4751
12	Permittivity	ASTM D4491
13	Ultraviolet degradation	ASTM D4355
14	Mass per unit area	ASTM D5261
15	Thickness	ASTM D5199

#### 19.2.2 Geogrids

Tests on geogrids for granular layers shall be carried out in accordance with the test standards provided in Table 19.2.

Table 19.2 Test Standards for Geogrids for Granular Layers

S/No.	Test Description	Test Standard
1	Sampling	ASTM D4354
2	Mass per unit area	ASTM D5261
3	Aperture size – machine direction and cross-machine direction	Direct measure
4	Wide width strip tensile strength at 5% strain and ultimate strength * To be measured in both the machine direction and cross machine direction.	ASTM D4595
5	Junction strength	ASTM D7737
6	Conformance	ASTM D4759
7	Flexural rigidity	ASTM D7748
8	Ultraviolet degradation	ASTM D4355

### 19.2.3 Asphalt Reinforcement Grids

Tests on asphalt reinforcement grids shall be carried out in accordance with the test standards provided in Table 19.3.

Table 19.3 Test Standards for Asphalt Reinforcement Grids

S/No.	Test Description	Test Standard
1	Sampling	ASTM D4354
2	Tensile strength	EN ISO 10319, ASTM D6637
3	Tensile elongation	EN ISO 10319, ASTM D6637
4	Mass per unit area	ISO 9864, ASTM D5261
5	Aperture size	Direct measure
6	Melting point coating Melting point glass	EN ISO 3146 ASTM C338

### 19.2.4 Geobelts

Tests on geobelts shall be carried out in accordance with the test standards provided in Table 19.4.

Table 19.4 Test Standards for Geobelts

S/No.	Test Description	Test Standard
1	Sampling	ASTM D4354
2	Tensile strength	EN ISO 10319, ASTM D6637
3	Tensile elongation	EN ISO 10319, ASTM D6637
4	Ultraviolet degradation	ASTM D4355

### 19.2.5 Geocells

Tests on geocells shall be carried out in accordance with the test standards provided in Table 19.5.

Table 19.5 Test Standards for Geocells

S/No.	Test Description	Test Standard
1	Sampling	ASTM D4354
2	Cumulative permanent deformation(creep) at 44°C at fixed load of 6.1	ASTM D6992 (SIM)
3	Cumulative permanent deformation(creep) at 52°C at fixed load of 6.2	ASTM D6992 (SIM)
4	Cumulative permanent deformation(creep) at 58°C at fixed load of 6.3	ASTM D6992 (SIM)
5	Elastic stiffness @ 60°C	EN ISO 10319
6	Tensile strength	EN ISO 10319
7	Dynamic Modulus ( <i>Elastic stiffness</i> ) at 30°C	EN ISO 6721-1, ASTM E2254
8	Dynamic Modulus ( <i>Elastic stiffness</i> ) at 45°C	EN ISO 6721-1, ASTM E2254
9	Dynamic Modulus ( <i>Elastic stiffness</i> ) at 60°C	EN ISO 6721-1, ASTM E2254
10	Cumulative plastic distortion	ASTM D6992
11	Tensile force, perforated cell wall ( <i>wide width</i> )	EN ISO 10319
12	Height of cell wall	EN ISO 10319
13	UV and oxidation resistance at 150°C	ASTM D 5885 per GRI GM13
14	Distance between internal connections	EN ISO 10321

## 20 Bridge Components

### 20.1 General

Test standards for bridge components such as bearings, expansion joints, joint sealants water proofing membranes, water stops, adhesives, mesh, wire strands, bolts, nuts and washers are provided in this chapter.

### 20.2 Standard Methods of Testing

#### 20.2.1 Bearings

Tests on bearings shall be carried out in accordance with the test standards provided in Table 20.1.

Table 20.1 Test Standards for Bearings

S/No.	Test Description	Test Standard
1	Elastomeric bearings	BS EN 1337 Part-3
2	Pot bearings	BS EN 1337 Part-5
3	Roller bearings	BS EN 1337 Part-4
4	Rocker bearings	BS EN 1337 Part -6
5	Spherical and Cylindrical PTFE bearings	BS EN 1337 Part -7
6	Guide bearings and Restraint bearings	BS EN 1337 Part -8
7	Sliding elements	BS EN 1337 Part -2

#### 20.2.2 Expansion Joints and Joint Sealants

Tests on expansion joints and joint sealants shall be carried out in accordance with the test standards provided in Table 20.2.

Table 20.2 Test Standards for Expansion Joints and Joint Sealants

S/No.	Test Description	Test Standard
1	Buried expansion joint	ETAG no. 032 Part-2
2	Flexible plug expansion joint	ETAG no. 032 Part-3
3	Nosing expansion joint	ETAG no. 032 Part-4
4	Mat expansion joint	ETAG no. 032 Part-5
5	Cantilever expansion joint	ETAG no. 032 Part-6
6	Supported expansion joint	ETAG no. 032 Part-7
7	Modular expansion joint	ETAG no. 032 Part-8
8	Joint sealant	BS EN 13880, Part-1 to Part-13

#### 20.2.3 Water Proofing Membranes

Tests on water proofing membranes shall be carried out in accordance with the test standards provided in Table 20.3.

Table 20.3 Test Standards for Water Proofing Membranes

S/No.	Test Description	Test Standard
1	Sheet applied systems	BS EN 14695
2	Liquid applied systems	ETAG 033

### 20.2.4 Water Stops

Tests on water stops shall be carried out in accordance with the test standards provided in Table 20.4.

Table 20.4 Test Standards for Water Stops

S/No.	Test Description	Test Standard
1	Rubber water stops - Tension	ASTM D412
2	Rubber water stops - Hardness	ASTM D2240
3	PVC water stops - Tension	ASTM D638 M
4	PVC water stops - Hardness	ASTM D2240

### 20.2.5 Adhesives

Tests on adhesives shall be carried out in accordance with the test standards provided in Table 20.5.

Table 20.5 Test Standards for Adhesives

S/No.	Test Description	Test Standard
1	Adhesives	ASTM D1084, ASTM D903, ASTM D1002, ASTM D 897

### 20.2.6 BRC Mesh and Wire Strands

Tests on BRC mesh and wire strands (pre-stressed steel) shall be carried out in accordance with the test standards provided in Table 20.6.

Table 20.6 Test Standards for BRC Mesh and Wire Standards

S/No.	Test Description	Test Standard
1	BRC mesh	BS 4483
2	Wire Strands ( <i>Pre-Stressed Steel</i> )	EN 10138 Part: 1, 2, 3 & 5

### 20.2.7 Bolts, Nuts and Washers

Tests on bolts, nuts and washers shall be carried out in accordance with the test standards provided in Table 20.7.

**Table 20.7** Test Standards for Bolts, Nuts and Washers

S/No.	Test Description		Test Standard
1	Sampling		ASTM F3125
Bolts			
2	Characteristics of hexagon head bolts	Grades A and B	ISO 4014
		Grades C	ISO 4016
3	Mushroom head bolts		ISO 8677
4	Anchor bolts		BS 8539
5	U bolts		BS 3974-1:1974, cl. 5
6	Suitability for preloading bolts		EN 14399-2
7	Requirements for hexagon bolt and nut assemblies	System HR	EN 14399-3
		System HY	EN 14399-4
8	Hexagon head screws	Grades A and B	ISO 4017
		Grades C	ISO 4018
Hexagon Nuts			
9	Grades A and B	Style 1	ISO 4032
		Style 2	ISO 4033
10	Grades C		ISO 4034
Washers			
11	Plain washers		EN 14399-5
12	Plain chamfered washers		EN 14399-6

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Bridge Components

# Appendices

**Table A.1** Field Ground Tests

Standard Number	Title
BS 1377-9:1990	Methods of test for soils for civil engineering purposes. In-situ tests
ISO 22476-1	Geotechnical investigation and testing - Field testing - Part 1: Electrical cone and piezocone penetration test
ISO 22476-2	Geotechnical Investigation and Testing - Field Testing - Part 2: Dynamic Probing
ISO 22476-3	Geotechnical investigation and testing - Field testing - Part 3: Standard penetration test
ISO 22476-9	Geotechnical investigation and testing - Field testing - Part 9: Field vane test (FVT and FVT-F)
BS EN 22476-12	Geotechnical investigation and testing - Field testing - Part 12: Mechanical cone penetration test (CPTM)

**Table A.2** Geotechnical Tests

Standard Number	Title
ASTM D3967	Standard Test Method for Splitting Tensile Strength of Intact Rock Core Specimens with Flat Loading Platens
ASTM D5731	Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications
ASTM D7012	Standard Test Methods for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures
BS 1377-9	Methods for test for soils for civil engineering purposes. In-situ tests
BS 5930	Code of practice for ground investigations
ISO 17892-10	Geotechnical investigation and testing - Laboratory testing of soil - Part 10: Direct shear tests
ISO 17892-11	Geotechnical investigation and testing - Laboratory testing of soil - Part 11: Permeability tests
ISO 17892-3	Geotechnical investigation and testing - Laboratory testing of soil - Part 3: Determination of particle density
ISO 17892-5	Geotechnical investigation and testing - Laboratory testing of soil - Part 5: Incremental loading oedometer test
ISO 17892-7	Geotechnical investigation and testing - Laboratory testing of soil - Part 7: Unconfined compression test
ISO 17892-9	Geotechnical investigation and testing - Laboratory testing of soil - Part 9: Consolidated triaxial compression tests on water saturated soils
ISO 22475-1	Geotechnical investigation and testing - Sampling methods and groundwater measurements Part 1: Technical principles for execution
ISO 11271	Soil quality. Determination of redox potential - Field method
ISO 22282-1	Geotechnical investigation and testing - Geohydraulic testing
ISO 22476-1	Geotechnical investigation and testing. Field testing - Part1: Electrical cone and piezocone penetration test
ISO 22476-11	Geotechnical investigation and testing. Field testing - Part 11: Flat dilatometer test
ISO 22476-12	Geotechnical investigation and testing. Field testing - Part 12: Mechanical cone penetration test (CPTM)
ISO 22476-13	Geotechnical investigation and testing. Field testing - Part 13: Plate loading test
ISO 22476-15	Geotechnical investigation and testing. Field testing - Part 15: Measuring while drilling
ISO 22476-2	Geotechnical investigation and testing. Field testing - Part 2: Dynamic probing
ISO 22476-3	Geotechnical investigation and testing. Field testing - Part 3: Standard penetration test
ISO 22476-4	Geotechnical investigation and testing. Field testing - Part 4: Ménard pressuremeter test
ISO 22476-9	Geotechnical investigation and testing. Field testing - Part 9: Field vane test (FVT and FVT-F)
ISO 17892-12	Geotechnical investigation and testing. Laboratory testing of soil - Part 12: Determination of liquid and plastic limits
BS 1377-4	Methods of test for soils for civil engineering purposes - Part 4: Compaction-related tests
BS 1377-3	Methods of test for soils for civil engineering purposes - Part 3: Chemical and electro-chemical testing
ISO 17892-4	Geotechnical investigation and testing. Laboratory testing of soil - Part 4: Determination of particle size distribution
ISO 17892-2	Geotechnical investigation and testing. Laboratory testing of soil - Part 2: Determination of bulk density
ISO 17892-1	Geotechnical investigation and testing. Laboratory testing of soil - Part 1: Determination of water content

Table A.3 Soils and Gravels

Standard Number	Title
AASHTO T180	Standard Test Method for Splitting Tensile Strength of Intact Rock Core Specimens with Flat Loading Platens
	Standard Method of Test for Moisture–Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
AASHTO T193 (ASTM D1883)	Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils
AASHTO T99	Methods for test for soils for civil engineering purposes. In-situ tests
	Standard Method of Test for Moisture–Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop
BS 1377-1	Methods of test for soils for civil engineering purposes. Part 1: General requirements and sample preparation
BS 1377-2	Methods of test for soils for civil engineering purposes. Part 2: Classification tests and determination of geotechnical properties.
BS 1377-3:2018	Methods of test for soils for civil engineering purposes. Part 3: Chemical and electro-chemical testing
ISO 17892-4	Geotechnical investigation and testing. Laboratory testing of soil - Part 4: Determination of particle size distribution



Table A.4 Aggregates

Standard Number	Title
AASHTO T100	Standard Method of Test for Specific Gravity of Soils
AASHTO T104/ ASTM C88	Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulphate or Magnesium Sulphate
AASHTO T176	Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test
AASHTO T182	Standard Method of Test for Coating and Stripping of Bitumen-Aggregate Mixtures
AASHTO T19	Standard Method of Test for Bulk Density (Unit Weight) and Voids in Aggregate
AASHTO T21/ ASTM C40	Standard Method of Test for Organic Impurities in Fine Aggregates for Concrete
AASHTO T304	Standard Method of Test for Uncompacted Void Content of Fine Aggregate
AASHTO T90	Standard Method of Test for Determining the Plastic Limit and Plasticity Index of Soils
AASHTO T96/ ASTM C131	Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C117/ AASHTO T11	Standard Test Method for Materials Finer than 75 µm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C127/ AASHTO T85	Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128/ AASHTO T84	Standard Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate
ASTM C136/ AASHTO T27	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C535	Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM D4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
BS 1924-2	Hydraulically bound and stabilised materials for civil engineering purposes Part 2: Sample preparation and testing of materials during and after treatment
BS 812-105	Testing aggregates. Part 105: Methods for determination of particle shape - Section 105.1 Flakiness index
BS 812-110	Testing aggregates - Part 110: Methods for determination of aggregate crushing value (ACV)
BS EN 1097-2	Tests for mechanical and physical properties of aggregates. Part 2: Methods for the determination of resistance to fragmentation
BS EN 1097-3	Tests for mechanical and physical properties of aggregates. Part 3: Determination of loose bulk density and voids
BS EN 1097-5	Tests For Mechanical and Physical Properties of Aggregates. Part 5: Determination of the Water Content by Drying in a Ventilated Oven
BS EN 1097-6	Tests for mechanical and physical properties of aggregates. Part 6: Determination of particle density and water absorption
BS EN 1097-8	Tests for mechanical and physical properties of aggregates. Part 8: Determination of the polished stone value
BS EN 1367-4	Tests for thermal and weathering properties of aggregates. Part 4: Determination of drying shrinkage
BS EN 1744-1	Tests for chemical properties of aggregates. Part 1: Chemical analysis
BS EN 932-1	Tests for General Properties of Aggregates Part 1: Methods for Sampling
BS EN 933-1	Tests for geometrical properties of aggregates. Part 1: Determination of particle size distribution - Sieving method
BS EN 933-10	Tests for geometrical properties of aggregates. Part 10: Assessment of fines - Grading of fillers (air-jet sieving)
BS EN 933-3	Tests for geometrical properties of aggregates. Part 3: Determination of particle shape - Flakiness index
BS EN 933-4	Tests for geometrical properties of aggregates. Part 4: Determination of particle shape - Shape index
BS EN 933-7	Tests for geometrical properties of aggregates. Part 7: Determination of shell content - Percentage of shells in coarse aggregates.
BS EN 933-8	Tests for geometrical properties of aggregates. Part 8: Assessment of fines - Sand equivalent test

Table A.5 Hydraulic Road Binders

Standard Number	Title
BS EN 13282-1	Hydraulic road binders Rapid hardening hydraulic road binders. Composition, specifications and conformity criteria
BS EN 13282-2	Hydraulic road binders Normal hardening hydraulic road binders. Composition, specifications and conformity criteria
BS EN 196-1	Methods of testing cement. Determination of strength
BS EN 196-2	Methods of testing cement. Chemical analysis of cement
BS EN 196-3	Methods of testing cement. Determination of setting time and soundness
BS EN 196-6	Methods of testing cement. Determination of fineness
BS EN 196-5	Methods of testing cement. Pozzolanicity test for pozzolanic cements

Table A.6 Cement

Standard Number	Title
KS EAS 148-1	Test methods Part 1: Determination of strength
KS EAS 148-2	Test methods Part 2: Chemical analysis
KS EAS 148-3	Test methods Part 3: Determination of setting times and soundness
KS EAS 148-4	Test methods Part 4: Quantitative determination of constituent
KS EAS 148-5	Test methods Part 5: Pozzolanicity test for pozzolanic cements
KS EAS 148-6	Test methods Part 6: Determination of fineness
KS EAS 148-7	Test methods Part 7: Methods of taking and preparing samples
KS EAS 148-8	Test methods Part 8: Heat of hydration - Solution method

Table A.7 Lime

Standard Number	Title
KS 1755-1.1	Methods of test for limes and limestones - Part 1.1: Sample preparation - Quicklime and hydrated lime
KS 1755-2.1	Methods of test for limes and limestones - Part 2.1: Fineness - Wet sieving
KS 1755-3.1	Methods of test for limes and limestones - Part 3.1: Slaking - Dewar flask
KS 1755-4.2	Methods of test for limes and limestones - Part 4.2: Soundness - Le chatelier
KS 1755-4.3	Methods of test for limes and limestones - Part 4.3: Soundness- Autoclave
KS 1755-5.1	Methods of test for limes and limestones - Part 5.1: Chemical composition - Quicklime and hydrated lime
KS 1755-6.1	Methods of test for limes and limestones - Part 6.1: Lime index - Available lime.
KS 1755-7.1	Methods of test for limes and limestones - Part 7.1: Loss on ignition - Quicklime, hydrated lime and limestone
KS 1755-8.1	Methods of test for limes and limestones - Part 8.1: Free moisture - Convection oven

Table A.8 Bituminous Binders

Standard Number	Title
AASHTO R28	Standard Practice for Accelerated Aging of Asphalt Binder Using a Pressurised Aging Vessel (PAV)
AASHTO T179 / ASTM D1754	Standard Method of Test for Effect of Heat and Air on Asphalt Materials (Thin-Film Oven Test)
AASHTO T228/ASTM D70	Standard Method of Test for Specific Gravity and Density of Semi-Solid Asphalt Materials/ Standard Test Method for Density of Semi-Solid Asphalt Binder (Pycnometer Method)
AASHTO T240	Standard Method of Test for Effect of Heat and Air on a Moving Film of Asphalt Binder (Rolling Thin-Film Oven Test)
AASHTO T301/ ASTM D6084	Standard Method of Test for Elastic Recovery Test of Asphalt Materials by Means of a Ductilometer
AASHTO T313 / ASTM D3497	Standard Method of Test for Determining the Flexural Creep Stiffness of Asphalt Binder Using the Bending Beam Rheometer (BBR)
AASHTO T314	Standard Method of Test for Determining the Fracture Properties of Asphalt Binder in Direct Tension (DT)
AASHTO T315	Standard Method of Test for Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)
AASHTO T316	Standard Method of Test for Viscosity Determination of Asphalt Binder Using Rotational Viscometer
AASHTO T350	Standard Method of Test for Multiple Stress Creep Recovery (MSCR) Test of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)
AASHTO T44	Standard Method of Test for Solubility of Bituminous Materials
AASHTO T48/ASTM D92	Standard Method of Test for Flash Point of Asphalt Binder by Cleveland Open Cup
AASHTO T49/ASTM D5	Standard Method of Test for Penetration of Bituminous Materials
AASHTO T53	Standard Method of Test for Softening Point of Bitumen (Ring-and-Ball Apparatus)
ASTM D113	Standard Test Method for Ductility of Asphalt Materials
ASTM D2042	Standard Test Method for Solubility of Asphalt Materials in Trichloroethylene or Toluene
ASTM D2170	Standard Test Method for Kinematic Viscosity of Asphalts (Bitumens)
ASTM D244	Standard Test Methods and Practices for Emulsified Asphalts
ASTM D402	Standard Test Method for Distillation of Cutback Asphaltic (Bituminous) Products
ASTM D4402	Standard Test Method for Viscosity Determination of Asphalt at Elevated Temperatures Using a Rotational Viscometer
ASTM D5	Standard Test Method for Penetration of Bituminous Materials
ASTM D5329	Standard Test Methods for Sealants and Fillers, Hot-Applied, for Joints and Cracks in Asphalt Pavements and Portland Cement Concrete Pavements
ASTM D6	Standard Test Method for Loss on Heating of Oil and Asphaltic Compounds
ASTM D6930	Standard Test Method for Settlement and Storage Stability of Emulsified Asphalts
ASTM D6933	Standard Test Method for Oversized Particles in Emulsified Asphalts (Sieve Test)
ASTM D6935	Standard Test Method for Determining Cement Mixing of Emulsified Asphalt
ASTM D6936	Standard Test Method for Determining Demulsibility of Emulsified Asphalt
ASTM D6997	Standard Test Method for Distillation of Emulsified Asphalt
ASTM D7173	Standard Practice for Determining the Separation Tendency of Polymer from Polymer-Modified Asphalt
ASTM D7402	Standard Practice for Identifying Cationic Emulsified Asphalts
ASTM D7496	Standard Test Method for Viscosity of Emulsified Asphalt by Saybolt Furol Viscometer
ASTM D7741	Standard Test Method for Measurement of Apparent Viscosity of Asphalt-Rubber or Other Asphalt Binders by Using a Rotational Handheld Viscometer
ASTM D95	Standard Test Method for Water in Petroleum Products and Bituminous Materials by Distillation
BS 434	Bitumen road emulsions - Part 1: Specification for anionic bitumen road emulsions
BS EN 12848	Bitumen and bituminous binders. Determination of mixing stability with cement of bituminous emulsions
BS EN 1428	Bitumen and bituminous binders. Determination of water content in bituminous emulsions. Azeotropic distillation method

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**Table A.8** Bituminous Binders (*continued...*)

Standard Number	Title
BS EN 1429	Bitumen and bituminous binders. Determination of residue on sieving of bituminous emulsions, and determination of storage stability by sieving
BS EN 1430	Bitumen and Bituminous Binders - Determination of Particle Polarity of Bituminous Emulsions
BS EN12592	Bitumen and bituminous binders — Determination of solubility
BS EN12607 – 1	Bitumen and bituminous binders - Determination of the resistance to hardening under influence of heat and air - Part 1: RTFOT method
BS EN1426	Bitumen and bituminous binders - Determination of needle penetration
BS EN1427	Bitumen and bituminous binders — Determination of the softening point — Ring and Ball method
BS ENISO 2592	Determination of flash and fire points. Cleveland open cup method
KS EAS 982-3	Bitumen and bituminous binders - Specification Part 3: Anionic bitumen emulsion
KS EAS 982-4	Bitumen and bituminous binders - Specification Part 4: Cationic bitumen emulsion
ASTM D140	Standard Practice for Sampling Asphalt Materials
AASHTO T55	Standard Method of Test for Water in Petroleum Products and Bituminous Materials by Distillation
ASTM D95	Standard Test Method for Water in Petroleum Products and Bituminous Materials by Distillation
ASTM D3143	Standard Test Method for Flash Point of Cutback Asphalt with Tag Open-Cup Apparatus

**Table A.9** Steel

Standard Number	Title
AASHTO M180-00	Standard Specification for Corrugated Sheet Steel Beams for Highway Guardrail
BS 5268-2	Structural use of timber — Part 2: Code of practice for permissible stress design, materials and workmanship
BS 5268-5	Structural use of timber — Part 5: Code of practice for preservative treatment of timber
BS EN 1317-5	Road restraint systems Product requirements and evaluation of conformity for vehicle restraint systems
BS EN10051	Continuously hot-rolled strip and plate/sheet cut from wide strip of non-alloy and alloy steels - Tolerances on dimensions and shape
EN 10138	Prestressing steels, Part 1: General requirements, Part 4: Bars
ISO 13918	Studs and ceramic ferrules for arc stud welding
ISO 14555	Arc stud welding of metallic materials
ISO 1461	Hot-dip galvanised coatings on fabricated iron and steel articles – Specifications and test methods.
ISO 15630-1	Steel for the reinforcement and prestressing of concrete. Test methods Reinforcing bars, rods and wire
ISO 15630-3	Steel for the reinforcement and prestressing of concrete. Test methods. Part 3: Prestressing steel
ISO 17660	Welding- Welding of reinforcing steel
ISO 6892-1	Metallic materials — Tensile testing — Part 1: Method of test at room temperature
ISO 7438	Metallic materials — Bend test
KS EAS 134	Cold rolled steel sections-Specification
KS EAS 412	Steel for the reinforcement of concrete
M 232M/M 232	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
AASHTO M180	Standard Specification for Steel Components for Highway Guardrail
ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanised) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
AASHTO M270	Standard Specification for Structural Steel for Bridges
AASHTO M111	Standard Specification for Zinc (Hot-Dip Galvanised) Coatings on Iron and Steel Products
AASHTO M232	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
AASHTO M291	Standard Specification for Carbon and Alloy Steel Nuts
ASTM A449	Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use

**Table A.10** Hydraulically Modified and Hydraulically Bound Materials

Standard Number	Title
AASHTO T180	Standard Method of Test for Moisture–Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
BS 1924-2	Hydraulically bound and stabilised materials for civil engineering purposes. Sample preparation and testing of materials during and after treatment.
BS EN 13286-42	Unbound and hydraulically bound mixtures. Test method for the determination of the indirect tensile strength of hydraulically bound mixtures
BS EN 13286-43	Unbound and hydraulically bound mixtures. Test method for the determination of the modulus of elasticity of hydraulically bound mixtures
BS EN10051	Continuously hot-rolled strip and plate/sheet cut from wide strip of non-alloy and alloy steels - Tolerances on dimensions and shape
BS EN 13286-47	Unbound and hydraulically bound mixtures Test method for the determination of California bearing ratio, immediate bearing index and linear swelling

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Appendices

Table A.11 Concrete for Pavements

Standard Number	Title
BS EN 12350-2	Testing fresh concrete Slump test
BS EN 12350-3	Testing fresh concrete. Vebe test
BS EN 12350-4	Testing fresh concrete Degree of compactability
BS EN 12350-5	Testing fresh concrete - Flow table test
BS EN 12350-6	Testing fresh concrete - Density
BS EN 12350-7	Testing fresh concrete Air content. Pressure methods
BS EN 12350-8	Testing fresh concrete Self-compacting concrete. Slump-flow test
BS EN 12350-9	Testing fresh concrete Self-compacting concrete. V-funnel test
BS EN 12390-10	Testing hardened concrete. Determination of the carbonation resistance of concrete at atmospheric levels of carbon dioxide
BS EN 12390-11	Testing hardened concrete - Determination of the chloride resistance of concrete, unidirectional diffusion
BS EN 12390-12	Testing hardened concrete - Determination of the carbonation resistance of concrete. Accelerated carbonation method
BS EN 12390-13	Testing hardened concrete Determination of secant modulus of elasticity in compression
BS EN 12390-14	Testing hardened concrete - Semi-adiabatic method for the determination of heat released by concrete during its hardening process
BS EN 12390-2	Testing hardened concrete - Making and curing specimens for strength tests
BS EN 12390-3	Testing hardened concrete. Compressive strength of test specimens
BS EN 12390-5	Testing hardened concrete. Flexural strength of test specimens
BS EN 12390-6	Testing Hardened Concrete. Tensile Splitting Strength of Test Specimens
BS EN 12390-7	Testing hardened concrete Density of hardened concrete
BS EN 12390-8	Testing hardened concrete - Depth of penetration of water under pressure
BS EN 12504-1	Testing concrete in structures - Cored specimens. Taking, examining and testing in compression
BS EN 12504-2	Testing concrete in structures Non-destructive testing. Determination of rebound number
BS EN 1338	Concrete paving blocks. Requirements and test methods
BS EN 1340	Concrete kerb units. Requirements and test methods
BS EN 13863-1	Concrete pavements Test method for the determination of the thickness of a concrete pavement by survey method
BS EN 13863-2	Concrete Pavements - Part 2: Test Method for the Determination of the Bond Between Two Layers
BS EN 13863-3	Concrete pavements Test methods for the determination of the thickness of a concrete pavement from cores
BS EN 13863-5	Concrete pavements Part 5. Determination of the bond stress of dowels to be used in concrete pavements
BS EN 13863-6	Concrete pavements. Test method for the determination of the splitting tensile strength of concrete on cylindrical discs
BS EN 12390-1	Testing hardened concrete - Shape, dimensions and other requirements for specimens and moulds
BS EN 12350-1	Testing fresh concrete Sampling and common apparatus
BS EN 12504-2	Testing concrete in structures - Non-destructive testing. Determination of rebound number
BS EN 12504-3	Testing concrete in structures - Determination of pull-out force
BS EN 12504-4	Testing concrete in structures Determination of ultrasonic pulse velocity
EN 13369	Common rules for precast concrete products
EN 15258	Precast concrete products. Retaining wall elements
EN 15050	Precast concrete products. Bridge elements
EN 14991	Precast concrete products - Foundation elements
EN 14844	Precast concrete products - Box culverts
EN 13225	Precast concrete products - Linear structural elements
EN 13198	Precast concrete products. Street furniture and garden products
EN 12843	Precast concrete products - Masts and poles
EN 12794	Precast concrete products - Foundation piles
EN 1916	Concrete pipes and fittings, unreinforced, steel fibre and reinforced



Table A.12 Water

Standard Number	Title
BS 6068-2.37	Water quality. Physical, chemical and biochemical methods Method for the determination of chloride via a silver nitrate titration with chromate indicator (Mohr's method)
BS EN 872	Testing fresh concrete. Vebe test
	Water quality. Determination of suspended solids. Method by filtration through glass fibre filters
ISO 10523	Water quality. Determination of pH
ASTM D1067	Standard Test Methods for Acidity or Alkalinity of Water
BS 6068-2.2.13	Water quality. Physical, chemical and biochemical methods. Determination of turbidity
BS 6068-2.39	Water quality. Physical, chemical and biochemical methods. Method for the determination of sulphate using barium chloride and gravimetry
BS 6068-2.50	Water quality. Physical, chemical and biochemical methods. Determination of pH
BS 6068-6	Water quality. Sampling.

Table A.13 Bitumen Stabilised Materials

Standard Number	Title
AASHTO T27/ ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
AASHTO T283 / ASTM D4867M	Standard Test Method for Indirect Tension Test for Resilient Modulus of Bituminous Mixtures
AASHTO T312	Standard Method of Test for Preparing and Determining the Density of Asphalt Mixture Specimens by Means of the Superpave Gyratory Compactor
AGPT/T301	Determining the Foaming Characteristics of Bitumen
ASTM D1074	Standard Test Method for Compressive Strength of Bituminous Mixtures
ASTM D1557/ AASHTO T180	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft <sup>3</sup> (2,700 kN-m/m <sup>3</sup> ))
ASTM D1883	Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils
ASTM D2172/ AASHTO T164	Standard Method of Test for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures
ASTM D4123	Standard Test Method for Indirect Tension Test for Resilient Modulus of Bituminous Mixtures
ASTM D6925	Standard Test Method for Preparation and Determination of the Relative Density of Asphalt Mix Specimens by Means of the Superpave Gyratory Compactor
ASTM D979	Standard Practice For Sampling Bituminous Paving Mixtures

Table A.14 Bitumen Bound Materials

Standard Number	Title
AASHTO R59/ ASTM D1856	Standard Practice for Recovery of Asphalt Binder from Solution by Abson Method
AASHTO T110 / ASTM D1461	Standard Method of Test for Moisture or Volatile Distillates in Asphalt Mixtures
AASHTO T164	Standard Method of Test for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures.
AASHTO T166 (ASTM D1188 and ASTM D2726)	Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens
AASHTO T182 / ASTM D1664	Standard Test Method for Coating and Stripping of Bitumen-Aggregate Mixtures
AASHTO T195 / ASTM D2489	Standard Method of Test for Determining Degree of Particle Coating of Asphalt Mixtures / Standard Practice for Estimating Degree of Particle Coating of Bituminous-Aggregate Mixtures
AASHTO T209 / ASTM D2041	Standard Method of Test for Theoretical Maximum Specific Gravity (Gmm) and Density of Asphalt Mixtures
AASHTO T230	Standard Method of Test for Determining Degree of Pavement Compaction of Bituminous Aggregate Mixtures
AASHTO T245 / ASTM D1559	Standard Method of Test for Resistance to Plastic Flow of Asphalt Mixtures Using Marshall Apparatus
AASHTO T283 / ASTM D4867M	Standard Test Method for Indirect Tension Test for Resilient Modulus of Bituminous Mixtures
AASHTO T30	Standard Method of Test for Mechanical Analysis of Extracted Aggregate
AASHTO T308	Standard Method of Test for Determining the Asphalt Binder Content of Asphalt Mixtures by the Ignition Method
AASHTO T312	Standard Method of Test for Preparing and Determining the Density of Asphalt Mixture Specimens by Means of the Superpave Gyrotory Compactor
AASHTO T319	Standard Method of Test for Quantitative Extraction and Recovery of Asphalt Binder from Asphalt Mixtures
AASHTO T321	Standard Method of Test for Determining the Fatigue Life of Compacted Asphalt Mixtures Subjected to Repeated Flexural Bending
AASHTO T324	Standard Method of Test for Hamburg Wheel-Track Testing of Compacted Asphalt Mixtures
AASHTO TP62	Standard Method of Test for Determining Dynamic Modulus of Hot Mix Asphalt (HMA)
ASTM D1138	Method of Test for Resistance to Plastic Flow of Fine-Aggregate Bituminous Mixtures by Means of the Hubbard-Field Apparatus
ASTM D2727	Test for Coating and Resistance to Stripping of Bituminous-Aggregate Mixtures Containing Adhesion Promoting Agents
ASTM D2950	Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods
ASTM D4123	Standard Test Method for Indirect Tension Test for Resilient Modulus of Bituminous Mixtures
BS EN 12697-32	Bituminous mixtures. Test methods Specimen preparation by vibratory compactor
BS EN 12697-33	Bituminous mixtures. Test methods for hot mix asphalt - Specimen prepared by roller compactor



Table A.15 Road Marking and Signs

Standard Number	Title
ASTM D 256	Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
ASTM D 790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D2205	Standard Guide for Selection of Tests for Traffic Paints
ASTM D3039	Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials
ASTM D3330	Standard Test Method for Peel Adhesion of Pressure-Sensitive Tape
ASTM D903	Standard Test Method for Peel or Stripping Strength of Adhesive Bonds
ASTM E 303	Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester
ASTM E810	Standard Test Method for Coefficient of Retroreflection of Retroreflective Sheeting Utilising the Coplanar Geometry
DS/EN 1871	Road marking materials – Paint, thermoplastic and cold plastic materials – Physical properties
BS EN1436	Road marking materials - Road marking performance for road users and test methods
BS EN1463 Part 2	Road marking materials - Retroreflecting road studs - Part 2: Road test performance specifications
BS EN1871	Road marking materials - Physical properties
ISO 527	Plastics. Determination of tensile properties - Part 1: General principles
KS 2563	Standard test method for peel adhesion of pressure-sensitive autoclaving tape.
KS EAS 927	Road marking paints-Specification
KS EAS 928-2	Hot applied thermoplastic road marking paint-Specification-Part 2: Road performance
AASHTO T168 / ASTM D979	Standard Method of Test for Sampling Bituminous Paving Mixtures
	Method of Test for Resistance to Plastic Flow of Fine-Aggregate Bituminous Mixtures by Means of the Hubbard-Field Apparatus
ASTM D7307	Standard Practice for Sampling of Thermoplastic Pavement Marking Materials
BS EN 13459	Road marking materials. Sampling from storage and testing
ASTM D4123	Standard Test Method for Indirect Tension Test for Resilient Modulus of Bituminous Mixtures

Table A.16 Paints for Structures

Standard Number	Title
ASTM D823-18	Standard Practices for Producing Films of Uniform Thickness of Paint, Coatings and Related Products on Test Panels
ISO 12944-6	Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
ISO 1461	Hot dip galvanised coatings on fabricated iron and steel articles
Specifications and test methods	Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials
ISO 1460	Metallic coatings. Hot dip galvanised coatings on ferrous materials - Gravimetric determination of the mass per unit area
ISO 1518-1	Paints and varnishes. Determination of scratch resistance
Part 1: Constant-loading method	Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester
ISO 1518-2	Paints and varnishes. Determination of scratch resistance
Part 2: Variable-loading method	Road marking materials – Paint, thermoplastic and cold plastic materials – Physical properties
ISO 2178	Non-magnetic coatings on magnetic substrates. Measurement of coating thickness - Magnetic method
ISO 2808	Paints and varnishes. Determination of film thickness

Table A.17 Geosynthetics

Standard Number	Title
ASTM C338	Standard Test Method for Softening Point of Glass
ASTM D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D3786	Standard Test Method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method
ASTM D4355	Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc-Type Apparatus
ASTM D4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D4751	Standard Test Methods for Determining Apparent Opening Size of a Geotextile
ASTM D4759	Standard Practice for Determining the Specification Conformance of Geosynthetics
ASTM D4833	Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
ASTM D5261	Standard Test Method for Measuring Mass per Unit Area of Geotextiles
ASTM D5321	Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear
ASTM D6637	Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method
ASTM D6706	Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil
ASTM D6992	Standard Test Method for Accelerated Tensile Creep and Creep-Rupture of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method
ASTM D7737	Standard Test Method for Individual Geogrid Junction Strength
ASTM D7748	Standard Test Method for Flexural Rigidity of Geogrids, Geotextiles, and Related Products
ASTM D7748	Standard Test Method for Flexural Rigidity of Geogrids, Geotextiles, and Related Products
ASTM E2254	Standard Test Method for Storage Modulus Calibration of Dynamic Mechanical Analysers
EN ISO 10319	Geosynthetics: Wide-width tensile test
EN ISO 10321	Tensile test for joints/seams by wide-width strip method
ISO 3146	Determination of melting behaviour (melting temperature or melting range) of semi-crystalline polymers by capillary tube and polarising-microscope methods
ISO 6721	Determination of dynamic mechanical properties
ISO 9864	Geosynthetics: Test method for the determination of mass per unit area of geotextiles and geotextile-related products
ASTM D4354	Standard Practice for Sampling of Geosynthetics and Rolled Erosion Control Products (RECPs) for Testing
ASTM D4595	Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D5261	Standard Test Method for Measuring Mass per Unit Area of Geotextiles
ASTM D5199	Standard Test Method for Measuring the Nominal Thickness of Geosynthetics

Table A.18 Bridge Components

Standard Number	Title
ASTM D 2240	Standard Test Method for Rubber Property - Durometer Hardness
ASTM D 897	Standard Test Method for Tensile Properties of Adhesive Bonds
ASTM D1002	Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)
ASTM D1084	Standard Test Methods for Viscosity of Adhesives
ASTM D412	Standard Test Methods for Vulcanised Rubber and Thermoplastic Elastomers - Tension
ASTM D638 M	Standard Test Method for Tensile Properties of Plastics (Metric)
ASTM D903	Standard Test Method for Peel or Stripping Strength of Adhesive Bonds
BS 4483	Steel fabric for the reinforcement of concrete- Specification
BS EN 13880	Hot applied joint sealants
BS EN 14695	Flexible sheets for waterproofing - Reinforced bitumen sheets for waterproofing of concrete bridge decks and other trafficked areas of concrete - Definitions and characteristics
EN 10138	Prestressing steels – Part-1 to Part-5
EN 14399-2	High strength structural bolting for preloading Part 2: Suitability Test for preloading.
EN 14399-3	High strength structural bolting for preloading Part 3: System HR -Hexagon bolt and nut assemblies.
EN 14399-4	High strength structural bolting for preloading - Part 4: System HY -Hexagon bolt and nut assemblies.
EN 14399-5	High strength structural bolting for preloading - Part 5: Plain washers for system HR.
EN 14399-6	High strength structural bolting for preloading - Part 6: Plain chamfered washers for systems HR and HY.
ETAG 033	Guideline for European Technical Approval of liquid applied bridge deck waterproofing kits
ETAG no. 032 Part-5	Guideline for European Technical Approval of Expansion Joints for Road Bridges- Part 5: Mat expansion joint
ETAG no. 032 Part-6	Guideline for European Technical Approval of Expansion Joints for Road Bridges- Part 6: Cantilever expansion joint
ETAG no. 032 Part-7	Guideline for European Technical Approval of Expansion Joints for Road Bridges- Part 7: Supported expansion joint
ETAG no. 032 Part-8	Guideline for European Technical Approval of Expansion Joints for Road Bridges- Part 8: Modular expansion joint
ISO 4032	Hexagon nuts, style 1 - Product grades A and B
ISO 4014	Hexagon head bolts - Product grades A and B
ISO 4016	Hexagon head bolts - Product grade C
ISO 4017	Hexagon head screws - Product grades A and B
ISO 4018	Hexagon head screws - Product grades C
ISO 4033	Hexagon nuts, style 2 - Product grades A and B
ISO 4034	Hexagon nuts - Product grades C
ASTM F3125	Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions
BS 3974-1	Pipe supports – Part 1: Pipe hangers, slider and roller type supports
ISO 8677	Mushroom head square neck bolts
BS 8539	Code of practice for the selection and installation of post-installed anchors in concrete and masonry.

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Appendices

Published by TRL



Prepared for:



REPUBLIC OF KENYA  
MINISTRY OF ROADS AND TRANSPORT

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