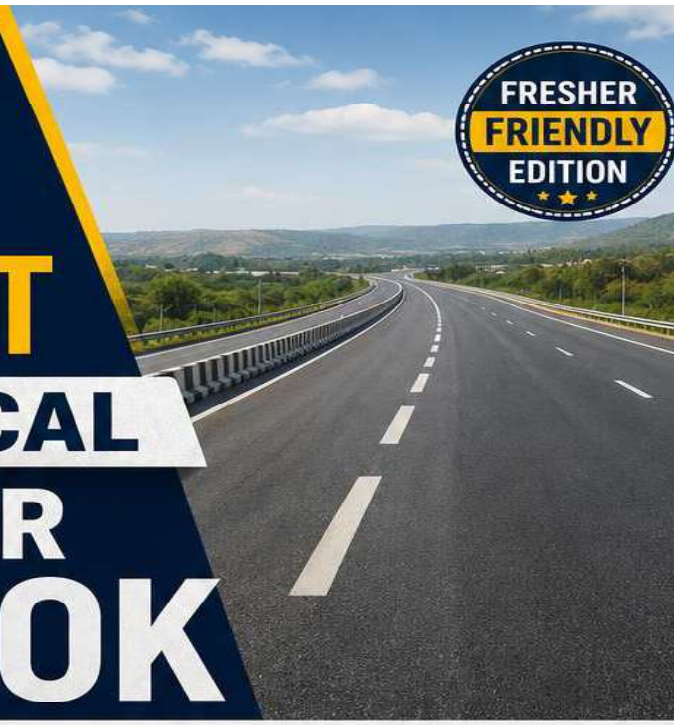
HIGHWAY QUALITY TEST

QA/QC PRACTICAL SITE ENGINEER HANDBOOK



MoRTH-Based Field Execution & Quality Control Guide

सड़क परिवहन और राजमार्ग मंत्रालय
MINISTRY OF
ROAD TRANSPORT & HIGHWAYS
(MoRTH)

सत्यमेव जयते

- EARTHWORK
- GSB | WMM
- BITUMINOUS WORKS (HMA)
- CONCRETE WORKS
- MoRTH-BASED PRACTICAL FIELD GUIDE

PRACTICAL FIELD GUIDE | STEP-BY-STEP QA/QC PROCESS | TEST PROCEDURES AS PER MoRTH | PERFECT FOR FRESHERS & SITE ENGINEERS

PRICE:
₹199
(FRESHER FIELD EDITION)

- 100% PRACTICAL – SITE ORIENTED
- QUALITY ASSURANCE | QUALITY CONTROL
- LEARN | APPLY | GROW

CHAPTER-1: ABOUT THIS BOOK

HIGHWAY CONSTRUCTION SITE ENGINEER & QA/QC HANDBOOK

Practical Field Execution, Inspection, Testing & Quality Control Guide Based on MoRTH Specifications, IRC Guidelines & Real Highway Construction Experience

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DESIGNED FOR

✔ Fresh Site Engineers
✔ QA/QC Engineers & Trainees
✔ Civil Engineering Graduates
✔ Highway Construction Professionals
✔ Site Supervisors
✔ Infrastructure Project Teams

WHAT YOU WILL LEARN

By using this handbook, you will be able to:

✔ Understand the complete highway construction sequence from earthwork to pavement completion
✔ Apply step-by-step site execution methods for major highway construction activities
✔ Identify common construction defects and implement preventive measures
✔ Understand QA/QC inspection requirements and critical hold points
✔ Conduct effective site inspections and quality verification checks
✔ Interpret field test results such as FDT, slump, density, core, and cube tests
✔ Follow practical MoRTH-based quality control procedures during execution
✔ Understand survey, chainage, line, level, and crossfall fundamentals
✔ Maintain essential QA/QC documentation, records, and inspection reports
✔ Recognize common reasons for site rejections and apply corrective actions
✔ Improve coordination with survey, laboratory, execution, and QA/QC teams
✔ Build confidence in making technical decisions during site execution
✔ Develop the professional mindset required for a successful career in highway construction and quality engineering

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KEY TOPICS COVERED

✔ Survey & Chainage Basics
✔ Earthwork Quality Control
✔ GSB & WMM Execution
✔ CTGSB Quality Control
✔ DLC & PQC Control Systems
✔ Bituminous Works (DBM / BC)
✔ RCC & Structural Concrete
✔ Hold Point Management
✔ QA/QC Documentation

✔ Site Rejections & Corrective Actions
✔ Ready-to-Use Site Checklists
✔ Career Guidance for Fresh Engineers

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Practical Highway Engineering Learning Series

MOTTO
"Inspect Before Work, Monitor During Work, Approve Only After Verification."

HIGHWAY QUALITY TEST
Quality First • Safety Always • Excellence Every Time

CHAPTER-2: HOW TO USE THIS GUIDE

PURPOSE OF THIS GUIDE:

This handbook is not just for reading — it is designed as a **practical site execution support tool**.

It helps engineers understand:

✔ What to check before starting work
✔ What to control during execution
✔ What to verify after completion

This ensures **correct work at first attempt and reduces site errors**

HOW TO APPLY THIS GUIDE ON SITE

STEP 1 — BEFORE STARTING WORK (PRE-CHECK)

Before starting any activity, always verify:

✔ Approved drawings and specifications available
✔ Material approvals completed
✔ Equipment and manpower ready
✔ Site conditions suitable for work
✔ QA/QC inspection clearance obtained

SIMPLE UNDERSTANDING:
If preparation is wrong → execution will also fail

STEP 2 — DURING EXECUTION (CONTROL STAGE)

While work is in progress:

✔ Follow layer thickness and design requirements
✔ Maintain proper moisture / temperature control
✔ Ensure correct equipment usage
✔ Monitor workmanship continuously
✔ Conduct in-process checks (FDT / Slump / Temperature etc.)
✔ Avoid shortcuts or deviations

SIMPLE UNDERSTANDING:
This is the most critical stage for quality control

STEP 3 — AFTER COMPLETION (VERIFICATION STAGE)
After finishing work:
✔ Conduct required field tests (density / cube / core etc.)
✔ Check surface level, line, and finish quality
✔ Verify documentation and test records
✔ Ensure QA/QC inspection approval
✔ Only then allow next stage work

SIMPLE UNDERSTANDING:
No approval = no progression to next layer

IMPORTANT SITE CONTROL RULES

❌Never proceed without QA/QC approval
❌Never ignore test results
❌Never skip inspection hold points
❌Never assume quality without verification

✔ Always follow system-based execution

ENGINEER MINDSET RULE

✔ Think before execution
✔ Control during execution
✔ Verify after execution

This 3-step approach ensures **zero rework and high-quality output**

HIGHWAY QUALITY TEST

"Site success is not about speed — it is about controlled execution at every stage."

Chapter 3: A Day in the Life of a Highway Site Engineer

Introduction:
Many fresh civil engineers join a highway project with theoretical knowledge but struggle with day-to-day site activities. This chapter explains the actual responsibilities of a site engineer during a typical working day on a highway construction project.

7:30 AM – 8:00 AM: Site Arrival & Planning

The first task is to review the day's construction targets.

Check Daily Work Plan

Review:

1. Chainages planned for execution
2. Type of work to be executed
3. Quantity target for the day
4. Availability of drawings
5. Previous day's pending activities

Typical Discussion with Senior Engineer

1. What layer is planned today?
2. How much quantity is targeted?
3. Any inspection scheduled?
4. Any material shortage expected?

8:00 AM – 8:30 AM: Resource Verification

Before work starts, verify all resources.

Manpower Check

Confirm availability of:

1. Supervisors
2. Survey team
3. Lab technicians
4. Machine operators
5. Skilled labour
6. Helpers

Machinery Check

Verify working condition of:

1. Excavator
2. Motor Grader
3. Soil Compactor
4. Vibratory Roller
5. PTR
6. Sensor Paver
7. Batch Mix Plant
8. Hot Mix Plant
9. Transit Mixers
10. Water Tankers

Material Availability Check
Verify stock of:
1. Soil
2. GSB material
3. WMM material
4. Bitumen
5. Cement
6. Aggregates
7. Admixtures
8. Reinforcement Steel

A shortage discovered at noon can stop production for the entire day.

8:30 AM – 9:00 AM: Survey Verification

Before any construction begins:
Check Line
Verify centerline and offset pegs.
Check Level
Confirm reduced levels (RLs) with survey team.
Check Cross Fall
Verify cross slope as per drawing.
Typical Values:
1. Flexible Pavement: 2.5%
2. PQC Pavement: 2.0%

Check Layer Thickness
Confirm required compacted thickness before placing material.

9:00 AM – 12:30 PM: Construction Monitoring

This is the most important part of the day.
During Earthwork
Check:
1. Moisture condition
2. Layer thickness
3. Compaction pattern
4. FDT locations
5. Side slope formation

Site Engineer Records
1. Chainage covered
2. Number of roller passes
3. Field Density Test results
4. Borrow area details

During GSB
Check:
1. Material gradation
2. Moisture content

3. Spreading thickness
4. Compaction sequence

Verify:

1. Width
2. Thickness
3. Density

During WMM

Check:

1. Plant production
2. Moisture content
3. Gradation reports
4. Segregation during laying

Verify:

1. Layer thickness
2. Rolling pattern
3. Density achievement

During DBM / BC

Monitor temperatures continuously.

Check at Plant

1. Aggregate temperature
2. Bitumen temperature
3. Mix discharge temperature

Check at Site

1. Arrival temperature
2. Laying temperature
3. Rolling temperature

Verify:

1. Segregation
2. Surface texture
3. Longitudinal joint quality
4. Density testing locations

During DLC / PQC

Check:

1. Concrete temperature
2. Slump
3. Dowel bars
4. Tie bars
5. Reinforcement (if applicable)

Verify:

1. Thickness
2. Level
3. Surface finish

4. Curing arrangements

Quality Control Coordination
Throughout the day, coordinate with the laboratory team.
Typical Tests to Monitor
Earthwork:
1. Moisture Content
2. FDT

GSB:
1. Gradation
2. Density

WMM:
1. Gradation
2. Density

DBM:
1. Marshall Properties
2. Bitumen Content
3. Core Density

BC:
1. Binder Content
2. Density
3. Temperature

PQC:
1. Slump
2. Flexural Beams
3. Cube Casting

12:30 PM – 1:00 PM: Mid-Day Progress Review

Review:
1. Quantity achieved
2. Delays encountered
3. Material consumption
4. Equipment breakdowns

Compare actual progress with target.

1:00 PM – 4:30 PM: Afternoon Monitoring

Continue monitoring:
Safety
Check:
1. PPE usage
2. Barricading
3. Traffic diversion
4. Warning signs

Quality
Verify:

1. Thickness
2. Density
3. Temperature
4. Alignment
5. Levels

Production

Track:

1. Number of trips
2. Plant output
3. Daily material consumption

4:30 PM – 5:30 PM: Measurement & Quantity Calculation

Measure executed work.

Examples:

Earthwork

Calculate:

Length × Width × Thickness

GSB

Calculate compacted volume.

WMM

Calculate compacted quantity.

DBM / BC

Calculate:

Length × Width × Thickness × Density

PQC

Calculate:

Length × Width × Thickness

Record chainages completed.

5:30 PM – 6:30 PM: Documentation

A good site engineer spends time on documentation every day.

Daily Progress Report (DPR)

Include:

1. Date
2. Weather
3. Work location
4. Quantity executed
5. Machinery deployed
6. Manpower deployed
7. Material consumed

Update Registers

Update:

1. Cube Register
2. Density Register
3. Bitumen Register

4. Cement Register
5. Test Register

Prepare Next Day Requirements

Inform stores and procurement about:

1. Aggregate requirement
2. Bitumen requirement
3. Cement requirement
4. Fuel requirement

Daily Site Engineer Checklist

1. Drawings available
2. Chainage verified
3. Line & level checked
4. Material available
5. Machinery available
6. Lab reports reviewed
7. Density checked
8. Temperature checked
9. Thickness checked
10. Quantity measured
11. DPR prepared
12. Test registers updated
13. Next day planning completed

Practical Advice for Fresh Engineers

1. Never start work without checking line and level.
2. Visit the laboratory every day.
3. Carry a notebook and record observations.
4. Learn chainage calculations.
5. Verify dimensions yourself.
6. Understand why a test is performed, not just its frequency.
7. Maintain good coordination with survey and QC teams.
8. Documentation is as important as execution.
9. Ask questions whenever you are unsure.
10. A successful site engineer controls Quality, Quantity, Safety and Progress simultaneously.

CHAPTER-4: EARTHWORK COMPACTION & LAYER QUALITY CONTROL SYSTEM

WHAT THIS SECTION ENSURES

This system ensures that every earthwork layer:

✔ Achieves proper strength and stability
✔ Meets compaction requirements
✔ Prevents settlement and pavement failure
✔ Is approved as per QA/QC standards before next activity

1. LAYER PREPARATION CONTROL

✔ Formation level properly prepared and trimmed before starting work
✔ All loose soil, vegetation, and soft material removed from surface
✔ Subgrade made uniform before placing new layer
✔ No uneven or weak pockets allowed in working area

SIMPLE UNDERSTANDING:
Good compaction starts only on a properly prepared base.

2. LAYER THICKNESS CONTROL

✔ Each soil layer maintained within **200–250 mm compacted thickness (or as per design)**
✔ No over-thick layers allowed (ensures proper compaction throughout depth)
✔ Uniform spreading of soil before rolling
✔ Thickness checked at random locations by QA/QC team

NOTE:
THICKER LAYERS = IMPROPER COMPACTION = FUTURE SETTLEMENT RISK

3. MOISTURE CONTROL SYSTEM

✔ Soil moisture maintained close to **Optimum Moisture Content (OMC)**
✔ Proper watering done when soil is dry
✔ Excess water avoided to prevent pumping and instability
✔ Moisture checked visually and by field testing if required

SIMPLE UNDERSTANDING:
Correct moisture = better compaction + higher density

4. COMPACTION EQUIPMENT CONTROL

✔ Approved roller used (vibratory / padfoot depending on soil type)
✔ Roller condition checked before starting work
✔ Required roller passes ensured as per trial section
✔ Rolling performed uniformly without skipping areas

5. ROLLING METHOD CONTROL

✔ Rolling started from edges towards centre
✔ Overlapping passes maintained for full coverage
✔ Uniform speed of roller maintained
✔ No sudden turning or uneven movement on layer

SIMPLE UNDERSTANDING:
Proper rolling pattern ensures uniform soil density

6. FIELD DENSITY TEST (FDT) CONTROL

✔ Field Density Test conducted as per frequency (MoRTH / project requirement)
✔ Density compared with Maximum Dry Density (MDD)
✔ Minimum required compaction achieved before approval
✔ All test results recorded in QA/QC register

KEY POINT:
FDT is the final proof of compaction quality

7. QUALITY OF COMPACTION

✔ Uniform density achieved throughout layer
✔ No loose patches or weak spots allowed
✔ No visible cracking or soil displacement after rolling
✔ Surface firm and stable after compaction

8. DEFECT CONTROL (COMMON ISSUES)

✖Over-thick layers not compacted properly
✖Excess moisture causing instability
✖Loose soil pockets left untreated
✖Improper roller passes or missed areas
✖No FDT before next layer

✔ All defects must be corrected immediately before proceeding

HOLD POINT (MANDATORY STOP)

NO NEXT LAYER WITHOUT QA/QC APPROVAL

✔ Earthwork layer shall NOT proceed to next stage unless:

1. Field Density Test is approved
2. Layer thickness is verified

3. Moisture condition is satisfactory
4. Surface is stable and uniform

✖Any failure requires rework, recompaction, or correction before approval

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SITE ENGINEER SIMPLE RULE

✔ Think of earthwork as the **foundation of the road**
✔ If this layer fails, the entire pavement will fail later
✔ Every layer must be treated as a **critical inspection point**

HIGHWAY QUALITY TEST — FIELD INSIGHT

"Proper compaction is not achieved by machines alone—it is achieved by correct thickness, correct moisture, and correct supervision."

HIGHWAY QUALITY TEST

INSPECTION AND TESTING PLAN
(HIGHWAY QUALITY TEST)

1. SETTING OUT & SOURCE INSPECTION (BORROW MATERIAL)

Sl. No.	Activity / Element	Inspection Stage	Test / Inspection	IS Code / Standard	Frequency	Acceptance Criteria
1	Setting out & survey	Before starting earth work / commencement of dismantling	Verify chainage, alignment, X-section and levels	Standard survey practice	Continual	Drawings, Specifications and Standard survey practice
	Excavation	Carrying out setting out work for that section	Verify finished foundation level	Leveling	Each defined chainage	As per drawings /tolerances
	Embankment (Source Borrow Material)	Inspection at source for Borrow Material	Grain Size Analysis (GSA)	IS:2720 (Part 4)	2 tests / 3000 m³	75 mm below material to be used
			Atterberg Limits	IS:2720 (Part 5)	2 tests / 3000 m²	Max 50%
			Plasticity Index	IS:2720 (Part 5)	2 tests / 3000 m²	Max 25%
			Free Swelling Index	IS:2720 (Part 40)	As required	Max 50%
			Maximum Dry Density (Mod. Proctor)	IS:2720 (Part 8)	2 tests / 3000 m²	MDD ≥ 1.75 g/cc (when height > 3.0 m)
			Deleterious Content	IS:2720 (Part 27)	As & when required	(a) Sodium sulphate ≤ 0.5% (b) Organic matter ≤ 1.0%
			CBR (4 days soaked)	IS:2720 (Part 16)	1 test / 3000 m²	As per design
		In-process Inspection	Alignment, X-section & level	Standard survey practice	Continual	As per drawings/ tolerances
			Field Density on Existing Ground & Embankment Layers	IS:2720 (Part 28)	0–3000 m² = 1 set (10 tests)	Min 95% Compaction (or as per spec)
			Moisture Content	IS:2720 (Part 2)	Each & every pit	-2% to +1% of OMC
	Acceptance Criteria		Control of Compaction (Field Density)	IS:2720 (Part 28)	Each & every layer	As per MoRTH Clause 902.3.2
			Tolerance in Surface Level	Standard survey practice	Each & every 10 m	± 20 mm

2. IN-PROCESS INSPECTION

Activity	Test / Check	Method / Standard	Frequency	Requirement / Limit
Alignment, X-section & level	Survey control	Standard survey practice	Continuous	As per drawings / tolerances
Moisture Content	Field test	IS:2720 (Part 2)	Each pit	-2% to +1% of OMC
Compaction Control (Field Density)	Field Density (Sand Replacement)	IS:2720 (Part 28)	0–2000 m² = 1 set (10 tests)	As per specification
Compaction Control (Nuclear Density Gauge)	Nuclear Density Gauge	AASHTO T310	0–2000 m² = 2 sets	As per specification

3. ACCEPTANCE CRITERIA

Parameter	Method / Standard	Frequency	Requirement / Limit
Field Density / Compaction	IS:2720 (Part 28)	Each layer	As per MoRTH (5th Revision) Clause 902.3.2
Surface Level Tolerance	Standard survey practice	Every 10 m	± 20 mm

SIMPLE SITE UNDERSTANDING

- Borrow soil must be tested before use
- Moisture should be close to OMC before compaction
- Each layer must pass density before next layer
- Level control is mandatory for final acceptance

All tests shall be carried out as per the latest relevant IS Codes and MoRTH Specifications.

HIGHWAY QUALITY TEST

QA/QC – SUBGRADE & EARTHEN SHOULDERS

(MoRTH Based)

1. SOURCE INSPECTION (BORROW MATERIAL)

Test	IS Code	Frequency	Requirement / Limit
Grain Size Analysis (GSA)	IS:2720 (Part 4)	2 tests / 3000 m^3	Material passing 50 mm sieve / below specified layer material
Atterberg Limits	IS:2720 (Part 5)	2 tests / 3000 m^3	Max 50%
Plasticity Index	IS:2720 (Part 5)	2 tests / 3000 m^3	Max 25%
Free Swelling Index	IS:2720 (Part 40)	As required	Max 50%
Modified Proctor Test	IS:2720 (Part 8)	2 tests / 3000 m^3	MDD ≥ 1.75 g/cc
Deleterious Content	IS:2720 (Part 27)	As required	Sodium sulphate ≤ 0.5% Organic matter ≤ 1.0%
CBR (4 days soaked)	IS:2720 (Part 16)	1 test / 3000 m^3	As per design

2. IN-PROCESS INSPECTION

Activity	Test / Check	Method	Frequency	Requirement
Alignment, X-section & level	Survey control	Standard survey practice	Continuous	As per drawing
Moisture Content	Field test	IS:2720 (Part 2)	Each pit	-2% to +1% of OMC
Compaction Control	Field Density (Sand Replacement)	IS:2720 (Part 28)	0–2000 m^2 = 1 set (10 tests)	As per spec
Compaction Control	Nuclear Density Gauge	AASHTO T310	0–2000 m^2 = 2 sets	As per spec

3. ACCEPTANCE CRITERIA

Parameter	Method	Frequency	Requirement
Field Density / Compaction	IS:2720 (Part 28)	Each layer	As per MoRTH (5th Revision) Clause 902.3.2
Surface Level Tolerance	Survey	Every 10 m	± 20 mm

SIMPLE SITE UNDERSTANDING

- Borrow soil must be tested before use
- Moisture should be close to OMC before compaction
- Each layer must pass density before next layer
- Level control is mandatory for final acceptance

All tests shall be carried out as per the latest relevant IS Codes and MoRTH Specifications.

HIGHWAY QUALITY TEST

INSPECTION AND TESTING PLAN

1. OGL (ORIGINAL GROUND LEVEL)

S.NO.	DESCRIPTION	TYPE OF TEST	INDIAN / FOREIGN STANDARDS REFERRED	FREQUENCY OF TESTING	LIMITS
1	Free Swell Index	Free Swell Index	IS : 2720 (P-40)	1 test for every 250 m of length	MAX 50 %
	Grain Size Analysis	Grain Size Analysis	IS : 2720 (P-4)		–
	Atterberg Limits	Atterberg Limits	IS : 2720 (P-5)		LL - 50 & PI - 25
	Proctor Test	Proctor Test	IS : 2720 (P-8)		Min -15.2 KN/cum
	CBR	CBR	IS : 2720 (P-16)		–
	FDD Test (pits)	FDD Test (pits)	IS : 2720 (P-28)	1 set per 3000 m^2 of each compaction area with minimum number of 10 Tests in one set of measurement	MIN - 95%

2. BORROW AREA MATERIAL

S.NO.	DESCRIPTION	TYPE OF TEST	INDIAN / FOREIGN STANDARDS REFERRED	FREQUENCY OF TESTING	LIMITS
2	Free Swell Index	Free Swell Index	IS : 2720 (P-40)	2 Tests per 3000 m^3	MAX 50 %
	Grain Size Analysis	Grain Size Analysis	IS : 2720 (P-4)	2 Tests per 3000 m^3	–
	Atterberg Limits	Atterberg Limits	IS : 2720 (P-5)	2 Tests per 3000 m^3	LL - 50 & PI - 25
	Proctor Test	Proctor Test	IS : 2720 (P-8)	2 Tests per 3000 m^3	For Emb Min -16.0 KN/cum, For SG Min -17.5 KN/cum
	CBR (For Sub grade)	CBR (For Sub grade)	IS : 2720 (P-16)	1 test per 3000 m^3	As specified in design (generally %)

3. ACCEPTANCE CRITERIA

PARAMETER	METHOD / STANDARD	FREQUENCY	REQUIREMENT / LIMIT
Field Density / Compaction	IS:2720 (Part 28)	Each layer	As per MoRTH (5th Revision) Clause 902.3.2
Surface Level Tolerance	Standard survey practice	Every 10 m	± 20 mm

SIMPLE SITE UNDERSTANDING

Borrow soil must be tested before use

Moisture should be close to OMC before compaction

Each layer must pass density before next layer

Level control is mandatory for final acceptance

All tests shall be carried out as per the latest relevant IS Codes and MoRTH Specifications.