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No. RW/NH-33044/31/2024-S&R(P&B) (Comp No 245397)
Government of India
Ministry of Road Transport & Highways
Transport Bhawan, 1, Parliament Street, New Delhi-110001

Dated: 31st August, 2026

OFFICE MEMORANDUM

Subject: Standard Operating Procedure (SOP) for Adoption of Automated & Intelligent Machine-aided Construction (AI-MC) in National Highways/ Expressways Projects - reg.

Ministry is contemplating for issuance of Standard Operating Procedure (SOP) for Adoption of Automated & Intelligent Machine-aided Construction (AI-MC) in National Highways/ Expressways Projects. Accordingly, a draft circular has been attempted (copy enclosed).

2. All the stakeholders of MoRT&H including NHAI, NHIDCL are requested herewith kindly send her/his comments/suggestions/value addition within 21 days on enclosed Draft Standard Operating Procedure (SOP) for Adoption of Automated & Intelligent Machine-aided Construction (AI-MC) in National Highways/ Expressways Projects, to enable finalizing the Draft SoP. Kindly send feedback to akil.ahmad@nic.in or sosandr-333@gov.in The last date of sending comments / feedback is 21.09.2026

Yours sincerely,
Digitally signed by Akil Ahmad
Date: 31-08-2026 15:29:46
(Akil Ahmad)
Superintending Engineer (S&R)
For Director General (Road Development) & Special Secretary

Enclosure: As above;

To:

All Stakeholders through ministry website

Copy for necessary action:

NIC-for uploading on Ministry's website under "What's new" for 30 days.

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Government of India

Ministry of Road Transport & Highways

Transport Bhawan, 1, Parliament Street, New Delhi-110001

Dated: .....

CIRCULAR

To,

1. The Chief Secretaries of all the State Governments/ UTs.
2. The Principal Secretaries/ Secretaries of all States/ UTs Public Works Department/ Road Construction Department/ Highways Department (dealing with National Highways and other centrally sponsored schemes).
3. The Chairman, National Highways Authority of India, G-5 & 6, Sector-10, Dwarka, New Delhi-110075.
4. The Managing Director, NHIDCL, 1 st & 2 nd floor, Tower-A, World Trade Centre, Nauroji Nagar, New Delhi-110029.
5. The Director General (Border Roads), Seema Sadak Bhawan, Ring Road, New Delhi-110010.
6. All Engineers-in-Chief and Chief Engineers of Public Works Department of States/ UTs/ Road Construction Department/ Highways Departments (dealing with National Highways and other centrally sponsored schemes).
7. The Secretary General, Indian Roads Congress
8. The Director, IAHE, Noida, UP
9. All CE-ROs, ROs and ELOs of the Ministry.

Subject: Standard Operating Procedure (SOP) for Adoption of Automated & Intelligent Machine-aided Construction (AI-MC) in National Highways/ Expressways Projects – reg.

Reference: - Ministry circular No RW/NH-33044/31/2024-S&R(P&B) dated 23.06.2025

Madam/Sir,

This in continuation of Ministry's Circular of even no. dated 23 rd June, 2025 regarding Adoption of Automated & Intelligent Machine-aided Construction (AI-MC) in National Highways Projects.

2. In the circular dated 23.06.2025, AI-MC in highway construction had been envisaged to be taken up in projects involving significant greenfield segments with high embankments.

3 . **Para 4, in Page 2** of the aforementioned circular dated 23.06.2025 may be partially modified as per below:

For	Read As
In Schedule-B of such project should have	Schedule-B/ **Schedule-D** of such projects, **as applicable,** shall include the provision of automated & intelligent construction

the provision of automated & intelligent construction machinery such as **GPS-aided Motor Grader to be used for earthworks, subbase & base** (Details given in Annex-I) and intelligent compaction Roller (IC Roller) - Single Drum/Tandem Vibratory Roller to be used for soil/ subbase/ base layer compaction (Details given in Annex-II). Also, a flow-chart of the work flow…	machinery, namely - (i) GPS-aided Motor Grader (Details given in Annex-I) **for spreading and grading of embankment and sub-grade in terms of Clause 305.3.5.1, and of Granular Sub-base and Crushed Cement Concrete Sub-base in terms of Clause 401.3.2 405.3.3 of the Ministry's Specifications for Road and Bridge Works, that is to say, for all layers which the said Specifications require to be spread by a motor grader;** and (ii) Intelligent Compaction Roller (IC Roller) - Single Drum/ Tandem Vibratory Roller (Details given in Annex-II) **to be used for soil/ sub-base/ base layer compaction.** **Where the Specifications require a layer to be laid by a paver finisher (such as Clause 406.3.4 for WMM Sub-base / Base), the requirement at (i) above shall not apply to that layer; in such case the automatic levelling control system with electronic sensing device stipulated under Clause 406.3.4 shall be ensured. Where, in exceptional cases, a motor grader is permitted under Clause 406.3.4, the grader so deployed shall be AI-MC enabled.** Also, a flow-chart of the work flow…

Other contents of the said circular will remain same.

4. Further in view of the initiatives taken to implement large-scale projects pursuant to the aforementioned circular dated 23.06.2025, a need has been felt to emphasize on some of the crucial aspects for successful implementation of AIMC Technology. Accordingly, a Standard Operating Procedure (SOP) highlighting such crucial aspects to be followed for projects where AIMC Technology has been all mandated is annexed herewith for ready reference with a request to bring it to the notice to all concerned for needful compliance. The SOP is enclosed at **Annexure-I**

5. Executing Agencies are hereby requested to ensure that AIMC is deployed for the entire length project of Highway/ Expressways for such projects where AIMC Technology is mandated and not on piecemeal basis at selective chainages. Multiple AIMC enabled Graders and compactors may need to be deployed to achieve this objective on contractors' as well as their approved sub-contractors' all Graders and all Compactors.

6. All Field Units of concerned Executing Agencies of NHs/ Expressways shall mandatory ensure necessary compliance to policy circular circulated on 23.06.2025 to the extent as amended by this instant reference at all relevant stages of project implementation and during payment of bills.

7. The Authority's Engineer/ Independent Engineer shall examine the AI-MC records available on the portal before according approval for any layer, and shall furnish a monthly AI-MC compliance statement as part of the Monthly Progress Report with screenshots of relevant layers / heat maps in appropriate color codes separately showing (i) adequacy of no. of passes applied for compaction & (ii) Compaction Meter Value (CMV) [Ref. Part D of SOP at **Annexure-I**] . Executing Agencies shall incorporate corresponding provisions in the Request for Proposal for supervision consultancy

services, so that adequate and identified manpower is available for review of AI-MC data at site.

8. These issues with the approval of the Competent Authority.

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Yours sincerely,

(Akil Ahmad)
Superintending Engineer (S&R)
For Director General (Road Development) & Special Secretary

Copy:

1. Technical circular file of S&R (P&B) Section Technical circular file of S&R (P&B) Section

2. NIC-for uploading on Ministry's website under "What's new" & "Comprehensive Compendium circulars"

Copy for kind information to:

1. PS to Hon'ble Minister (RT&H)
2. PS to Hon'ble MOS (RT&H)
3. OSD to Hon'ble MOS (Corporate Affairs and RT&H)
4. Sr. PPS to Secretary (RT&H)
5. Sr. PPS to DG (RD) & SS
6. Sr. PPS to Addl. Secretary (Transport)/AS&FA
7. Joint Secretary(H)/JS(Toll)/JS(Parl)
8. Sr. PPS/ PPS to all ADGs/ CEs

Annexure-I

Standard Operating Procedure (SOP) for Adoption of Automated & Intelligent Machine-aided Construction (AI-MC) in National Highways/ Expressways Projects

A. Setting out of Site Control Points and Site Calibration

1. The Contractor shall establish Site Control Points as per Para 11.2 of Annex-II of Ministry's circular RW/NH-33044/31/2024-S&R (P&B) dated 23.06.2025.
2. The Contractor shall submit details of such Control Points and Temporary Bench Marks (TBMs) in digital format to the Authority. The submitted control points and TBMs (containing both horizontal and vertical coordinate values) shall be physically verifiable on the ground.

3. Adequate base stations should be set up for Real Time Kinematics (RTK) operations of each Grader and Compaction Systems as well as for all Rovers. RTK communication can be either through Internet or UHF or WiFi or cloud or any other as suitable to the site condition. Proof of adequate deployment of Base stations with serial numbers of instruments for RTK operation should be provided to the Authority by the contractor. Each base station shall be set over a verified control point and its coordinates recorded.

4. The GNSS accuracy of every instrumented grader and roller shall be verified each day prior to start of work in the manner set out in para 11.6.2 of Annex-II of the circular dated 23.06.2025, the readings being within ± 5 cm; a register of such daily verification shall be maintained at site and made available to the Authority's Engineer/ Independent Engineer on demand.

5. The Contractor shall carry out site calibration with the help of GNSS Real Time Kinematics (RTK) Rover for accurately transforming latitude, longitude and ellipsoidal height values of the GNSS data into the corresponding project site/ grid coordinates comprising of northing, easting and elevation. Accordingly, Contractor shall submit a Site Calibration Report establishing the relationship between GNSS-derived coordinates and the site control points.

B. Preparation and Submission of Digital 3D Design Models

1. The Contractor shall prepare and submit digital three-dimensional (3D) models of the embankment, sub-grade, sub-base and base layers based on the approved contract drawings and design information. Such models shall be reviewed and approved by the Authority's Engineer/ Independent Engineer before being loaded on to any machine.

2. 3D Modelling should be carried out from the lowest layer of embankment and should include every intermediate embankment layer/lift in accordance with the layer thickness requirements stipulated under Clause 305.3.5.1 of the Ministry's Specifications for Road and Bridge Works.

3. The Contractor shall ensure that such 3D models are aligned with the site calibration/ localisation file as per Para 11.4 & 11.5 of Annex-II of aforementioned circular dated 23.05.2025 and therefore capable of being utilized by all AIMC systems deployed on the Project.
4. A version control register of all 3D models shall be maintained. Any revision of the approved drawings shall be reflected in the models within 7 (seven) days and the superseded models withdrawn from all machines and survey controllers under intimation to the Authority.

C. Installation and Deployment of AIMC Systems and Synchronization with cloud based software platform

1. The Contractor shall ensure installation and operational use of AIMC systems (as per specifications laid out in Annex-I of policy circular dated 23.06.2025) on

every motor grader deployed for spreading and grading of embankment, sub-grade and granular sub-base layers. Where the Specifications require a layer to be laid by a paver finisher, the paver so deployed shall be provided with the automatic levelling control system with electronic sensing device stipulated under Clause 406.3.4.

2. The Contractor shall ensure installation and operational use of AIMC systems (as per specifications laid out in Annex-II of policy circular dated 23.06.2025) on every Single Drum/Tandem Vibratory Rollers deployed for construction and compaction of embankment, sub-grade, sub-base and base layers.
3. The Contractor shall assign a unique identification number or serial number to each grader and compactor equipped with AIMC systems and ensure mapping of the same in the designated cloud-based software platform.
4. The Contractor shall ensure synchronization of approved design information and real-time positional data from all survey controllers and AIMC system controllers with the cloud-based software platform.
5. The Contractor shall provide documentary evidence of installation, configuration and commissioning of AIMC systems on all graders and compactors deployed on the Project. This includes all subcontractors' Graders and compactors as well.

D. Implementation of AIMC Technology for Motor Grader and Compactor operations:

1. AIMC technology shall be mandatory implemented for leveling of each individual layer / lifts of embankment (and not just top layer), subgrade and subbase.

2. AIMC technology shall be mandatory implemented for compaction of each individual layer of embankment, subgrade, subbase and base layers.
3. Target number of passes and target Compaction Meter Value (CMV) shall be finalized for a trial stretch (of minimum dimensions of one lane width or two drum widths with overlap, whichever is greater, and 50 m length)) for every borrow earth source/ subgrade material/ subbase mix/ base mix. The target passes and CMV values for each source/ mix are to be substantiated using field dry density/ sand replacement test results in the trial stretch.
4. AI-MC shall not be insisted upon at locations where its deployment is not practicable, namely, backfill behind abutments, return walls and box structures; reinforced fill within 2 m of the facing of RE walls and similar locations where light compaction plant is mandated; approach slabs; confined widening strips, service road patches and like locations. The Contractor shall submit a chainage-wise list of such locations for approval of the Authority's Engineer/ Independent Engineer before execution, and the quality control prescribed under Section 900 of the Specifications shall apply in full measure at such locations. The approved exclusion list, and any addition to it, shall form part of the Monthly Progress Report.
5. The Contractor shall ensure that such information is continuously available for monitoring and verification by the Authority on a cloud-based software platform.

6. To ensure uniform compaction quality and structural integrity of the pavement layers, the AI-MC system must generate separate, distinct heat maps for the following two

parameters:

(i) Heat Maps for Number of Passes: The IC system shall record and continuously display the exact number of rollers passes over every high-precision GPS-mapped coordinate within the compaction zone. The pass-count heat map shall utilize a clearly defined color-coding scale to visually differentiate the cumulative number of passes, specifically utilizing green to indicate that the target pass count has been achieved. This heat map shall be utilized by the operator and Quality Control (QC) personnel to ensure 100% coverage and verify uniform pass counts.

(ii) Heat Maps for Compaction Meter Value (CMV): Concurrently, the system shall dynamically generate a separate heat map mapping the Compaction Meter Value (CMV) . This heat map shall evaluate the stiffness of the compacted material across the mapped area, utilizing green to clearly indicate where the target stiffness has been met. Varying degrees of material stiffness above and below the target shall be represented through a gradient color scale. The CMV heat map shall be analysed to verify continuous compaction progress and explicitly identify spatial anomalies, weak spots, or soft zones that require additional rolling, moisture adjustment, or underlying material remediation.

E. Submission of Reports from AIMC enabled Motor Grader:

The Contractor shall record the following details from AIMC enabled Motor Grading devices and upload the following records on the cloud-based software platform for verification by the Authority:

a. Digital Layer Thickness Records containing thickness of each layer of embankment, sub-grade and sub-base (wherever applicable).
b. Digital Cut-and-Fill maps for all applicable layers
c. As-Graded Surface Records containing coordinates of as-graded surface generated during the final grading pass of each layer.

F. Submission of Reports from AIMC enabled Compactor:

1. The Contractor shall record compaction data given below in digital **format in form of color coded heatmap** and upload the same on the cloud-based software platform for verification by the Authority:
    a) Geo-tagged pass counts, and
    b) CMV values.
    c) Digital Layer Thickness Records containing thickness after compaction for each layer of embankment, sub-grade, sub-base and base layers.

G. Verification, Acceptance and Relationship with Conventional Quality Control

1. In terms of para 5 of the circular dated 23.06.2025, AI-MC data and reports are in addition to, and not in substitution of, the quality control and quality assurance prescribed under the Contract and under the Specifications. Acceptance of any layer shall continue to be governed by the field density and other tests prescribed in Table 300-2, Clause 401.3.2, Clause 406.3.5 and Section 900, as applicable.
2. The Authority's Engineer/ Independent Engineer shall not approve a layer unless - (i) the target number of passes established in the trial has been achieved over not less than 90% of the mapped area of that layer, with no contiguous under-compacted patch exceeding 100 sqm; (ii) the recorded CMV is not less than the target CMV over not less than 90% of the mapped area; and (iii) the increase in mean CMV between the last two

passes does not exceed 5%.

3. Locations for the conventional field density tests prescribed in the Specifications shall be selected, within the prescribed frequency, from the zones showing the lowest CMV and the lowest pass count on the compaction heat map, instead of being selected at random. This is to ensure that the weakest areas of the layer are the areas actually tested.
4. Areas not meeting the criteria at (i) and (ii) above shall be re-rolled and the records regenerated. Where the target is still not achieved, the layer shall be reworked in accordance with Clause 305.3.6, Clause 401 or Clause 406, as applicable.
5. Nothing in this SOP shall be construed as diluting the requirement of Clause 305.3.5.1 that successive layers shall not be placed until the layer under construction has been thoroughly compacted to the requirements of Table 300-2 and approved by the Engineer.
6. The Authority's Engineer/ Independent Engineer shall furnish a monthly AI-MC compliance statement covering the length executed with AI-MC, the number of graders and rollers deployed against the number that are AI-MC enabled, the approved exclusions, and the non-conformance raised and closed during the month.

H. Digital Records Management, Data Custody and Access to Authority

1. The Contractor shall maintain complete, accurate and up-to-date digital records generated through AIMC enabled grading and compaction systems throughout the construction period and shall make the same available to the Authority as and when required.
2. The Contractor shall provide the Authority with secure access to the cloud-based software platform, including necessary user credentials, permissions and associated support, to enable real-time monitoring, verification and audit of all grading and compaction activities carried out on the Project.

3. All data generated through AI-MC on the Project shall be the property of the Authority. The cloud-based platform shall be hosted on servers located in India and the data shall be retained through the construction period, the Defect Liability Period and the O&M period. The data shall be capable of export in open, non-proprietary formats such as LandXML, CSV and GeoJSON/ shapefile, and shall be delivered to the Authority in such formats before issue of the Completion/ Provisional Completion Certificate and, in any case, before payment of the final bill. Continuity of the data shall be ensured notwithstanding any change in the Machine Control Technology Provider or in the platform, and the data shall be migrated to the Ministry's back end facility as and when the same is created in terms of para 5 of the circular dated 23.06.2025.

4. On completion, Contractor shall ensure that all as-built project model along with all machine-generated field data from AIMC technology—including continuous compaction mapping, pass counts, elevation, heat map results are saved in a structured manner in the cloud-based platform. Secure access to the saved data should be given to the Authority to serve as legacy data during DLP/ in O&M phase thereof.
5. Subsequently, for all maintenance works executed using AIMC enable equipment (if any) during DLP/ O&M Period, the generated data must be saved into the

same cloud based platform.

6. The Contractor shall ensure that all digital records, models, calibration reports, grading data, compaction data and cloud-hosted information submitted under these provisions are accurate, complete, traceable and capable of independent verification by the Authority at any stage of the Project.

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