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Republic of the Philippines
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
OFFICE OF THE SECRETARY
Manila

MAR 19 2015

DEPARTMENT ORDER)
)
No. 47)
Series of 2015 03.20.N)

SUBJECT: **ADOPTION OF INTERNATIONAL ROUGHNESS INDEX VALUES FOR ALL NATIONAL PRIMARY ROADS.**

Road roughness has been highly recognized as an indicator of road condition in terms of road pavement performance and as a major determinant in vehicle operating cost. Poor roughness characteristic of pavement will result to poor riding quality, increase in vehicle operating cost, increase in accident potential and reduction in pavement life.

Presently, road roughness is quantified in terms of International Roughness Index (IRI) which was developed by the World Bank in the 1980s. Henceforth, the following values of IRI shall form part of the basis for acceptance of newly constructed concrete and asphalt road projects.

Acceptable International Roughness Index (IRI) Values

Road Classification	**International Roughness Index (IRI) Values, m/km**	
	Asphalt Pavement	Concrete Pavement
National Primary Road	Not more than 3.00	Not more than 3.00

Attached hereto are the amendments to the pertinent provisions of the DPWH Standard Specifications for Highways, Bridges and Airports, Volume II, 2013 Edition (Blue Book).

Except for the attached amendments, the other provisions of the DPWH Standards and Specifications of Part B – Other General Requirement, Item 307 and 311 shall remain in force.

This Order takes effect immediately.

ROGELIO L. SINGSON
Secretary

5.4 MGM/RCA

AMENDMENTS TO PART B – OTHER GENERAL REQUIREMENTS

B.4 – CONSTRUCTION SURVEY AND STAKING

B.4.1 Description

This item shall consist of furnishing the necessary equipment and material to survey, stake, calculate, and record data for the control of work in accordance with this Specification and in conformity with the lines, grades and dimensions shown on the Plans or as established by the Engineer.

The introduction of maximum values for International Roughness Index (IRI) as part of the basis for acceptance of newly constructed concrete and asphalt road projects should require additional survey work by the Contractor to more accurately control surface grades and tolerances. In particular, roadway cross-sections shall be at a maximum centerline spacing of 10 meters, reducing as required for curves and tie-ins, to achieve the IRI values specified. For Portland Cement Concrete Pavement (PCCP), survey control is required at the top and bottom of each and every steel form where used.

Similarly, pavement surface tolerances shall be reduced to achieve the IRI values specified (asphalt 3.0 m/km, concrete 3.0 m/km) equivalent to 9 mm as measured with a 3-m straight-edge.

The Contractor shall make due allowance for this additional work in the relevant Pay Items under B4.

AMENDMENTS TO ITEMS 307 AND 311
of the DPWH Standard Specifications for Highways, Bridges And Airports, Volume II, 2013 Edition

ITEM 307 – BITUMINOUS PLANT-MIX SURFACE COURSE-GENERAL

Section 307.1 Description

This item includes general requirements that are applicable to all types of bituminous plant mix surface courses irrespective of gradation of aggregate or kind and amount of bituminous material. Derivations from these general requirements will be indicated in the specific requirements for each type.

This work shall consist of constructing one or more bituminous bound layers on a prepared foundation in accordance with the Specifications and the specific requirements of the type under contract, and in reasonably close conformity with the lines, grades, thickness, and typical cross-sections shown on the Plans within the tolerances specified or established by the Engineer.

The introduction of maximum values for International Roughness Index (IRI) as part of the basis for acceptance of newly constructed concrete and asphalt road projects requires more accurate process control on the Contractor's part. The Contractor's Quality Control Plan shall include for the Engineer's review and acceptance, a process control flow chart, and a Method Statement covering all activities in the process, describing how the activities will be managed and undertaken to deliver the specified IRI values.

International best practice indicates that factors critical to success include:

- *a well-chosen plant mixture*
- *reasonable grades and alignment to suit the paver*
- *tight level control or stringline management*
- *continuous supply of asphalt to the paver*
- *consistent temperature/workability*
- *well-maintained paving equipment*
- *proper operation of paving and compaction equipment*
- *controlled density of asphalt – just the right compaction effort*
- *a skilled and dedicated team.*

Section 307.2.1 Composition and Quality of Bituminous Mixture

(Job-Mix Formula). The bituminous mixture shall be composed of aggregate, mineral filler, hydrated lime, and bituminous material.

At least three weeks prior to production, the Contractor shall submit in writing a job-mix formula for each mixture supported by laboratory test data along with samples and sources of the components and viscosity-temperature relationships information to the Engineer for testing and approval.

Each job-mix formula submitted shall propose definite single values for:

1. The percentage of aggregate passing each specified sieve size.
2. The percentage of bituminous material to be added.
3. The temperature of the mixture delivered on the road.
4. The kind and percentage of additive to be used.
5. The kind and percentage of mineral filler to be used.

After the job-mix is established, all mixture furnished for the project shall conform thereto within the following ranges of tolerances:

Passing No. 4 and larger sieves	±	7 percent
Passing No. 8 to No. 100 sieves (inclusive)	±	4 percent
Passing No. 200 sieve	±	2 percent
Bituminous Material	±	0.4 percent
Temperature of Mixture	±	10^0C

Should a change in source of material be proposed or should a job-mix formula prove unsatisfactory, a new job-mix formula shall be submitted by the Contractor in writing and be approved by the Engineer prior to production.

Approval of a new job-mix formula may require laboratory testing and verification.

The mixture shall have a minimum compressive strength of 1.4 MPa.

The mixture shall have a mass percent air voids with the range of 3 to 5.

The mixture shall also have an index of retained strength of not less than 70 when tested by AASHTO T 165. For aggregates having maximum sizes over 25 mm, AASHTO T 165 will be modified to use 150 mm x 150 mm cylindrical specimens. The 150 mm (cylinders will be compacted by the procedures outlined in AASHTO T 167 modified to employ 10 repetitions of a molding load of 9.6 MPa, with no appreciable holding time after each application of the full load.

To achieve smooth pavements with values for International Roughness Index (IRI) of not more than 3.0 m/km, the Contractor shall consider tightening the ranges of tolerances and mass percent air voids for mixtures stated in this clause, and include revised target values in the job-mix, the Contractor's Quality Control Plan and Method Statement.

307.3.2 Construction Equipment

1. Bituminous Mixing Plant

Sufficient storage space shall be provided for each size of aggregate. The different aggregate sizes shall be kept separated until they have been delivered to the cold elevator feeding the drier. The storage yard shall be maintained neat and orderly and the separate stockpiles shall be readily accessible for sampling.

Plants used for the preparation of bituminous mixtures shall conform to the requirements for all plants under (a) below except that scale requirements shall apply only where weight proportioning is used. In addition, batch mixing plants and continuous mixing plants shall conform to the respective requirements which follow this Subsection.

a. Requirements for all Plants.

Mixing plants shall be of sufficient capacity and coordinated to adequately handle the proposed bituminous construction.

1.Plant Scales. Scales shall be accurate to 0.5 percent of the maximum load that may be required. Poises shall be designed to be locked in any position to prevent unauthorized change of position. In lieu of plant and truck scales, the Contractor may provide an approved automatic printer system which will print the weights of the material delivered, provided the system is used in conjunction with an approved automatic batching and mixing control system. Such weights shall be evidenced by a weight ticket for each load.

Scales shall be inspected and sealed as often as the Engineer may deem necessary to assure their continued accuracy. The Contractor shall have on hand not less than ten 20-kg weights for testing the scales.

2.Equipment for Preparation of Bituminous Material. Tanks for the storage of bituminous material shall be equipped with the proper devices to heat and hold the material at the required temperatures. The heating shall be accomplished by steam coils, electricity, or other approved means so that no flame shall be in contact with the tank. The circulating system for the bituminous material shall be designed to assure proper and continuous circulation during the operating period. Provision shall be made for measuring and sampling storage tanks.

3. Feeder for Drier. The plant shall be provided with accurate mechanical means for uniformly feeding the aggregate into the drier so that uniform production and temperature will be obtained.

4. Drier. The plant shall include a drier or driers which continuously agitate during the heating and drying process. For cold-type bituminous mix, equipment for mechanical cooling of the dried aggregate to the temperature prescribed for cold

mixtures shall be provided and shall be capable of supplying prepared material for the mixer to operate at full capacity.

5. Screens. Plant screens, capable of screening all aggregate to the specified sizes and proportions and having normal capacities in excess of the full capacity of the mixer, shall be provided.

6. Bins. The plant shall include storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Bins shall be arranged to assure separate and adequate storage of appropriate fractions of the mineral aggregates. Separate dry storage shall be provided for filler or hydrated lime when used and the plant shall be equipped to feed such material into the mixer. Each bin shall be provided with overflow pipes, of such size and at such locations as to prevent backing up of material into other compartments or bins. Each compartment shall be provided with individual outlet gate, constructed so that when closed, there shall be no leakage. The gates shall cut off quickly and completely. Bins shall be so constructed that samples can be readily obtained. Bins shall be equipped with adequate tell-tale devices to indicate the position of the aggregates in the bins at the lower quarter points.

7. Bituminous Control Gate. Satisfactory means, either by weighing or metering, shall be provided to obtain the proper amount of bituminous material in the mix within the tolerance specified. Means shall be provided for checking the quantity or rate of flow of bituminous material into the mixer.

8. Thermometric Equipment. An armored thermometric equipment of adequate range in temperature reading shall be fixed in the bituminous feed line at a suitable location near the charging valve at the mixer unit.

The plant shall also be equipped with either an approved dial-scale, mercury-actuated thermometer, an electric pyrometer, or other approved thermometric instrument so placed at the discharge chute of the drier as to register automatically or indicate the temperature of the heated aggregates.

The Engineer may require replacement of any thermometer by an approved temperature-recording apparatus for better regulation of the temperature of aggregates.

9. Dust Collector. The plant shall be equipped with a dust collector constructed to waste or return uniformly all or any part of the material to the hot elevator collected as directed.

10. Truck Scales. The bituminous mixture shall be weighed on approved scales furnished by the Contractor or on public scales at the Contractor's expense. Such scales shall be inspected and sealed as often as the Engineer deems necessary to assure their accuracy. (See paragraph I).

11. Safety Requirements. Adequate and safe stairways to the mixer platform and sampling points shall be provided, and guarded ladders to other plant units shall be placed at all points where accessibility to plant operations is required. Accessibility to the top of truck bodies shall be provided by a platform or other suitable device to enable the Engineer to obtain sampling and mixture temperature data. A hoist or pulley system shall be provided to raise scale calibration equipment, sampling equipment and other similar equipment from ground to the mixer platform and return. All gears, pulleys, chains, sprockets, and other dangerous moving parts shall be

thoroughly guarded and protected. Ample and unobstructed space shall be provided on the mixing platform. A clear and unobstructed passage shall be maintained at all times in and around the truck loading area. This area shall be kept free from drippings from the mixing platforms.

b. Requirements for Batching Plants

1. Weigh box or hopper. The equipment shall include a means for accurately weighing each size of aggregate in a weight box or hopper suspended on scales and of ample size to hold a full batch without hand raking or running over. The gate shall close tightly so that no material is allowed to leak into the mixer while a batch is being weighed.

2. Bituminous Control. The equipment used to measure the bituminous material shall be accurate to plus or minus 0.5 percent. The bituminous material bucket shall be a nontilting type with a loose sheet metal cover. The length of the discharge opening or spray bar shall be less than ¾ the length of the mixer and it shall discharge directly into the mixer. The bituminous material bucket, its discharge valve or valves and spray bar shall be adequately heated. Steam jackets, if used, shall be efficiently drained and all connections shall be so constructed that they will not interfere with the efficient operation of the bituminous scales. The capacity of the bituminous material bucket shall be at least 15 percent in excess of the weight of bituminous material required in any batch. The plant shall have an adequately heated quick-acting, non-drip, charging valve located directly over the bituminous material bucket.

The indicator dial shall have a capacity of at least 15 percent in excess of the quantity of bituminous material used in a batch. The controls shall be constructed so that they may be locked at any dial setting and will automatically reset to that reading after the addition of bituminous material to each batch. The dial shall be in full view of the mixer operator. The flow of bituminous material shall be automatically controlled so that it will begin when the dry mixing period is over. All of the bituminous material required for one batch shall be discharged in not more than 15 seconds after the flow has started. The size and spacing of the spray bar openings shall provide a uniform application of bituminous material the full length of the mixer. The section of the bituminous line between the charging valve and the spray bar shall be provided with a valve and outlet for checking the meter when a metering device is substituted for a bituminous material bucket.

3. Mixer. The batch mixer shall be an approved type capable of producing a uniform mixture with the job-mix tolerances. If not enclosed, the mixer box shall be equipped with a dust hood to prevent loss of dust.

The clearance of blades from all fixed and moving parts shall not exceed 25 mm unless the maximum diameter of the aggregate in the mix exceed 30 mm, in which case the clearance shall not exceed 40 mm.

4. Control of Mixing Time. The mixer shall be equipped with an accurate time lock to control the operation of a complete mixing cycle. It shall lock the weigh box gate after the charging of the mixer until the closing of the mixer gate at the completion of the cycle. It shall lock the bituminous material bucket throughout the

dry and wet mixing periods. The dry mixing period is defined as the interval of time between the opening of the weigh box gate and the start of introduction of bituminous material. The wet mixing period is the interval of time between the start of introduction of bituminous material and the opening of the mixer gate.

The control of the timing shall be flexible and capable of being set at intervals of 5 seconds or less throughout a total cycle of up to 3 minutes. A mechanical batch counter shall be installed as a part of the timing device and shall be so designed as to register only completely mixed batches.

The setting of time interval shall be performed in the presence and at the direction of the Engineer who shall then lock the case covering the timing device until such time as a change is to be made in the timing periods.

c. Requirement for Continuous Mixing Plants

1. Aggregate Proportioning. The plant shall include means for accurately proportioning each size of aggregate.

The plant shall have a feeder mounted under each compartment bin. Each compartment bin shall have an accurately controlled individual gate to form an orifice for volumetrically measuring the material drawn from each compartment. The feeding orifice shall be rectangular with one dimension adjustable by positive mechanical means provided with a lock.

Indicators shall be provided for each gate to show the respective gate opening in millimeter.

2. Weight Calibration of Aggregate Feed. The plant shall include a means for calibration of gate openings by weighing test samples. Provision shall be made so that materials fed out of individual orifice may be by passed to individual test boxes. The plant shall be equipped to conveniently handle individual test samples weighing not less than 50 kilograms. Accurate scales shall be provided by the Contractor to weigh such test samples.

3. Synchronization of Aggregate Feed and Bituminous Material Feed. Satisfactory means shall be provided to afford positive interlocking control between the flow of aggregate from the bins and the flow of bituminous material from the meter or other proportioning device. This control shall be accomplished by interlocking mechanical means or by any other positive method satisfactory to the Engineer.

4. Mixer. The plants shall include a continuous mixer of an approved type, adequately heated and capable of producing a uniform mixture within the job-mix tolerances. It shall be equipped with a discharge hopper with dump gates which will permit rapid and complete discharge of the mixture. The paddles shall be adjustable for angular position on the shafts and reversible to retard the flow of the mix. The mixer shall have a manufacturer's plate giving the net volumetric contents of the mixer of the several heights inscribed on a permanent gauge. Charts shall be provided showing the rate of feed or aggregate per minute for the aggregate being used.

2. Hauling Equipment

Trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds which have been thinly coated with approved material to prevent the mixture from adhering to the beds. Each truck shall have a cover of canvass or other suitable material of such size as to protect the mixture from the weather. When necessary, such that the mixture will be delivered on the road at the specified temperature, truck beds shall be insulated and covers shall be securely fastened.

Truck beds shall be drained prior to loading.

3. Bituminous Pavers

The equipment shall be self-contained, power-propelled units, provided with an adjustable activated screed or strike-off assembly, heated if necessary, and capable of spreading and finishing courses of bituminous plant mix material in lane widths applicable to the specified typical section and thickness shown on the Plans.

Pavers shall be equipped with a control system capable of automatically maintaining the screed elevation as specified herein. The control system shall be automatically actuated from either a reference line or surface through a system of mechanical sensors or sensor directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. When directed, the transverse slope control system shall be made inoperative and the screed shall be controlled by sensor directed automatic mechanisms which will independently control the elevation of each end of the screed from reference lines or surface.

The controls shall be capable of working in connection with any of the following attachments.

a. Ski-type device of not less than 9 m in length or as directed by the Engineer.
b. Taut stringline (wire) set to grade.
c. Short ski or shoe

The Contractor shall furnish the long ski, the short ski or shoe and furnish and install all required stakes and wire for a taut stringline.

Should the automatic control systems become inoperative during the day's work, the Contractor will be permitted to finish the day's work using manual controls, however, work shall not be resumed thereafter until the automatic control system has been made operative.

The Contractor shall provide and have ready for use at all times enough covers, as may be necessary, for use in any emergency such as rain, chilling wind, on unavoidable delay, for the purpose of covering or protecting any material that may have been dumped and not spread.

To achieve smooth pavements with values for International Roughness Index (IRI) of not more than 3.0 m/km, the Contractor shall ensure that the paver control system is

capable of smooth adjustments to automatically follow the surface shape (elevations and grades) required. The preferred method is laser control following a surface shape input to the onboard computer.

4. Rollers

The equipment shall be of the steel and/or pneumatic tire type and shall be in good condition, capable of reversing without backlash. It shall be operated at speeds slow enough to avoid displacement of the bituminous mixture. The number and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. The use of equipment which results in excessive crushing of the aggregate will not be permitted.

Section 307.3.3 Conditioning of Existing Surface

Immediately before placing the bituminous mixture, the existing surface shall be cleaned of loose or deleterious material by brooming or other approved means.

Contact surface or curb, gutters, manholes and other structures shall be painted with a thin, uniform coating of bituminous material prior to the bituminous mixture being placed against them.

To achieve smooth pavements with values for International Roughness Index (IRI) of not more than 3.0 m/km, the Contractor shall ensure that the existing surface, prior to cleaning, is prepared using a grader or milling machine control system capable of smooth adjustments to automatically follow the surface shape (elevations and transverse slopes) required. The preferred method is laser control following a surface shape input to the onboard computer.

Section 307.3.8 Compaction

Immediately after the mixture has been spread, struck off and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rollers as specified under paragraph No. 4 of Subsection 307.3.2.

The surface shall be rolled when the mixture is in proper condition and when the rolling does not cause under displacement, cracking and shoving. Rolling shall begin at the sides and proceeds longitudinally parallel toward the road centerline, each trip overlapping ½ the roller width, gradually progressing to the crown of the road. When paving in echelon or abutting a previously placed lane, the longitudinal joint should be rolled first followed by the regular rolling procedure. On superelevated curves, the rolling shall begin at the low side and progress to the high side overlapping of longitudinal trips parallel to the center line.

Rollers shall move at a slow but uniform speed with the drive roll or wheels nearest the paver. Rolling shall be continued until roller marks are eliminated and a minimum of 97 mass percent *and maximum mass percent limited to ensure that the mass per cent of air voids is within the range required in 307.2.1* of the density of the laboratory compacted specimens prepared in accordance with AASHTO T 166 has been obtained.

Any displacement occurring as a result of the reversing of the direction of a roller, or from other causes, shall be corrected at once by the use of rakes and addition of fresh mixture when required. Care shall be exercised in rolling not to displace the line and grade of the edges of the bituminous mixture.

To prevent adhesion of the mixture to the rollers, the wheels shall be kept properly moistened with water or water mixed with very small quantities of detergent or other approved material. Excess liquid will not be permitted.

Along forms, curbs, headers, walls and other places not accessible to the rollers, the mixture shall be thoroughly compacted with hot hand tampers, smoothing irons or with mechanical tampers.

Section 307.3.10 Acceptance, Sampling and Testing

The contractor shall cut full depth samples as directed, from the finished pavement, for testing. Samples shall be neatly cut by saw or core drill. Each sample shall be at least 150 mm x 150 mm or 100 mm diameter full depth. At least one, but not more than three samples shall be taken for each full day's operation. If no core samples were taken during the day's operation, core samples shall be taken from the completed pavement for every 100 L. M. per lane. The contractor shall supply and furnish new material to backfill boreholes left by the samples taken.

No acceptance and final payment shall be made on *the* completed asphalt pavement unless *it meets the acceptable International Roughness Index (IRI) Value for National Primary Roads, and* core test for thickness determination is conducted, except for Barangay Roads where the implementing office is allowed to waive such test. *The asphalt pavement shall be considered accepted if it meets the specified IRI Value at the time of completion.*

For acceptance of the asphalt pavement, the IRI value shall be no more than 3.0m/km for National Primary Roads, measured in 100 meter sections, at the time of completion.

The samples obtained will be used to measure the thickness of the pavement. The same samples will be used to test the density of the compacted pavement by AASHTO T 166.

The compacted pavement shall have a density equal to, or greater than 97 mass percent of the density of a laboratory specimen. The asphalt pavement represented by the cores shall not be accepted if the deficiency in density is more than 2%.

The compacted pavement shall have a thickness tolerance of -5 mm. Thickness in excess of the specified thickness shall not be considered in the payment of asphalt pavement. The asphalt pavement represented by the core shall not be accepted if the deficiency in the average thickness is more than 5 mm. Averaging of the density and thickness of asphalt cores is not permitted.

If the deficiency in the core thickness is more than 5 mm, additional layer may be permitted in order to meet the designed thickness, however, the minimum additional asphalt

overlay thickness should be dependent on the minimum thickness capacity of asphalt paver but it should not be less than 50 mm and that proper construction procedures are followed.

The alternatives of asphalt cold milling to permit correction of the layer thickness, reduced payment or remove and replace shall also be considered by the implementing office, provided that the design thickness is not compromised.

Section 307.3.11 Surface Tolerances

The surface will be checked by the use of a 3-m straight-edge at sites selected by the Engineer. The straight-edge will be applied at right angles, as well as, parallel to the centerline of the roadbed.

The variation of the surface from the testing edge of the straight-edge between any two contacts with the surface shall not exceed 9 mm.

Tests will be made immediately after initial compaction and any variations detected shall be corrected by removing or adding materials, as may be necessary. Rolling shall then be continued as specified. After final rolling, the smoothness of the course shall be checked again and any area defective in texture or composition shall be corrected, including removal and replacement of unsatisfactory material at the Contractor's expense as directed by the Engineer

The asphalt pavement shall be subjected to surface test using an approved profiling system which shall qualify as a Class 1 roughness measurement device and conform to the latest version of ASTM E-950/E950M.

The components of the profiling system shall be validated on regular basis per manufacturer's recommendations to ensure that the system is properly calibrated. Validation reports shall be generated, for presentation to the Engineer, confirming that the validations are current, and within tolerances specified by the manufacturer.

The acceptable IRI for asphalt pavements shall be not more than 3.0 m/km for National Primary Road.

Prior to any testing, the road surface for test shall be cleaned of loose or deleterious material by brooming or other approved means. Survey shall only be conducted on dry pavement surfaces. Wide-beam lasers are recommended for coarse textured surfaces like chip seal or open graded asphalt where they yield lower IRI values than single point or spot lasers.

Prior to data collection, a test segment with a length of 500 meters will be selected at site for repeatability test. The repeatability test shall be witnessed by the authorized representative of the contractor and the project engineer. Five profile runs will be made on the test segment for the repeatability test. The profile runs for repeatability are acceptable if the average IRI of the two wheelpaths satisfy the following criteria:

a. *The IRI values of each of the five (5) runs are within 1% of the mean IRI of the selected runs*
b. *The standard deviation of IRI of the selected runs are within 2% of the mean IRI*

If the IRI values from the profile runs (for repeatability) meet the above criteria, three (3) runs per lane per site should be conducted for acceptance measurement. The IRI value for the lane shall be the average IRI of the two wheelpaths for the three (3) runs combined.

If the runs do not meet the above criteria, the Profiling Team shall determine if the variability between runs are due to operator or equipment error, and make additional runs until five (5) runs free of equipment or operator errors are obtained. Where necessary an accuracy calibration test shall be conducted in comparison with a Class 1 Profiler (SSI Walking Profiler CS8800 or similar) to resolve said errors.

If the IRI value of the whole asphalt pavement meets the required value regardless if there are areas found to have exceeded the required IRI value, no correction shall be required, provided that the areas with exceedance have an IRI value within the tolerance limit of 0.5 m/km.

However, if the IRI value of the whole asphalt pavement falls beyond the prescribed IRI for National Primary Roads and exceeds the allowable tolerance, the contractor may opt to undertake corrective action, either overlay with or without cold milling or removal and replacement, otherwise, no payment shall be made.

Cold milling shall be done with an approved equipment. Milling shall be done using cutting tools mounted on a self-propelled machine designed for milling and texturing pavement. The equipment shall have an automatic grade control that will mill a strip of minimum 1/3 lane width. Milling equipment that causes ravelling, aggregate fractures, or deterioration at joints and cracks shall not be permitted. The milling operation shall produce a pavement surface that is true in grade and uniform in appearance. The milling depth for corrective action must not compromise the design depth of the pavement.

After the correction has been undertaken by the contractor, further IRI Survey will be conducted to validate if the pavement irregularities had been eliminated. Only one IRI survey will be done after the corrective action takes place. If the IRI value of the whole asphalt pavement meets the prescribed IRI value of 3.0 m/km for National Primary Road and any 100 m sections exceeding the prescribed value are within the allowable tolerance after correction, no reduction in payment will be made; otherwise, no payment shall be made.

ITEM 311 – PORTLAND CEMENT CONCRETE PAVEMENT

311.1 Description

This Item shall consist of pavement of Portland Cement Concrete, with or without reinforcement, constructed on the prepared base in accordance with this Specification and in conformity with lines, grades, thickness and typical cross-section shown on the Plans.

The introduction of minimum values for International Roughness Index (IRI) as part of the basis for acceptance of newly constructed concrete and asphalt road projects requires more accurate process control on the Contractor's part. The Contractor's Quality Control Plan shall include for the Engineer's review and acceptance, a process control flow chart, and a Method Statement covering all activities in the process, describing how the activities will be managed and undertaken to deliver the specified IRI values.

International best practice indicates that factors critical to success include:

- *a well-chosen concrete mixture*
- *reasonable grades and alignment to suit the paver*
- *tight level control or stringline management*
- *continuous supply of concrete to the paver*
- *consistent concrete workability*
- *well-maintained paving equipment*
- *proper operation of paving equipment*
- *controlled density of concrete – just the right vibration and finishing*
- *a skilled and dedicated team.*

311.2.12 Proportioning, Consistency and Strength of Concrete

The Contractor shall prepare the design mix based on the absolute volume method as outlined in the American Concrete Institute (ACI) Standard 211.1, "Recommended Practice for Selecting Proportions for Normal and Heavyweight Concrete".

It is the intent of this Specification to require at least 364 kg of cement per cubic meter of concrete to meet the minimum strength requirements. The Engineer shall determine from laboratory tests of the materials to be used, the cement content and the proportions of aggregate and water that will produce workable concrete having a slump of between 40 and 75 mm if not vibrated or between 10 and 40 mm if vibrated, and a flexural strength of not less than 3.8 MPa when tested by the third-point method or 4.5 MPa when tested by the mid-point method at fourteen (14) days in accordance with AASHTO T 97 and T 177, respectively; or a compressive strength of 24.1 MPa for cores taken at fourteen (14) days and tested in accordance with AASHTO T 24.

Slump shall be determined using AASHTO T 119.

The designer shall consider the use of lean concrete (econocrete) mixtures using local materials or specifically modified conventional concrete mixes in base course and in the lower course composite, monolithic concrete pavements using a minimum of 75 mm of conventional concrete as the surface course.

The mix design shall be submitted to the Engineer for approval and shall be accompanied with certified test data from an approved laboratory demonstrating the adequacy of the mix design. A change in the source of materials during the progress of work may necessitate a new design mix.

To achieve smooth pavements with values for International Roughness Index (IRI) of not more than 3.0 m/km, the Contractor shall consider tightening the ranges and tolerances of mix design components to produce a more consistent mix, and include revised target values in the Contractor's Quality Control Plan and Method Statement.

311.3.2 Equipment

Equipment and tools necessary for handling materials and performing all parts of the work shall be approved by the Engineer as to design, capacity and mechanical condition. The equipment shall be at the jobsite sufficiently ahead of the start of construction operations to be examined thoroughly and approved.

1. Batching Plant and Equipment

   a. General. The batching shall include bins, weighing hoppers, and scales for the fine aggregate and for each size of coarse aggregate. If cement is used in bulk, a bin, a hopper, and separate scale for cement shall be included. The weighing hopper shall be properly sealed and vented to preclude dusting operation. The batch plant shall be equipped with a suitable non-resettable batch counter which will correctly indicate the number of batches proportioned.

   b. Bins and Hoppers. Bins with adequate separate compartments for fine aggregate and for each size of coarse aggregate shall be provided in the batching plant.

   c. Scales. Scales for weighing aggregates and cement shall be of either the beam type or the springless-dial type. They shall be accurate within one-half percent (0.5%) throughout the range of use. Poises shall be designed to be locked in any position and to prevent unauthorized change.

      Scales shall be inspected and sealed as often as the Engineer may deem necessary to assure their continued accuracy.

   d. Automatic Weighing Devices. Unless otherwise allowed on the Contract, batching plants shall be equipped with automatic weighing devices of an approved type to proportion aggregates and bulk cement.

2. Mixers.

   a. General. Concrete may be mixed at the Site of construction or at a central plant, or wholly or in part in truck mixers. Each mixer shall have a manufacturer's plate attached in a prominent place showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.

b. Mixers at Site of Construction. Mixing shall be done in an approved mixer capable of combining the aggregates, cement and water into a thoroughly mixed and uniform mass within the specified mixing period and discharging and distributing the mixture without segregation on the prepared grade. The mixer shall be equipped with an approved timing device which will automatically lock the discharge lever when the drum has been charged and released it at the end of the mixing period. In case of failure of the timing device, the mixer may be used for the balance of the day while it is being repaired, provided that each batch is mixed 90 seconds. The mixer shall be equipped with a suitable nonresettable batch counter which shall correctly indicate the number of the batches mixed.

c. Truck Mixer and Truck Agitators. Truck mixers used for mixing and hauling concrete, and truck agitators used for hauling central-mixed concrete, shall conform to the requirements of AASHTO M 157.

d. Non-Agitator Truck. Bodies of non-agitating hauling equipment for concrete shall be smooth, mortar-tight metal containers and shall be capable of discharging the concrete at a satisfactory controlled rate without segregation.

3. Paving and Finishing Equipment

The concrete shall be placed with an approved paver designed to spread, consolidate, screed and float finish the freshly placed concrete in one complete pass of the machine in such a manner that a minimum of hand finishing will be necessary to provide a dense and homogeneous pavement in conformance with the Plans and Specifications.

The finishing machine shall be equipped with at least two (2) oscillating type transverse screed.

Vibrators shall operate at a frequency of 8,300 to 9,600 impulses per minute under load at a maximum spacing of 60 cm.

To achieve smooth pavements with values for International Roughness Index (IRI) of not more than 3.0 m/km, the Contractor shall ensure that the paver control system is capable of smooth adjustments to automatically follow the surface shape (elevations and grades) required. The preferred method is laser control following a surface shape input to the onboard computer.

4. Concrete Saw

The Contractor shall provide sawing equipment in adequate number of units and power to complete the sawing with a water-cooled diamond edge saw blade or an abrasive wheel to the required dimensions and at the required rate. He shall provide at least one (1) stand-by saw in good working condition and with an ample supply of saw blades.

5. Forms

Forms shall be of steel, of an approved section, and of depth equal to the thickness of the pavement at the edge. The base of the forms shall be of sufficient width to provide necessary stability in all directions. The flange braces must extend outward on the base to not less than 2/3 the height of the form.

All forms shall be rigidly supported on bed of thoroughly compacted material during the entire operation of placing and finishing the concrete. Forms shall be provided with adequate devices for secure setting so that when in place, they will withstand, without visible spring or settlement, the impact and vibration of the consolidation and finishing or paving equipment.

311.3.3 Preparation of Grade

After the subgrade of base has been placed and compacted to the required density, the areas which will support the paving machine and the grade on which the pavement is to be constructed shall be trimmed to the proper elevation by means of a properly designed machine extending the prepared work areas compacted at least 60 cm beyond each edge of the proposed concrete pavement. If loss of density results from the trimming operations, it shall be restored by additional compaction before concrete is placed. If any traffic is allowed to use the prepared subgrade or base, the surface shall be checked and corrected immediately ahead of the placing concrete.

The subgrade or base shall be uniformly moist when the concrete is placed.

To achieve smooth pavements with values for International Roughness Index (IRI) of not more than 3.0 m/km, the Contractor shall ensure that the subgrade or base is prepared using equipment with a control system capable of smooth adjustments to automatically follow the surface shape (elevations and grades) required. The preferred method is laser control following a surface shape input to the onboard computer.

Section 311.3.4 Setting Forms

1. Base Support.

The foundation under the forms shall be hard and true to grade so that the form when set will be firmly in contact for its whole length and at the specified grade. (Any roadbed, which at the form line is found below established grade, shall be filled with approved granular materials to grade in lifts of three (3) cm or less, and thoroughly rerolled or tamped.) Imperfections or variations above grade shall be corrected by tamping or by cutting as necessary.

2. Form Setting

Forms shall be set sufficiently in advance of the point where concrete is being placed. After the forms have been set to correct grade, the grade shall be thoroughly tamped, mechanically or by hand, at both the inside and outside edges of the base of the forms. The forms shall not deviate from true line bv more than one (1) cm at any point.

3. Grade and Alignment

The alignment and grade elevations of the forms shall be checked and corrections made by the Contractor immediately before placing the concrete. *To ensure compliance to the maximum International Roughness Index (IRI) set by the Department, checking using appropriate surveying instruments shall be done at 5.0 m intervals along the top portion of the forms with a tolerance of +/- 0.001 m.*

When any form has been disturbed or any grade has become unstable, the form shall be reset and rechecked. *Also, when any form has been badly deteriorated which could affect the smoothness of the surface, the form shall be replaced and not be used in any future paving works.*

Section 311.3.14 Surface Test

Paved shoulders shall be subjected to surface test using a 3-m straight-edge. All areas within the carriageway shall be subjected to surface test using an approved profiling system. The profiling system shall qualify as Class 1 roughness measurement device and shall conform to the latest version ASTM E-950/E950M.

The components of the profiling system shall be validated on regular basis per manufacturer's recommendations to ensure that the system is properly calibrated. Validation reports shall be generated, for presentation to the Engineer, confirming that the validations are current, and within tolerances specified by the manufacturer.

The acceptable International Roughness Index (IRI) for concrete pavements shall be not more than 3.0 m/km for National Primary Road, measured in 100 meter sections, at the time of completion.

Prior to any testing, the road surface for test shall be cleaned of loose or deleterious material by brooming or other approved means. Survey shall only be conducted on dry pavement surfaces only. Wide-beam lasers are recommended for textured surfaces like diamond ground, diamond grooved or tyned surfaces where they yield lower IRI values than single point or spot lasers.

Prior to data collection, a test segment with a length of 500 meters will be selected at site for repeatability test. The repeatability test shall be witnessed by the authorized representative of the contractor and the project engineer. Five profile runs will be made on the test segment for repeatability test. The profile runs for repeatability are acceptable if the average IRI of the two wheelpaths satisfy the following criteria:

a. *The IRI values of each of the five (5) runs are within 1% of the mean IRI of the selected runs*
b. *The standard deviation of IRI of the selected runs are within 2% of the mean IRI*

If the runs do not meet the above criteria, the Profiling Team shall determine if the variability between runs are due to operator or equipment error, and make additional runs until five (5) runs free of equipment or operator errors are obtained. Where necessary an accuracy calibration test shall be conducted in comparison with a Class 1 Profiler (SSI Walking Profiler CS8800 or similar) to resolve said errors.

If the IRI values from the profile runs (for repeatability) meet the above criteria, three (3) runs per lane per site should be conducted for acceptance measurement. The IRI value for the lane shall be the average IRI of the two wheelpaths for the three (3) runs combined.

If the IRI value of the whole concrete pavement meets the required value regardless if there are areas found to have exceeded the required IRI value, no correction shall be required, provided that the areas with exceedance have an IRI value within the tolerance limit of 0.5 m/km.

However, if the IRI value of the whole concrete pavement falls beyond the prescribed IRI of 3.0 m/km for National Primary Roads and exceeds the allowable tolerance, the contractor may opt to undertake corrective action, otherwise, no payment shall be made. The alternatives of diamond grinding to permit correction of the IRI, reduced payment or remove and replace shall also be considered by the implementing office, provided that the design thickness is not compromised. Correction by diamond grinding shall be done with approved equipment.

After the correction has been undertaken by the contractor, further IRI Survey will be conducted to validate if the pavement irregularities had been eliminated. Only one IRI survey will be done after the corrective action takes place. If the IRI value of the whole asphalt pavement meets the prescribed IRI value of 3.0 m/km for National Primary Road and any 100 m sections exceeding the prescribed value are within the allowable tolerance after correction, no reduction in payment will be made; otherwise, no payment shall be made.

As soon as the concrete has hardened sufficiently, *and achieved 14-day design strength*, the pavement surface shall be tested with a 3-m straight-edge or approved profiling system. Areas showing high spots of more than 1.5 mm but not exceeding 9 mm in 3 m shall be marked and immediately ground down with approved *diamond grinding equipment.*

Diamond grinding shall be done with an approved equipment. Grinding shall be done using diamond blades mounted on a self-propelled machine designed for grinding and texturing pavement. The equipment shall have an automatic grade control that will grind a strip of minimum 0.45m (18 in.) width. Grinding equipment that causes ravelling, aggregate fractures, or deterioration at joints and cracks shall not be permitted. The grinding operation shall produce a pavement surface that is true in grade and uniform in appearance. The grinding depth for corrective action must not compromise the design depth of the pavement. Project data such as design thickness, actual thickness, coring data and field survey will serve as reference in the determination of the grinding depth. Where the departure from correct cross-section exceeds 10.5 mm, the pavement shall be removed and replaced by and at the expense of the Contractor.

Any area or section so removed shall be not less than 1.5 m in length and not less than the full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than 1.5 m in length, shall also be removed and replaced.

Section 311.3.19 Concrete Pavement – Slip Form Method

If the Contract calls for the construction of pavement without the use of fixed forms, the following provisions shall apply:

1. Grade

   After the grade or base has been placed and compacted to the required density, the areas which will support the paving machine shall be cut to the proper elevation by means of a properly designed machine. The grade on which the pavement is to be constructed shall then be brought to the proper profile by means of properly designed machine. If the density of the base is disturbed by the grading operation, it shall be corrected by additional compaction before concrete is placed. The grade should be constructed sufficiently in advance of the placing of the concrete. If any traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately before the placing of concrete. *Slip form paver requires a guidance system. The preferred method is laser control following a surface shape input to the onboard computer. Where the alternative of guide wires are to be used, they should be properly tensioned, installed parallel to the edges of the construction at both sides of the work area and maintained at fixed height and tension in order to meet the maximum IRI set by the Department. Checking using appropriate surveying instruments of the guide wire elevations shall be done at 5.0 m intervals with a tolerance of +/- 0.001m.*

2. Placing Concrete

   The concrete shall be placed with an approved slip-form paver designed to spread, consolidate, screed and float-finish the freshly placed concrete in one complete pass of the machine in such a manner that a minimum of hand finish will be necessary to provide a dense and homogenous pavement in conformance with the Plans and Specifications. The machine shall vibrate the concrete for the full width and depth of the strip of pavement being placed. Such vibration shall be accompanied with vibrating tubes or arms working in the concrete or with a vibrating screed or pan operating on the surface of the concrete. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. The forms shall trail behind the paver for such a distance that no appreciable slumping of the concrete will occur, and that necessary final finishing can be accomplished while the concrete is still within the forms. Any edge slump of the pavement, exclusive of edge rounding, in excess of 6 mm shall be corrected before the concrete has hardened.

The concrete shall be held at a uniform consistency, having a slump of not more than 40 mm. The slip form paver shall be operated with as nearly as possible a continuous forward movement and that all operations of mixing, delivering and spreading concrete shall be coordinated so as to provide uniform progress with stopping and starting of the paver held to a minimum. If, for any reason, it is necessary to stop the forward movement of the paver the vibratory and tamping elements shall also be stopped immediately. No tractive force shall be applied to the machine, except that which is controlled from the machine.

3. Finishing

The surface smoothness and texture shall meet the requirements of Subsections 311.3.13 and 311.3.14.

4. Curing

Unless otherwise specified, curing shall be done in accordance with one of the methods included in Subsection 311.3.15. The curing media shall be applied at the appropriate time and shall be applied uniformly and completely to all surfaces and edges of the pavement.

5. Joints

All joints shall be constructed in accordance with Subsection 311.3.12.

6. Protection Against Rain

In order that the concrete may be properly protected against rain before the concrete is sufficiently hardened, the Contractor will be required to have available at all times, materials for the protection of the edges and surface of the unhardened concrete. Such protective materials shall consist of standard metal forms or wood planks having a nominal thickness of not less than 50 mm and a nominal width of not less than the thickness of the pavement at its edge for the protection of the pavement edges, and covering material such as burlap or cotton mats, curing paper or plastic sheeting materials for the protection of the surface of the pavement. When rain appears imminent, all paving operations shall stop and all available personnel shall begin placing forms against the sides of the pavement and covering the surface of the unhardened concrete with the protective covering.

7. Guide Wires

For flat terrain, guide wire shall be supported at 10.0 m intervals. For, curves and tie-ins to existing pavement, guide wires shall be supported at 5.0 m intervals.

311.3.20 Acceptance of Concrete

No acceptance and final payment shall be made for the completed concrete pavement unless core test for thickness determination is conducted, except for Barangay Roads where the implementing office is allowed to waive such test, and for National Primary Roads where the concrete pavement shall also meet the International Road Roughness (IRI) criteria at the time of completion. The concrete pavement shall only be considered accepted if it meets the specified IRI value at the time of completion.

The strength level of the concrete will be considered satisfactory if the averages of all sets of three (3) consecutive strength test results equal or exceed the specified strength, f_c' and no individual strength test result is deficient by more than 15% of the specified strength, f_c'. A set shall consist of a minimum of three (3) concrete beam specimens.

Concrete deemed to be not acceptable using the above criteria may be rejected unless the Contractor can provide evidence, by means of core tests, that the quality of concrete represented by failed test results is acceptable in place. At least three (3) representative cores shall be taken from each member or area of concrete in place that is considered deficient. The location of cores shall be determined by the Engineer so that there will be at least impairment of strength of the structure. The obtaining and testing of drilled cores shall be in accordance with AASHTO T 24.

Concrete in the area represented by the cores will be considered adequate if the average strength of the cores is equal to at least 85% of, and if no single core is less than 75% of, the specified strength, f_c'.

If the strength of control specimens does not meet the requirements of this Subsection, and it is not feasible or not advisable to obtain cores from the structure due to structural considerations, payment of the concrete will be made at an adjusted price due to strength deficiency of concrete specimens as specified hereunder:

Deficiency in Strength of Concrete Specimens, Percent (%)	Percent (%) of Contract Price Allowed
Less than 5	100
5 to less than 10	80
10 to less than 15	70
15 to less than 20	60
20 to less than 25	50
25 or more	0

The concrete pavement shall have an IRI value tolerance of 0.5 m/km. If the IRI value of the whole concrete pavement falls beyond the prescribed IRI of 3.0 m/km for National Primary Road and exceeded the allowable tolerance, and the contractor opts not to undertake any corrective measure, no payment shall be made.

If the correction had been undertaken by the contractor, IRI Survey will be conducted to validate if the pavement irregularities had been eliminated. Only one IRI survey will be done after the corrective action takes place. If corrective measure had been made and the IRI value of the whole concrete pavement meets the prescribed IRI of 3.0 m/km for National Primary Road, no reduction to payment will be made. If the IRI value of the whole concrete pavement still falls beyond the prescribed IRI of 3.0 m/km for National Primary Road and any 100 m sections exceeding the prescribed value and within the allowable after correction, no reduction in payment will be made; otherwise, no payment shall be made.