

MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
DIAMOND GRINDING CONCRETE PAVEMENT

DES:SCB

1 of 3

09-02-99

C&T:APPR:JAR:GMM 09-03-99

a. Description. This work will consist of diamond grinding portland cement concrete pavement at the location as shown on the plans or in the proposal. The purpose of this work is to improve friction levels and riding quality. All work shall conform with details as shown on the plans and as specified in the 1996 Standard Specifications for Construction, unless modified herein.

b. Equipment. Grinding operations will utilize diamond blades mounted on a self propelled machine designed for grinding and texturing pavement. The equipment shall be such that it will not cause strain or damage to the underlying surface of the pavement. Grinding equipment that causes ravels, aggregate fractures, spalls, or disturbance to the transverse or longitudinal joints will not be permitted. Vacuuming equipment for removal of residue and excess water shall be used. The equipment will have a positive means of extracting the slurry material from the pavement and for preventing dust from escaping into the air.

c. Construction Methods. Grinding will be performed in a longitudinal direction and will begin and end at lines normal to the pavement centerline. The area ground shall not be left slick or polished. Grinding shall be discontinued when there is danger of water freezing. Grinding limits will be as shown on the plans or in the proposal.

Reflective Pavement Markers (RPM) shall not be disturbed as part of the grinding operation. Grinding shall be tapered to the existing pavement surface within 50 millimeters of the RPM.

A minimum of 95 percent of the pavement surface shall be textured by the grinding operation. Extra depth grinding to eliminate minor depressions in order to provide texturing of the entire pavement surface is not required. Exceptions can be made as directed by the Engineer.

Faulting at transverse cracks and joints should not exceed 2 millimeters after grinding. Areas in excess of 2 millimeters shall be re-ground until faulting is less than 2 millimeters.

Grinding shall result in a parallel corduroy type texturing consisting of grooves between 2 millimeters and 3 millimeters wide. The distance between grooves shall be between 2 millimeters and 3 millimeters. The peaks of the ridge shall average approximately 2 millimeters higher than the bottom of the grooves. The finished texture shall be uniform. The transverse slope of the pavement shall be uniform to the degree that no depressions or misalignment of slope greater than 3 millimeters in 3 meters exists when tested with a 3 meter straightedge. Straightedge requirements do not apply across longitudinal joints or outside ground areas. Adequate cross slope drainage must result after grinding so that no ponding of water exists.

Auxiliary or ramp lane grinding shall transition, as required, from the mainline edge to provide positive drainage and acceptable riding surface. Transitions from ground to unground pavement surfaces shall be gradual to conform to ridability. Transitions will be determined by the Engineer.

All joint restoration work (except sealing) shall be completed prior to the diamond grinding operation. All sealing of joints shall be completed after the grinding operation.

Disposal of grinding residue shall meet the following requirements:

1. At no time will the grinding residue be allowed to enter a closed drain system. The Contractor is responsible for providing suitable means to restrict the infiltration of the grinding residue into the closed drain system at no additional cost.
2. The Contractor will be responsible for hauling the grinding residue to a suitable location at no additional cost. If possible, the grinding residue can be spread along the slopes of the roadway a minimum of 1.5 meters from the edge of curb, per approval from the Engineer.
3. Residue will not be spread within 30 meters of any natural stream or lake.
4. Residue will not be spread within 1.5 meters of a water filled ditch.
5. The Spread rate will not generate surface runoff. The Contractor will haul the grinding residue to a suitable location when surface runoff occurs at the grinding location at no additional cost.
6. The Contractor shall obtain approval of the spreading/disposal method from the Engineer prior to beginning the grinding operation.

d. Testing and Acceptance. The Department will take random samples of the grinding residue and cooling water for chemical testing. The contractor shall allow access for department personnel to obtain the samples.

e. Measurement and Payment. The completed work as measured for Diamond Grinding Concrete Pavement will be paid for at the contract unit price for the following contract item (pay item).

<u>Contract Item (Pay Item)</u>	<u>Pay Unit</u>
Diamond Grinding Concrete Pavement	square meters

Diamond Grinding Concrete Pavement will be measured by area in square meters. Pay Areas will include the final textured surface area. Minor areas of untextured pavement will be included in the measurement. Minor areas shall total no more than 5 percent of the designated area to be textured.

The work of collection, hauling and spreading of the grinding residue is included in the contract unit price for diamond grinding. Payment for additional passes or regrinding to meet ride quality requirements will not be paid for separately and will be included in other contract items.

MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
RIDE QUALITY ON DIAMOND GRINDING PROJECTS

DES:SCB

1 of 5

12-03-98

C&T:APPR:JTL:MF 12-11-98

a. Description. This specification outlines ride quality requirements on this project. This specification provides two methods of measuring the ride quality of concrete pavements. The Contractor has the option of using either method. Once a method has been selected by the Contractor, it may not be changed without authorization from the Engineer. The ride quality of pavements will be determined on the finished surface only. This Special Provision deletes paragraph four of Section 502.03A4 , Section 502.03H, and Section 602.03 I paragraphs three, four, and five of the 1996 Standard Specifications.

b. Methods of Determining Pavement Smoothness.

1. California Type Profilograph

Ride quality of the pavement, expressed in mm/km, will be determined from a mechanically produced profilogram (trace) or from a computerized version of the California type profilograph.

2. GM Type Rapid Travel Profilometer

Ride quality of the pavement, expressed as RQI (Ride Quality Index) units, or mm/km will be determined by proper reduction of the true profile obtained by a GM Type of Rapid Travel Profilometer. The Contractor has the option of using either unit of measurement. Once the unit of measurement has been chosen by the Contractor, it may not be changed without authorization from the Engineer.

c. Equipment. The Contractor will certify in writing that the equipment, manufacturers calibration procedures and visual inspections are in compliance with this special provision. A manufacturers operating manual and a metric tire pressure gauge will be available at the site.

1. California Type Profilograph

The Contractor will furnish a California type profilograph, which is either mechanical or computerized. The profilograph will produce a profilogram with a true 1:1 vertical scale and a true 1:300 horizontal scaling. The profilogram will have roadway stations recorded thereon.

If the profilograph is equipped with an on-board computer, the following conditions will apply: Vertical displacement will be sampled every 76 mm or less along the roadway. The profile data will be bandpass filtered in the computer to remove all spatial wavelengths shorter than 0.61 m and longer than 33.5 m. This will be accomplished by a third order, low pass Butterworth filter set at 0.61 m and a third order, high pass Butterworth filter set at 33.5 m. The resulting band limited profile will then be computer analyzed according to the California Profilograph reduction process to produce the required mm/km statistic. This will be accomplished by fitting a linear regression line to each 160 m of contiguous pavement section. This corresponds to the perfect placement of the blanking bar by a human trace reducer. Scallop analysis is then detected and totaled according to the California protocol. Bump analysis will take place according to the California Profilograph reduction process.

The computerized profilograph will produce a plot of the profile and a printout which will give the following data: Stations every km, bump or dip height and length of specification (8 mm and 8 m respectively), the blanking band width, date of measurement, overall mm per km for that measurement, total length of that measurement, and the raw mm for each 160 m segment.

The calibration procedure for the mechanical machine will consist of profiling two replicate runs on a designated roadway of 300 m in length. Horizontal calibration will be checked by running the profilograph over the 300 m length and measuring the length of the resulting output on the profilogram. A 300 m run must produce $1 \text{ m} \pm 3 \text{ mm}$ of profilogram output. Vertical calibration will be checked by running the test wheel over a block of known thickness (usually 25 mm) and measuring the displacement it produces on the profilogram. There will be no visible tolerance allowed on the vertical calibration.

Calibration of the computerized versions will have a run made over a distance of a measured 300 m. The computer must print out a distance equal to the measured distance $\pm 1 \text{ m}$. The vertical calibration will be as per the manufacturer's specification.

If the horizontal or vertical checks do not meet specifications, the machinery must be corrected. In addition to the calibration procedures, a visual inspection of the profilograph must be conducted. This would include condition of the test tire and bogey wheels, tire pressure ($175 \text{ kPa} \pm 7 \text{ kPa}$), tracking of the paper on the spool and paper drum, condition of chains and cables, tracking of the device down the road, and general condition of the test device. This calibration procedure is the same for either type of profilograph.

2. GM Type Rapid Travel Profilometer

The Contractor will furnish a profilometer based on the General Motors Rapid Travel concept. The unit will produce a true profile for spatial wavelengths from 0.61 to 33.5 m. The unit must also be able to generate the equivalent California Profilograph plot and values as well as locations of bumps or dips over 8 mm/8 m. The unit will also be capable of producing a plot of the true profile with a range from 0.61 m to 33.5 m wavelengths.

The digitized profile will be processed by dividing it into three spatial wavelength bands by using third order Butterworth high and low pass filters. The three bands are 15.2 m to 7.6 m, 7.6 to 1.5 m, and 1.5 to 0.6 m. Variance of the profile in each band is then computed:

$$\text{Var}_i = \frac{\sum (x - \bar{x})^2}{N}$$

Where x is an individual profile elevation, in mm, for the band, \bar{x} is the average profile elevation value, in mm for the band, and N is the number of profile elevations measured in the band.

Where Var_i is the variance for band 1.

$i = 1$ for 15.2 m to 7.6 m, $i = 2$ for 7.6 m to 1.5 m and $i = 3$ for 1.5 to 0.6 m.

RQI is then given by the formula:

$$\text{RQI} = 3.077 \ln (\text{Var}_1 \times 10^8) + 6.154 \ln (\text{Var}_2 \times 10^8) + 9.231 \ln (\text{Var}_3 \times 10^8) - 141.85$$

This provides a scale from 0 (a perfect road) to 100 (the roughest road).

This equipment will give a printout of the same information as the profilograph with the addition of the ride quality index for each 160 m segment and for the total run.

These devices can be tested for overall operation by performing the "Bounce" test procedure included with the unit. In addition, any other tests prescribed by the manufacturer will be performed. Horizontal measurement will be checked over a measured distance of 300 m and will read within ± 1 m of the measured distance. The vertical calibration will be as per the manufacturer's specification.

d. Method of Testing. The Contractor will submit a written plan for the ride quality measuring to the Engineer for approval prior to the start of paving operations. The Contractor's plan will include, but not be limited to calibration schedule, the length of the official test run, method of traffic control, and the testing time frame in relation to paving operations.

The Engineer will establish and mark the limits for Ride Quality Measurement including the POB, POE, and any excluded area.

The Contractor will notify the Engineer a minimum of 24 hours prior to any pavement corrections and determination of ride quality.

The run will not be considered an official run until the pavement profile is in compliance with the requirements for this special provision.

The Contractor will be responsible for starting the California type profilometer with the measuring wheel on the mark and ending on the mark at the end of the run. The GM type profilometer measurement should start 5 m prior to the mark and end 5 m after the mark at the end of the run. Profiles will be taken 1 m from each side of each lane that is to be measured. Bridge decks will be excluded for payment of Ride Quality, but not for Ride Quality Measurement. This requires software, mechanical or electronic means of suspending calculation of the ride quality statistic during passage over such sections, while retaining linear measurement. All damage to the pavement surface caused by the profilometer will be repaired at no cost to the Department.

e. Method of Interpretation.

1. Profile Index (mm/km)

The trace generated by the mechanical profilograph will be analyzed by the Engineer using a 5 mm blanking band measuring each deviation above and below the band to the nearest 1 mm according to **Michigan Test Method MTM 204-88**. Deviations will be summed for each 160 m and proportional lengths as follows:

Segments less than 160 m shall be prorated to a 160 m segment. Each run will be reported by the Contractor to the nearest 0.5 mm as the average mm/km of the two runs for each lane.

For computerized profilograph use, the Engineer will not need to reduce the trace. A copy of the official computer generated trace and printout will be submitted for project records and to determine the ride quality payment. Each run will be reported by the Contractor to the nearest 0.5 mm as the average mm/km of the two runs for each lane.

Lanes with more than 160 mm/km will not be acceptable. All areas with bumps or dips exceeding 8 mm/8 m will be corrected. All pavements will be corrected to achieve a value of 160 mm/km or less at no cost to the Department. Any 160 m segments greater than 25 mm will require correction .

2. Ride Quality Index (RQI)

RQI will be calculated for each 160 m segment. Partial segments will be computed as partial segments at the beginning and end of excluded sections and at the end of a run.

Each run will be reported to the nearest one tenth of a RQI unit (e.g., 48.6), as the average of the two runs for each lane. The Contractor will provide to the Engineer a trace and a printout which gives the same information as described for the profilograph.

Pavement lanes with a RQI more than 53 are not acceptable. All pavement lanes will be corrected to achieve an RQI value of 53 or less at no cost to the Department.

All areas with bumps or dips exceeding 8 mm/8 m will be corrected.

f. Methods of Correction. Bumps or dips which measure over 8 mm in 8 m must be corrected. Restoration of the transverse grooves in these areas will not be necessary provided that the grinding equipment establishes a grooved surface in the longitudinal direction. The Contractor will determine those areas which need correction. All corrections to concrete pavements will be by diamond grinding for a full lane width and are at the Contractor's expense.

g. Measurement and Payment. Ride quality measurement will start at a point five meters before the project Point of Beginning and will cease five meters beyond the project Point of Ending. Payment for Ride Quality will considered included in other contract items and will not be paid for separately.