

AMENDMENTS
to
2012
Manual of
STANDARD SPECIFICATIONS

Adopted by
Standard Specifications Committee

Amendment
No. 4

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FORWARD

This document modifies a portion of the 2012 "Manual of Standard Specifications". All other provisions in the manual remain in full force and effect.

DELETIONS

Delete Section 32 12 05 entitled Asphalt Concrete (previously changed by Amendment No. 3).
Delete Section 32 12 16.13 entitled Plant Mix Asphalt Paving.

ADDITIONS

Add Section 32 01 31 entitled Pavement Smoothness (attached hereto).
Add Section 32 12 05 entitled Bituminous Concrete (attached hereto)
Add Section 32 12 16.13 entitled Plant Mix Bituminous Paving (attached hereto)

The deletions and additions are approved.

AGC
Representative: _____

_____ Date

APWA
Representative: _____



5/5/16
_____ Date

SECTION 32 01 31
PAVEMENT SMOOTHNESS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Smoothness tolerances for placing flexible and rigid pavements and for installing pavement patches.
- B. Procedure for correcting defective smoothness.

1.2 REFERENCES

A. ASTM Standards:

- E950 Measuring the Longitudinal profile of Traveled Surfaces with an Accelerometer Established Inertial Profiling Reference.
- E1274 Measuring Pavement Roughness Using a Profilograph.

1.3 DEFINITIONS

- A. **Must Grind:** Areas of roadway pavement not meeting profile deviation tolerance.
- B. **Road Class:**
 - Class I:** (ESAL < 10⁴ per year) Includes maintenance mixes, bike paths, parking lots, residential driveways, light traffic residential streets, light traffic rural farm roads.
 - Class II:** (ESAL between 10⁴ and 10⁶ per year). Includes heavy traffic residential streets, rural farm collector roads, non-industrial parking lots, urban low volume collector streets.
 - Class III:** (ESAL > 10⁶ per year). Includes high volume collectors, arterials, industrial parking lots (primary load from 3-axle or greater vehicles), climbing lanes, truck weigh stations.
- C. **Wheel Path:** A continuous parallel line inside a travel lane 2.5 feet from the lane line or median line.

1.4 SUBMITTALS

- A. Traffic control plan, Section 01 55 26.
- B. Certifications for profilographs, profilers, and operators.
- C. Summary report of smoothness profile testing.

1.5 QUALITY ASSURANCE

- A. Provide testing equipment and a person capable of calculating grades and cross-slopes in degrees and percentages. Cross slopes vary when the crown line is not parallel to pavement edge line.

1.6 ACCEPTANCE

- A. General:
 - 1. Acceptance is by Lot.
 - 2. Dispute resolution, Section 01 35 10.
 - 3. Opening a profiled surface to traffic does not constitute acceptance.
 - 4. Observation of CONTRACTOR's field quality control testing does not constitute

acceptance. Such testing; however, may be used by ENGINEER for acceptance if requirements of Section 01 35 10 are met.

B. Profile Roughness:

1. Lot is 0.1 lane mile (528 feet long one lane wide). Add segments shorter than 250 feet to preceding lot. Treat partial segments longer than 250 feet as a lot.
2. Excluded from the lot are turn lanes, parking lanes, medians, Street Fixtures, crowns of intersecting streets, bridge decks, grades greater than eight (8) percent, and vertical curves less than 1,000 feet radius (including super-elevation transitions).

C. Profile Deviation: Verify “must grind” bumps and depressions are removed from the lot surface. Lot is area of total placement. No area is excluded.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 CONSTRUCTION EQUIPMENT

A. Profilograph:

1. Capable of producing results required by ASTM E950 and ASTM E1274.
2. Set profilograph readings with corresponding project survey stationing, or as a minimum, correlate equipment station 0+00 with a specific project station number. ENGINEER to select.

B. Milling and Grinding Machines:

1. Equipped to prevent air pollution.
2. Equipped with a system to control depth and slope of pavement cut.

C. Cleaning equipment able to pick up millings and waste water.

3.2 PREPARATION

A. Traffic Control:

1. Implement traffic control plan requirements, Section 01 55 26.
2. Provide safe passage for pedestrians and vehicles.
3. Do not proceed without certified flaggers if work requires.

B. If indicated elsewhere, evaluate existing pavement smoothness before placement of thin bonded overlay, micro-surfacing, slurry seal, chip seal, etc. If not indicated elsewhere, method of payment is to be determined by ENGINEER.

3.3 TOLERANCES

A. Profile Roughness and Profile Deviation: Verify bumps and depressions meet tolerance. Trace all wheel paths in direction of travel. Begin traces 50 feet before edge of new pavement and end traces 50 feet after edge of new pavement. Areas (including the 50 feet end trace areas) exceeding profile deviation tolerance are “must grind” areas.

Table 1 – Tolerances						
Speed mph	Road Class	Profile Roughness Index Inches / Mile				Profile Deviation Inches/25 feet Maximum
		IRI		PI		
		Min	Max	Min	Max	
0 to 30	I	–	–	–	–	0.4
	II or III	129	177	46	66	0.4
31 to 45	I or II	90	155	35	50	0.4
	III	70	90	21	35	0.4
>45	All Classes	–	70	–	21	0.3
NOTES						
(a) IRI (International Roughness Index), ASTM E 950. Use a 1/4 car.						
(b) PI (Profile Index), ASTM E 1274. Use a zero blanking band.						

3.4 REPAIR

A. General:

1. Follow Section 32 01 26 to smooth out profile irregularities.
2. Do not begin repairs without ENGINEER's knowledge of such activity.
3. All expenses are at no additional cost to OWNER.

B. Bituminous Concrete Repair:

1. Apply Section 32 12 03 cationic or anionic emulsion at 0.11 ± 0.01 gal/yd² and a sand friction blotter over all grind areas.
2. If depressions cannot be corrected by grinding, do a cold mill and inlay repair per Section 32 01 16.71 or a remove and replace patch repair per Section 33 05 25.

Raising depressions with a skin patch and feathered edges is NOT ACCEPTABLE. Patching must meet this section's tolerance requirements.

C. Portland Cement Concrete Repair:

1. Apply Section 07 19 00 penetrating sealer over all grind areas.
2. If depressions cannot be corrected by grinding, remove concrete and provide a concrete pavement patch per Section 32 01 19.

END OF SECTION

SECTION 32 12 05
BITUMINOUS CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Composition of a bituminous concrete mix.

1.2 REFERENCES

A. AASHTO Standards:

- M323 Superpave Volumetric Mix Design, Single User Digital Publication.
- R30 Mixture Conditioning of Hot-Mix Asphalt (HMA).
- T324 Hamburg Wheel-Track Testing of Compacted Hot-Mix Asphalt (HMA).

B. AI Standards:

- MS-2 Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types.

C. ASTM Standards:

- C29 Unit Weight and Voids in Aggregate.
- C88 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
- C117 Materials Finer Than 0.075mm (No. 200) Sieve in Mineral Aggregates by Washing.
- C131 Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- C136 Standard Method for Sieve Analysis of Fine and Coarse Aggregate.
- C142 Clay Lumps and Friable Particles in Aggregates.
- D75 Sampling Aggregates.
- D140 Sampling Bituminous Materials.
- D242 Mineral Filler for Bituminous Paving Mixtures.
- D979 Sampling Bituminous Paving Mixtures.
- D995 Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
- D2041 Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures.
- D2419 Sand Equivalent Value of Soils and Fine Aggregate.
- D3203 Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures.
- D3515 Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
- D3665 Random Sampling of Construction Materials.
- D3666 Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials.
- D4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- D4552 Classifying Hot-Mix Recycling Agents.
- D4791 Flat or Elongated Particles in Coarse Aggregate.

- D4867 Effect of Moisture on Asphalt Concrete Paving Mixtures.
- D5444 Mechanical Size Analysis of Extracted Aggregate.
- D5821 Determining the Percentage of Fractured Particles in Coarse Aggregate.
- D6307 Determining Asphalt Content of Hot-Mix Asphalt by Ignition Method.
- D6373 Performance Graded Asphalt Binder.
- D6927 Marshall Stability and Flow of Bituminous Mixtures.

1.3 DEFINITIONS

- A. **Mix Designator:** An alphanumeric code that identifies the aggregate grade, binder, and compaction level in a bituminous concrete mix. For example.
 - **SP-1, PG70-28, 75Nd:** SP-1 is the aggregate grade. PG70-28 is a performance graded asphalt binder. 75Nd is the compaction level at design.
 - **SP-3/4, OS/PG, 75Nd:** SP-3/4 is the aggregate grade. OS/PG is a Blended Binder. 75Nd is the compaction level at design.
 - **DM-1/2, PG64-22, 50 blow:** DM-1/2 is the aggregate grade. PG64-22 is a performance graded asphalt binder. 50 blow is the compaction level at design.
 - **DM-3/4, OS/PG, 50 blow:** DM-3/4 is the aggregate grade. OS/PG is a Blended Binder. 50 blow is the compaction level at design.
- B. **Bituminous Binder:** A cement composed of any of several viscous or solid mixtures of hydrocarbons and their nitrogen and sulfur derivatives.
 1. Asphalt Binder: A refined or manufactured bitumen cement known as performance graded asphalt binder (PG or PGAB) whether virgin or contained in RAP.
 2. Bitumen Binder: A natural bitumen cement contained in an Oil Sand (OS) or contained in a ROSP.
 3. Blended Binder: A mixture of Asphalt Binder and Bitumen Binder.
- C. **Mean of Deviations:** Defined in Section 32 11 23.
- D. **Nominal Maximum Size:** One sieve size larger than first sieve size retaining more than 10 percent of the sample. One hundred percent of the aggregate might be able to pass through the nominal maximum size sieve but not more than 10 percent will be retained on that sieve. The maximum size will be one (1) sieve size larger than the nominal maximum size.
- E. **Oil Sand (OS):** Naturally occurring sediments or sedimentary rock containing gravel, sand, clay, water and bitumen cement.
- F. **RAP** (acronym for reclaimed asphalt pavement): A granular product recovered from a bituminous pavement containing aggregate and an Asphalt Binder.
- G. **ROSP** (acronym for reclaimed Oil Sand Pavement): A granular product recovered from a bituminous pavement containing an aggregate and a Bitumen Binder.

1.4 SUBMITTALS

- A. **General:**
 1. Allow ENGINEER 10 days to evaluate mixing equipment and mix design submittals.
 2. Once a mix design is accepted, a new mix design submittal is required if the following occurs.
 - a. Asphalt Binder grade is changed.

- b. Aggregate source is changed. When this occurs, submit a physical properties report on the proposed aggregates.
- B. **Independent Laboratory:** Submit names, certification levels, and years of experience of testing agency's field technicians that are assigned to the Work. Verify laboratory complies with ASTM D3666.
- C. **Mix Production Equipment:** Submit verification by an individual acceptable to ENGINEER, that plant equipment complies with requirements of ASTM D995.
- D. **Mix Design:** Submit the following.
 - 1. Date of mix design. If the date exceeds the following times, the mix design is invalid and must be redesigned.
 - a. One (1) year for non-commercial plants.
 - b. Two (2) years for commercial plants if there is no change in the aggregate source. A new mix design will be required if aggregate source is changed.
 - 2. Binder source, type, and grade. Disclose if RAP or ROSP is used in the mix.
 - 3. Optimum compaction temperature at the project site.
 - 4. Theoretical maximum specific gravity.
 - 5. Compaction density at design target air voids.
 - 6. Target Grading Curve for aggregate.
 - 7. Binder target percentage, dust to binder ratio, and the following as applicable.
 - a. For Superpave mix design provide (1) voids in the mineral aggregate (VMA), (2) voids filled with Bituminous Binder also known as (VFA), and (3) Hamburg Wheel Tracker results.
 - b. For Marshall mix design provide (1) tensile strength ratio (moisture sensitivity), (2) voids in the mineral aggregate (VMA), (3) stability, (4) flow, (5) voids in the bituminous mix, and (6) voids filled with Bituminous Binder also known as (VFA).
 - 8. Percentages of (1) mineral filler, (2) anti-strip, (3) reclaimed bituminous pavement (RAP or ROSP), (4) recycle agent in the mix, and (5) virgin aggregate.
 - 9. Aggregate physical properties (this section article 2.2). The information is for suitability of source and not for project control. A new report may be required if aggregate source is changed. Test results shall not be older than two (2) calendar years from the date of submission.
- E. **Pre-approved Mix Design:** Submit name and address of Supplier.
- F. **Testing Report:** If requested by ENGINEER, submit a report of source and field quality control testing performed by CONTRACTOR and Suppliers.

1.5 QUALITY ASSURANCE

- A. Use a laboratory that complies with ASTM D3666 and follows Section 01 45 00 requirements.
- B. Do not change aggregate source or binder grade until ENGINEER accepts new source and mix design.

1.6 ACCEPTANCE

- A. General:
 - 1. Acceptance is by Lot. One (1) Lot is one (1) day production.

2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring material as part of its installation, Section 01 29 00.
 3. If test results are not within this section's limits, options include correction of production procedures or production of an alternate mix design acceptable to ENGINEER.
 4. Observation of CONTRACTOR's field quality control testing does not constitute acceptance. Such testing; however, may be used by ENGINEER for acceptance if requirements in Section 01 35 10 are met.
 5. Dispute resolution, Section 01 35 10.
- B. Mix Sampling and testing:
1. Sub-lot size is 500 tons or part thereof.
 2. Sampling Protocol: ASTM D3665 and ASTM D979. Collect at least one (1) random Sample per sub-lot from behind paver and before compaction. Any sample collected because of non-uniform appearance shall not be used in determining a pay factor for the Lot.
 3. Testing Protocol: Field samples will be compacted in the laboratory and tested for:
 - a. Air voids, ASTM D3203.
 - b. Voids in the mineral aggregate, AI MS-2.
 - c. Binder content, ASTM D6307
 - d. Aggregate gradation, ASTM D5444.
- C. Pay Reduction: Lot is acceptable if binder content and aggregate gradation test deviations are within pay factor 1.00 limits in Table 1 or Table 2 as applicable. At ENGINEER's discretion a Lot with a sub-lot test deviation greater than pay factor 0.85 limits may stay in place at 50 percent pay.

Table 1 – Pay Factors - Superpave Mix Design					
Criteria	Pay Factor	Range of Mean of Deviations of Tests Results in Percentage Points from Binder and Gradation Targets			
		500 Tons	1,000 Tons	1,500 Tons	≥ 2,000 Tons
Binder Content	1.00	0.0 – 0.7	0.0 – 0.54	0.0 – 0.46	0.0 – 0.41
	0.975	0.71 – 0.8	0.55 – 0.61	0.47 – 0.52	0.42 – 0.46
	0.95	0.81 – 0.9	0.62 – 0.68	0.53 – 0.58	0.47 – 0.52
	0.90	0.9 – 1.0	0.69 – 0.75	0.59 – 0.64	0.53 – 0.56
	0.85	1.01 – 1.1	0.76 – 0.82	0.65 – 0.69	0.57 – 0.61
1/2" and larger Sieve	1.00	0.0 – 10.0	0.0 – 7.3	0.0 – 6.3	0.0 – 5.6
	0.975	11.0 – 12.0	7.4 – 8.3	6.4 – 7.1	5.7 – 6.3
	0.95	13.0 – 13.9	8.4 – 9.3	7.2 – 7.9	6.4 – 7.0
	0.90	14.0 – 14.9	9.4 – 10.3	8.0 – 8.7	7.1 – 7.7
	0.85	15.0 – 16.0	10.4 – 11.3	8.8 – 9.5	7.8 – 8.4
3/8" Sieve	1.00	0.0 – 9.9	0.0 – 6.9	0.0 – 5.9	0.0 – 5.3
	0.975	10.0 – 10.9	7.0 – 7.8	6.0 – 6.6	5.4 – 5.9
	0.95	11.0 – 11.9	7.9 – 8.7	6.7 – 7.3	6.0 – 6.6
	0.90	12.0 – 13.9	8.8 – 9.6	7.4 – 8.0	6.7 – 7.2
	0.85	14.0 – 15.0	9.7 – 10.5	8.1 – 8.9	7.3 – 7.9

No.4 Sieve	1.00	0.0 – 9.9	0.0 – 6.7	0.0 – 5.7	0.0 – 5.2
	0.975	10.0 – 10.9	6.8 – 7.6	5.8 – 6.3	5.3 – 5.8
	0.95	11.0 – 11.9	7.7 – 8.5	6.4 – 6.9	5.9 – 6.4
	0.90	12.0 – 12.9	8.6 – 9.4	7.0 – 7.5	6.5 – 7.0
	0.85	13.0 – 14.0	9.5 – 10.2	7.6 – 8.0	7.1 – 7.6
No. 8 Sieve	1.00	0.0 – 7.9	0.0 – 5.6	0.0 – 4.8	0.0 – 4.3
	0.975	8.0 – 8.9	5.7 – 6.3	4.9 – 5.4	4.4 – 4.8
	0.95	9.0 – 9.9	6.4 – 7.0	5.5 – 6.0	4.9 – 5.3
	0.90	10.0 – 10.9	7.1 – 7.7	6.1 – 6.6	5.4 – 5.8
	0.85	11.0 – 12.0	7.8 – 8.5	6.7 – 7.2	5.9 – 6.4
No. 200 Sieve	1.00	0.0 – 3.0	0.0-2.4	0.0 – 2.0	0.0 – 1.8
	0.975	3.1 – 3.5	2.5 – 2.7	2.1 – 2.2	1.9 – 2.0
	0.95	3.6 – 4.0	2.8 – 3.0	2.3 – 2.4	2.1 – 2.2
	0.90	4.1 – 4.5	3.1 – 3.3	2.5 – 2.7	2.3 – 2.4
	0.85	4.6 – 5.0	3.4 – 3.6	2.8 – 3.0	2.5 – 2.6

NOTES

- (a) Test binder content using a burn-off oven, ASTM D6307.
(b) Determine aggregate gradation by extraction, ASTM D5444.

Table 2 – Pay Factors – Marshall Mix Design

Criteria	Pay Factor	Range of Mean of Deviations of Tests Results from the Binder and Gradation Targets in Percentage Points				
		500 Tons	1,000 Tons	1,500 Tons	2,000 Tons	≥2,500 Tons
Binder Content	1.00	0.00–0.70	0.00–0.54	0.00–0.46	0.00–0.41	0.00–0.38
	0.975	0.71–0.80	0.55–0.61	0.47–0.52	0.42–0.46	0.39–0.43
	0.95	0.81–0.90	0.62–0.68	0.53–0.58	0.47–0.52	0.44–0.47
	0.90	0.91–1.00	0.69–0.75	0.59–0.64	0.53–0.56	0.48–0.52
	0.85	1.01–1.10	0.76–0.82	0.65–0.69	0.57–0.61	0.53–0.56
1/2"and larger Sieve	1.00	0.0–10.9	0.0–7.3	0.0–6.5	0.0–5.6	0.0–5.2
	0.975	11.0–12.9	7.4–8.3	6.4–7.1	5.7–6.3	5.3–5.8
	0.95	13.0–13.9	8.4–9.3	7.2–7.9	6.4–7.0	5.9–6.4
	0.90	14.0–14.9	9.4– 10.3	8.0–8.7	7.1–7.7	6.5–7.1
	0.85	15.0–16.0	10.4–11.3	8.8–9.5	7.8–8.4	7.2–7.7
3/8" Sieve	1.00	0.0–9.9	0.0–6.9	0.0–5.9	0.0–5.3	0.0–4.9
	0.975	10.0–10.9	7.0–7.8	6.0–6.6	5.4–6.9	5.0–5.5
	0.95	11.0–11.9	7.9–8.7	6.7–7.3	6.0–6.6	5.6–6.1
	0.90	12.0–13.9	8.8–9.6	7.4–8.0	6.7–7.2	6.2–6.6
	0.85	14.0–15.0	9.7–10.5	8.1–8.9	7.3–7.9	6.7–7.2
No. 4 Sieve	1.00	0.0–9.9	0.0–6.7	0.0–5.7	0.0–5.2	0.0–4.8
	0.975	10.0–11.0	6.8–7.6	5.8–6.3	5.3–5.8	4.9–5.4
	0.95	11.1–11.9	7.7–8.5	6.4–6.9	5.9–6.4	5.5–5.9
	0.90	12.0–12.9	8.6–9.4	7.0–7.5	6.5–7.0	6.0–6.5
	0.85	13.0–14.0	9.5–10.2	7.6–8.0	7.1–7.6	6.6–7.0
No. 8 Sieve	1.00	0.0–7.9	0.0–5.6	0.0–4.8	0.0–4.3	0.0–4.0
	0.975	8.0–8.9	5.7–6.3	4.9–5.4	4.4–4.8	4.1–4.5
	0.95	9.0–9.9	6.4–7.0	5.5–6.0	4.9–5.3	4.6–4.9
	0.90	10.0–10.9	7.1–7.7	6.1–6.6	5.4–5.8	5.0–5.4
	0.85	11.0–12.0	7.8–8.5	6.7–7.2	5.9–6.4	5.5–5.8

No. 16 Sieve	1.00	0.0–7.9	0.0–5.2	0.0–4.6	0.0–4.2	0.0–3.9
	0.975	8.0–8.9	5.3–5.8	4.7–5.1	4.3–4.6	4.0–4.3
	0.95	9.0–9.9	5.9–6.4	5.2–5.6	4.7–5.1	4.4–4.7
	0.90	10.0–10.9	6.5–7.0	5.7–6.1	5.2–5.5	4.8–5.1
	0.85	11.0–12.0	7.1–7.6	6.2–6.6	5.6–5.9	5.2–5.4
No. 50 Sieve	1.00	0.0–6.9	0.0–4.3	0.0–3.8	0.0–3.4	0.0–3.2
	0.975	7.0–7.9	4.4–4.8	3.9–4.1	3.5–3.8	3.3–3.5
	0.95	8.0–8.9	4.9–5.3	4.2–4.5	3.9–4.1	3.6–3.8
	0.90	9.0–9.9	5.4–5.8	4.6–4.9	4.2–4.4	3.9–4.1
	0.85	10.0–11.0	5.9–6.4	5.0–5.5	4.5–4.9	4.2–4.5
No. 200 Sieve	1.00	0.0–3.0	0.0–2.4	0.0–2.0	0.0–1.8	0.0–1.7
	0.975	3.1–3.5	2.5–2.7	2.1–2.2	1.9–2.0	1.8–1.9
	0.95	3.6–4.0	2.8–3.0	2.3–2.4	2.1–2.2	2.0–2.1
	0.90	4.1–4.5	3.1–3.3	2.5–2.7	2.3–2.4	2.2–2.3
	0.85	4.6–5.0	3.4–3.6	2.8–3.0	2.5–2.6	2.4–2.5
NOTES						
(a) Test binder content using a burn-off oven, ASTM D6307.						
(b) Determine aggregate gradation by extraction, ASTM D5444.						

D. **Installation:** Acceptance requirements are stipulated in Section 32 12 16.13.

PART 2 PRODUCTS

2.1 BINDER

A. **Performance Graded Asphalt Binder (PGAB),** ASTM D6373:

- Blending with polymers is allowed.
- Do not use acid blends without documentation supporting need.
- Adjust binder grade according to AASHTO M 323 to account for any binder stiffness caused by adding RAP or ROSP to the mix.

B. **Bitumen Binder.** Oil Sand (OS) source is CONTRACTOR's choice.

C. **Blended Binder:** CONTRACTOR's choice. A blended ratio of Asphalt Binder to Bitumen Binder in the range of about 1:4 to about 4:1 may require patent licensure (Reference: US RE39,289 E). CONTRACTOR to verify.

2.2 AGGREGATE

A. Crushed stone, crushed gravel, slag, sand, or combination.

B. Use Table 3 to determine suitability of aggregate source.

Table 3 – Aggregate Physical Properties				
Property		Standard	Road Class	
			I&II	III
Coarse Aggregate				
Angularity, percent, minimum	One Fractured face	D 5821	90	95
	Two Fractured faces		90	90
Wear (hardness or toughness), percent, maximum		C 131	35	35

Flats or elongates (3:1 length to width), percent, maximum	D 4791	--	20
Fine Aggregate			
Angularity (uncompacted void content), percent, minimum	T 304	40	45
Sand equivalent, percent, minimum	D 2419	45	60
Plastic limit, maximum	D 4318	0	0
Blended Physical Properties			
Dry-rodded Unit Weight, lb/ft ³ , minimum	C 29	75	75
Weight Loss (Soundness), percent, maximum	C 88	16	16
Friable particles, percent, maximum	C 142	2	2
<p>NOTES</p> <p>(a) Road Class is defined in Section 32 01 31.</p> <p>(b) Course aggregate does not pass No. 4 sieve. Fine aggregate passes.</p> <p>(c) Angularity by weight.</p> <p>(d) Wear of aggregate may have higher values if aggregate source is known to have higher values.</p> <p>(e) Sand equivalent is waived for RAP or ROSP aggregate but applies to the remainder of the aggregate blend.</p> <p>(f) Plastic limit, passing No. 40 sieve. Aggregate is non-plastic even when filler material is added to the aggregate.</p> <p>(f) Weight loss, using sodium sulfate.</p> <p>(g) Friable particles are clay lumps, shale, wood, mica, coal passing the No. 4 sieve, and other deleterious materials.</p>			

2.3 ADDITIVES

- A. Mineral Filler: ASTM D242.
- B. Recycle Agent: ASTM D4552.
- C. Anti-strip Agent: Heat stable cement slurry, lime slurry, or chemical liquid.
- D. RAP or ROSP: Free of detrimental quantities of deleterious materials.
 - 1. Allowed up to 15 percent by weight of RAP or binder, whichever is lesser, with no change in specified binder grade.
 - 2. Allowed from 15 to 30 percent by weight of RAP or binder, whichever is lesser, if the binder grade is adjusted according to AASHTO M 323 to meet the specified binder grade.
 - 3. Determine RAP binder content by chemical extraction.

2.4 MIX DESIGN

- A. **Preparation:**
 - 1. Get the Mix Designator and the Road Class from the OWNER, ENGINEER, or bid documents.
 - 2. Use paragraph 1.4D to determine submittal requirements.

- B. **Aggregate Gradation – Superpave Mix Design:** Table 4. The Target Grading Curve for the specified aggregate grade must lie within the Master Grading Band limits. The target grading band limits for the Target Grading Curve are the appropriate grading limits for pay factor 1.00 in Table 1. The target grading band limits are allowed to extend outside of the Master Grading Band limits.

Table 4 - Master Grading Bands - Superpave Mix Design				
Sieve	Grade			
	SP-1.5	SP-1.0	SP-3/4	SP-1/2
1.5 inch	100.0	–	–	--
1 inch	90.0 – 100.0	100.0	–	--
3/4 inch	< 90	90.0 – 100.0	100.0	–
1/2 inch	–	< 90	90.0 – 100.0	100.0
3/8 inch	–	–	< 90	90.0 – 100.0
No. 4	–	–	–	< 90
No. 8	19.0 – 45.0	23.0 – 49.0	28.0 – 58.0	32.0 – 67.0
No. 200	1.0 – 7.0	2.0 – 8.0	2.0 – 10.0	2.0 – 10.0

NOTES

(a) Gradation is expressed in percent passing by weight, ASTM C136. Percentage of fines passing No. 200 sieve determined by washing, ASTM C117.

(b) The alpha portion of the grade designator (SP) represents Superpave mix. The numerical portion (1, 3/4, 1/2, 3/8) represents the *nominal maximum* sieve size.

- C. **Aggregate Gradation – Marshall Mix Design:** Table 5. The Target Grading Curve for the specified aggregate grade must lie within the Master Grading Band limits. The target grading band limits for the Target Grading Curve are the appropriate grading limits for pay factor 1.00 in Table 2. The target grading band limits are allowed to extend outside of the Master Grading Band limits.

Table 5 – Master Grading Bands – Marshall Mix Design						
Sieve	Aggregate Grade					
	DM-1	DM-3/4	DM-1/2	OM-1/2	FM-1	FM-1/2
1 inch	100					
3/4 inch		100			100	
1/2 inch	75 – 91		100	100	90 – 100	100
3/8 inch		75 – 91		93 – 100	60 – 100	90 – 100
No. 4	47 – 61	46 – 62	60 – 80	36 – 44	15 – 40	30 – 50
No. 8				14 – 21	4 – 12	5 – 15
No. 16	23 – 33	22 – 34	28 – 42			
No. 50	12 – 22	11 – 23	11 – 23			
No.200	3 – 7	3 – 7	3 – 7	2 – 4	2 – 5	2 – 5

NOTES

- (a) Gradation is expressed in percent passing by weight, ASTM C136. Percentage of fines passing No. 200 sieve determined by washing, ASTM C117.
- (b) Friction Mixture, ASTM D3515.
- (c) The alpha portion of the grade designator (DM, OM, FM) represents dense mix, open mix and friction mix. The numerical portion (1, 3/4, 1/2) represents the *maximum* sieve size.

D. Mix Design Parameters: Table 6. Determined by AI MS-2.

Table 6 - Mix Design Parameters						
Criteria		SuperPave			Marshall	
Compaction Level	(b)	50Nd	75Nd	100Nd	50 blow	75 blow
Stability, lbs., minimum	(c)	--			1200	1800
Flow, in 0.01 inch units	(c)	--			10 - 18	
Design Air Void Target, percent	(d)	3.5			3.5	
Voids in Mineral Aggregate (VMA), percent, minimum, relative to maximum or nominal sieve size grading and calculated using Gsb(dry)		ASTM D3203			ASTM D6927	
		Nominal Grading			Maximum Grading	
		1		12.0	1	13.0
		3/4		13.0	3/4	14.0
		1/2		14.0	1/2	15.0
		3/8		15.0	3/8	16.0
RAP or ROSP specific gravity for calculations		Gsb (dry) by chemical extraction				
Dust to Binder Ratio, maximum		1.4			1.6	
Tensile Strength Ratio (moisture sensitivity), minimum	(e)	--			0.80	
Rutting (Hamburg rut test)	(f)	AASHTO T 324				
Road Class I		--			--	--
Road Class II		15 mm/10,000 passes			--	--
Road Class III		10 mm/20,000 passes			--	--
NOTES						
(a) Road Class is defined in Section 32 01 31.						
(b) 100Nd mix is for very high traffic applications only as defined by ENGINEER. 100Nd mix is intended for lower lift applications or surface applications with proactive seal coat program.						
(c) Design Density Target: ASTM D2041. Percent of maximum theoretical specific gravity.						
(d) Stability, Flow, Voids: ASTM D6927.						
(e) Tensile Strength Ratio (moisture sensitivity): ASTM D4867. Use freeze thaw conditioning. Compact test specimen to seven (7) percent plus or minus one (1) percent air voids.						
(f) With testing performed at temperatures representing the <u>specified</u> binder grade in the Hamburg rut test, the average rut depth of two (2)						

mix design test Samples is less than the amount shown for the respective Road Classes.

2.5 SOURCE QUALITY CONTROL

- A. Collect Samples randomly, ASTM D3665. Do not change sampling points:
 - 1. Sampling aggregate, ASTM D75. Collect samples before the drum mixer.
 - 2. Sampling binder, ASTM D140.
 - 3. Sampling bituminous paving mixture, ASTM D979.
- B. Validate binder grade received from Supplier, Section 32 12 03.
- C. Test mix every production day for the following:
 - 1. Combined aggregate gradation in the mix, ASTM D5444.
 - 2. Binder content in the mix, ASTM D6307.
 - 3. Temperature of mix placed in the transport vehicle at the production plant.
 - a. Asphalt Binder mixes.
 - 1) Hot Mix: 325 deg F maximum.
 - 2) Warm Mix: 325 deg F maximum.
 - b. Bitumen Binder mixes or Blended Binder mixes.
 - 1) Hot Mix: NOT ALLOWED.
 - 2) Warm Mix: 230 degrees maximum.
- D. Warm Mix Testing: When rutting or moisture susceptibility tests are required on plant produced warm mix, condition the warm mix material before testing for two (2) hours at 275 plus or minus five (5) deg F per AASHTO R 30 (short term aging). The material may be cooled to room temperature before conditioning.

PART 3 EXECUTION

3.1 CONSTRUCTION EQUIPMENT

- A. Mixing Plant: ASTM D995. Provide.
 - 1. Positive means to determine the moisture content of aggregate.
 - 2. Positive means to sample all material components.
 - 3. Sensors to measure the temperature of the mix at discharge.
 - 4. Ability to maintain discharge temperature of mix.
 - 5. Capability of maintaining plus or minus five (5) percent tolerance on component percentages in final mix.
 - 6. Oil Sand Introduction System: **Do not burn off the light oils in the Oil Sand Bitumen Binder.**

3.2 INSTALLATION

- A. Paving, Section 32 12 16.13.
- B. Patches, Section 33 05 25.

END OF SECTION

SECTION 32 12 16.13
PLANT MIX BITUMINOUS PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Place a bituminous concrete mix in a base course, leveling course, surface course, overlay course, or an inlay course.
- B. Refer to Section 33 05 25 for pavement patch restorations.

1.2 REFERENCES

A. AASHTO Standards:

- R9 Acceptance Sampling Plans for Highway Construction.
- TP68 Bulk Specific Gravity and Density of Compacted Asphalt Mixtures Using Automatic Vacuum Sealing Method.
- T324 Hamburg Wheel-Track Testing of Compacted Hot-Mix Asphalt (HMA).

B. ASTM Standards:

- D979 Sampling Bituminous Paving Mixtures.
- D1188 Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples.
- D2041 Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures.
- D2725 Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
- D2950 Density of Bituminous Concrete In Place by Nuclear Method.
- D3549 Thickness or Height of Compacted Bituminous Paving Mixture Specimens.
- D3665 Random Sampling of Construction Materials.
- D5361 Sampling Compacted Bituminous Mixtures for Laboratory Testing.
- D6927 Marshall Stability and flow of Bituminous Mixtures.

1.3 SUBMITTALS

A. Before Delivery: Submit 48 hours before delivery:

- 1. Location and name of bituminous concrete production facility.
- 2. Mix design method.
- 3. Mix identification number or code.
- 4. Type, grade, and weight of binder.
- 5. Type, grade, and weight of aggregate.
- 6. Traffic control plan, Section 01 55 26.
- 7. Type and number of rollers.
- 8. Manufacturer's certificate of compliance for paving geotextiles. (Refer to Section 31 05 19).
- 9. Certification of profilograph and profilograph operator.

10. Cold weather paving plan.
- B. **At Delivery:** For each batch delivered to site identify:
 1. Date and project description.
 2. Producer and plant.
 3. Name of contractor.
 4. Serial number of ticket.
 5. Mix identification number or code.
 6. Truck number and time dispatched.
 7. Volume of mix delivered.
- C. **After Placement:** Submit:
 1. Profile deviation report.
 2. Profile roughness index report.

1.4 **QUALITY ASSURANCE**

- A. Do not change aggregate source or binder grade until ENGINEER accepts new source or new mix design.
- B. Reject product and work that does not meet requirements of this Section.
- C. Remove product found defective after installation and install acceptable product at no additional cost to OWNER.
- D. Foreman of paving crew has completed at least three (3) projects of similar size and nature.
- E. If requested, submit a quality control and testing report describing source and field quality assurance activities performed by CONTRACTOR and Suppliers.
- F. Use a release agent that does not dissolve asphalt and is acceptable to the ENGINEER for all equipment and hand tools used to mix, haul, and place the bituminous concrete.

1.5 **WEATHER**

- A. Temperature:
 1. **April 15 to October 15:** Place when air temperature in the shade and the roadway surface temperature are above 50 deg F. The ENGINEER determines and provides written approval if it is acceptable to place outside these limits.
 2. **Before April 15 and After October 15:** Provide a Cold Weather Paving Plan. ENGINEER must accept the plan before proceeding. Include the following details.
 - a. Haul details.
 - b. Placement details.
 - c. Compaction aids used in production.
 - d. Coordination procedure for acceptance testing.
- B. Moisture:
 1. Do not place on frozen base or during adverse climatic conditions such as precipitation or when roadway surface is wet or icy.

1.6 **NOTICE**

- A. Follow Laws and Regulations concerning when and to whom notices are to be given. Send written notice at least three (3) days before start of paving.

- B. Indicate paving time and when new surface can be used.
- C. Warn of potential vehicle tow away and other construction issues affecting neighborhood.
- D. Should work not occur on specified day, send a new notice.

1.7 ACCEPTANCE

- A. General:
 - 1. Acceptance is by Lot.
 - 2. If non-complying material has been installed and no price for the material is specified, apply pay adjustment against cost of work requiring complying material as part of its installation, Section 01 29 00.
 - 3. Dispute resolution, Section 01 35 10.
 - 4. Opening a paved surface to traffic does not constitute acceptance.
 - 5. Observation of CONTRACTOR’s field quality control testing does not constitute acceptance. Such testing; however, may be used by ENGINEER for acceptance if requirements of Section 01 35 10 are met.
- B. Mix Material: Accepted as specified for bituminous concrete, Section 32 12 05, or rubberized asphalt concrete, Section 32 12 08.
- C. Mix Temperature at Site:
 - 1. Reject mixes in the transport material exceeding the following temperatures.
 - a. Hot mix, 425 deg F.
 - b. Warm mix, 300 deg F.
 - c. Oil sand bituminous concrete, 230 deg F.
 - 2. Dispose of cold mix in paver hopper as thin spread underlay.
- D. Grade, Cross Slope: Verify tolerances are not exceeded.
- E. Compaction: Options for acceptance are (1) core density, (2) non-destructive test density, or (3) control strip density with visual observation. Use core density unless specified elsewhere. A Lot is acceptable if density tests are within pay factor 1.00 limits. At ENGINEER’s discretion, a Lot with deficient sub-lot density tests may be accepted if pay is adjusted using an applicable pay factor in the following table, or accepted at 50 percent pay if a sub-lot is in Reject.

Table 1 – Compaction Pay Factors		
Pay Factor	Density, in Percent Relative to ASTM D2041	
	Average	Lowest Test
0.70	More than 96	–
1.00	92 to 96	89 or greater
0.90	92 to 96	Less than 89
0.80	Less than 92	89 or greater
Reject	Less than 92	Less than 89

1. **Core Density:** This method compares the average density of cores extracted from a pavement surface to maximum theoretical density:
 - a. Lot Size: One (1) day production with 1,000 square yard sub-lots or part thereof.
 - b. Sampling Protocol: Use ASTM D3665 to randomly select in each sub-lot at least one (1) surface test location and one (1) longitudinal joint test location. Collect at least two (2) test samples at each test location, ASTM D5361. Samples are full depth or overlay depth in overlay construction.
 - c. Testing Protocol: ASTM D2725 for core density and ASTM D2041 (Rice) for maximum theoretical density.
 2. **Non-Destructive Density Testing by Gage:**
 - a. Lot Size: One (1) day production with 1,000 square yard sub-lots or part thereof.
 - b. Sampling Protocol: Use ASTM D3665 to randomly select in each sub-lot at least one (1) surface test location and one (1) longitudinal joint test location.
 - c. Testing Protocol: ASTM D2950 (nuclear gage) or AASHTO TP 68 (non-nuclear gage) and ASTM D2041 (Rice) for maximum theoretical density.
 3. **Control Strip Density with Visual Observation:**
 - a. Lot: One (1) day production.
 - b. Sampling Protocol: Not required after rolling pattern is determined.
 - c. Testing Protocol: ASTM D6927 (Marshall) and D2041 (Rice method) to determine rolling pattern for 94 percent compaction, thereafter visual examination.
 4. **Compaction Dispute Resolution:**
 - a. CONTRACTOR:
 - 1) Provide an Independent Testing Agency, [Section 01 45 00](#).
 - 2) Take two (2) supplement cores midway between deficient acceptance test locations, and midway between a deficient test location and an adjacent acceptable test location.
 - 3) Patch core holes.
 - 4) Conduct testing at no additional cost to OWNER.
 - b. ENGINEER:
 - 1) Accept Lot at full pay if new information shows compliance, or
 - 2) Accept Lot at pay reduction using new test information, or
 - 3) Reject Lot.
- F. Thickness: A Lot is acceptable if test deficiencies are within pay factor 1.00 limits. At ENGINEER's discretion, a Lot with sub-lot deficiencies greater than allowed for pay factor 1 in the following table may be accepted if pay is adjusted using one of the following applicable pay factors, or accepted at 50 percent pay if a sub-lot is in Reject.

Table 2 – Thickness Pay Factor	
Pay Factors	Deficiency Limits, in Inches
1.00	0.00 to 0.375
0.90	0.376 to 0.50
0.70	0.51 to 0.75
Reject	0.76 to 1.00

1. Lot Size: One (1) day production with 1,000 square yard sub-lots or part thereof.
 2. Sampling Protocol: Use ASTM D3665 to randomly select at least one surface test location and one longitudinal joint test location in each sub-lot. Collect at least two (2) core samples at each test location, ASTM D5361. Samples are full depth. Overlay construction measured only on overlay portion of core sample.
 3. Testing Protocol: ASTM D3549:
 - a. Minimum Specified Thickness: A Lot specified to have minimum thickness will be accepted if all sub-lot measurements meet or exceed minimum. If thickness is deficient, additional material may be placed over the deficient thickness if there is no pavement feathering; placement matches this section's thickness tolerance; surface continues to drain; and roughness tolerance is met.
 - b. Actual Specified Thickness: A Lot specified to have actual thickness is acceptable if any sub-lot measurement does not exceed deficiency limits for thickness pay factor 1.00.
 4. Thickness Dispute Resolution:
 - a. CONTRACTOR:
 - 1) Hire an Independent Testing Agency, Section 01 45 00.
 - 2) Take two (2) additional cores midway between deficient acceptance test locations, and midway between a deficient test location and the next adjacent acceptable test location.
 - 3) Patch core holes.
 - 4) Conduct testing at no additional cost to OWNER.
 - b. ENGINEER:
 - 1) Graph deficient areas by plotting new cores and original cores to define deficient areas assuming the following.
 - a) The graph represents the thickness of the pavement.
 - b) Thicknesses vary linearly along the pavement length from core depth to core depth.
 - c) The pavement is a constant depth in the transverse direction.
 - 2) Accept Lot at full pay if new information shows compliance, or
 - 3) Accept Lot at pay reduction using new test information, or
 - 4) Reject Lot.
- G. Profile Roughness and Profile Deviation: Verify tolerances of Section 32 01 31 are not

exceeded.

1.8 WARRANTY

- A. Joints at Street Fixtures and Portland Cement Concrete Flat Work: If wider than 1/2 inch before end of one year correction period seal joints with asphalt rubber or rubberized asphalt; Section 32 01 17.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Bituminous concrete, Section 32 12 05.
- B. Rubberized asphalt concrete, Section 32 12 08.
- C. Tack coat, Section 32 12 13.13.
- D. Prime coat, Section 32 12 13.19.
- E. Paving geotextile, Section 31 05 19.
- F. Paving geogrid, Section 31 05 21.

PART 3 EXECUTION

3.1 CONSTRUCTION EQUIPMENT

- A. Paver Machine: Use track equipment when operating on fabrics, geogrids or pavement mats hotter than 180 deg F
- B. Compactors: Steel wheel static or vibratory. Use pneumatic tire roller for intermediate rolling only.

3.2 PREPARATION

- A. General:
 - 1. Locate and preserve utilities, Section 31 23 16. **Contact utility companies and other agencies, for dangerous concentration of combustible, flammable, or explosive matter.**
 - 2. Lower Street Fixtures if paving machine is not capable of passing over the fixtures.
 - 3. Remove vegetation from cracks, edges and joints. Sweep surface clean. Blow cracks clean. Remove leaves.
 - 4. Fill cracks and fix potholes, Section 32 01 17.
 - 5. Stabilize Portland cement concrete subgrade slabs.
- B. Traffic Control:
 - 1. Implement notification and traffic control plan requirements, Section 01 55 26. Do not proceed without certified flaggers.
 - 2. Apply temporary lane marking tape or paint after layout has been verified with ENGINEER.
- C. Aggregate Base Course:
 - 1. Verify base course is placed to grade, compacted and dampened.

2. If indicated, follow Section 31 31 19 requirements for herbicide treatment or Section 32 12 13.19 for prime coat application.

3.3 PROTECTION

- A. Trees, Plants, Ground Cover:
 1. Protect trees, plants and other ground cover from damage.
 2. Prune trees to allow equipment passage underneath, Section 32 01 93. Repair tree damage at no additional cost to OWNER.
- B. Protect all structures, including curb, gutter, sidewalks, guard rails and guide posts from physical damage. Remove spatter, over-coat, or mar.
- C. Do not discharge bituminous materials into borrow pits or gutters.
- D. Protect hot pavement from traffic until cool enough not to become marred.
- E. Remove saw-cut dust immediately. Protect neighborhood, storm drains and down-stream fish habitat.

3.4 TEMPORARY SURFACING

- A. Place, roll, maintain, remove and dispose of temporary pavement surfaces.
- B. In sidewalk areas construct temporary pavements at least 1 inch thick and in all other areas at least two (2) inches thick. At major intersections and other critical locations a greater thickness may be required.

3.5 LINE AND GRADE CONTROL

- A. Provide necessary survey stakes for horizontal and vertical control.
- B. Furnish, place, and maintain supports, wire devices, and materials as required to provide continuous line and grade reference controls for placing pavement, matching existing pavement surfaces, etc.

3.6 FABRIC PLACEMENT

- A. Section 31 05 19.

3.7 PAVEMENT PLACEMENT

- A. General:
 1. Barricade or eliminate fall off edges.
 2. Repair ride disturbing or unsafe butt joints.
 3. Provide continuous forward paver movement so temperature 10 feet behind paver is as follows:
 - a. Warm Mix Placement: 200 deg F minimum.

b. Hot Mix Placement:

Table 3 – Minimum Pavement Temperature in Degrees F.						
Air Temperature Deg F.	Compacted Mat Thickness					
	3/4"	1"	1-1/2"	2"	3"	4"+
45 – 50	–	–	–	–	280	265
50 - 59	–	–	–	280	270	255
60 - 69	–	–	285	275	265	250
70 - 79	285	285	280	270	265	250
80 - 89	280	275	270	265	260	250
90 +	275	270	265	260	250	250

2. Do not leave unsafe butt joints if paving operation stops.
 3. Barricade or eliminate fall off edges.
- B. Overlays or Subsequent Lifts:
1. Allow new base pavement or new inlay pavement to cure (harden) before placing overlays.
 2. Apply tack coat per Section 32 12 13.13 if inlay or sub-base Pavement surface is dirty or older than 24 hours.
- C. Irregular Areas: Handwork is acceptable if specified grade, slope, compaction and smoothness are achieved.
- D. Compaction:
1. Test mix placement until a compaction pattern is acceptable to CONTRACTOR. Continue random quality control testing.
 2. Do not over compact or under compact.
 3. Complete compaction before the following temperature are reached:
 - a. 180 deg F for hot mixes.
 - b. 140 deg F for warm mixes.
- E. Joints:
1. Construct joints to industry standards for texture, density and smoothness.
 2. Clean contact surfaces and apply tack coat. Ensure continuous bond between old and new pavements, or between successive day's work.
 3. Offset longitudinal joints a minimum of 12 inches in succeeding courses and at least six (6) feet transversely to avoid a vertical joint through more than one course. In the top course restrict longitudinal joint to 1 foot either side of lane lines.
 4. Prevent traffic, including construction traffic, from crossing vertical edges. Apply tack coat to vertical edges before making another pass with paver if mix has cooled to 90 deg F
- F. Pavement Smoothness: Meet Section 32 01 31 smoothness requirements.

3.8 TOLERANCES

- A. Compaction: Target is 94 percent of ASTM D2041 (Rice density) plus or minus two (2) percent.
- B. Lift Thickness: If not indicated, meet the following lift thickness tolerance.

Table 4 – Lift Thickness Tolerance		
Mix Design Method	Minimum	Maximum
Marshall	2 times maximum aggregate size	Not more than limits established by manufacturer of compactor equipment
Performance Grade (Superpave)	4 times nominal aggregate size	
NOTES (a) Thickness is measured after compaction.		

- C. Longitudinal Grade: 1/8 inch in 10 feet parallel to centerline.
- D. Cross Slope: 1/4 inch in 10 feet perpendicular to crown line except at cross section grade breaks.
- E. Roughness: Tolerances are indicated in Section 32 01 31.

3.9 REPAIR

- A. All expenses are at no additional cost to OWNER.
- B. If pavement smoothness is deficient follow Section 32 01 31 repair requirements.
- C. When thickness is deficient, place additional material over deficient areas. DO NOT skin patch. Mill for inlay if necessary.
- D. Defective Joints, Seams, Edges: Repair.
- E. Unacceptable Paving: Remove and replace.

3.10 OPENING TO TRAFFIC

- A. Temperature of pavement surface not more than 180 deg F

END OF SECTION