

APPENDICES

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APPENDIX 1.17
ENVIRONMENTAL MANAGEMENT
AND MONITORING PLAN (EMMP)

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APPENDIX 1.17: ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN (EMMP)

The schedule below is to be used by the Contractor and by the Engineer in accordance sub clause 1.17.1.1 and 1.17.4 of the Environmental Safeguards.

The Contractor should complete Columns 2 and 3 before the Pre-Construction meeting. The contents of column 2 and 3 will then be discussed and agreed. The Engineer should complete on a monthly basis Columns 4, 5, 6 and 7. If there are no environmental failures or activities in any sub clause this should be listed as *nothing to report*. For column 4, 5, and 6 any report should be backed up by documentary proof of activity. The Engineer should submit to the contractor for his immediate action where necessary.

1. ENVIRONMENTAL ACTIVITY	CONTRACTOR TO COMPLETE		ENGINEER TO COMPLETE			7. REVIEWED BY ENGINEER (SIGN)
	2. TARGET FOR THE ACTIVITY	3. POTENTIAL LOCATION OF ACTIVITY	4. DEFINE MONITORING ACTIVITIES	5. ENVIRONMENT ISSUE	6. ACTIVITY CARRIED OUT TO RECTIFY ENV ISSUE	
Clause as referred to in section 1.17 Environmental Safeguards	Define target and timeframe for the activity	Tick appropriate location: Worksite (state location) AMP etc area Base Camp Haul Routes Quarry, fill sources Outside	List all environmental monitoring activities carried out (site visits, surveys, measurements etc).	List all adverse environmental activities or environmental failures that have occurred in connection with sub clause	List the activity that has been carried out to ensure that the issue has been rectified	
1.17.2.1 IMPACTS ON WATER RESOURCES						
(a) The Contractor shall ensure that polluting effluent from all of the Contractor’s activities shall not exceed the values stated in the prescribed applicable Laws (Refer specifically to Government Regulation (Peraturan Pemerintah) No.82 Year 2001 regarding Water Quality Management and Water Pollution Control).		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(b) Natural streams or channels within or adjacent to the works of this Contract shall not be disturbed without the approval of the Engineer.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(c) If any excavation or dredging in the stream bed that is unavoidable for the proper execution of the works, the Contractor shall, after the works are constructed, backfill all such excavations to the original ground surface or stream bed with material approved by the Engineer.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(d) Material deposited within the stream area from		Worksite				

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foundation or other excavations, or from the placing of cofferdams, shall be removed completely following construction.		AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(e) All waterways shall be relocated to ensure unrestricted flow past the works at all usual levels of flood, where embankment stabilization or other permanent works will unavoidably block, or partially block, any existing waterway.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(f) All excavation shall be maintained free of water and the Contractor shall provide all necessary materials, equipment and labor for diverting waterways and the construction of temporary drains, cut off walls and cofferdams.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(g) Excavation for borrow materials shall be prohibited or restricted where they might interfere with all drainage channels		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(h) Any damaging liquid or solid contaminant, such as hydraulic or lubricating oils, dropped or spilled upon any portion of the site work and adjacent environment, base camp, or haul route shall be cleaned up immediately by the Contractor in order to avoid contamination of water and soil. The Engineer must approve the completion of the clean up.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(i) Adequate means of trapping silt at the mixing plants shall be provided through temporary systems discharging		Worksite AMP etc area				

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into permanent drainage systems.		Base Camp Haul Routes Quarry, fill sources Outside				
(j) Washing of contractor's vehicles and equipment shall only be permitted in specially designated and equipped areas and shall not be permitted in any existing water courses.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
1.17.2.2 IMPACTS ON AIR QUALITY						
(a) The Contractor shall ensure that emissions from all the Contractor's activities including transportation activities are kept to an absolute minimum through of modern equipment and through good management and maintenance, and any emissions shall not exceed the values stated in the applicable Laws (Refer specifically to Government Regulation (Peraturan Pemerintah) No.41 Year 1999 regarding Air Pollution Control).		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(b) The asphalt mixing plant, stone crusher and any other static construction equipment shall be installed in area as distant as possible from housing and other sensitive areas to ensure minimal disturbance and complaint from any member of the local community. The location shall be approved by the Engineer.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(c) The asphalt mixing plant (AMP) shall be provided with a complete dust collector, i.e. dry cyclone and wet cyclone or filter tube system to ensure no air pollution in the atmosphere. If either of these systems is damaged or not functioning the equipment shall not be operated.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				

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(d) Trucks shall be sealed and all covers shall be securely fastened.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(e) The Contractor shall maintain at the work site adequate supplies of water for moisture control during all placing and compacting operations, and shall also remove excess material from all existing roadways		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
1.17.2.3 IMPACTS ON NOISE ENVIRONMENT						
The Contractor shall take all necessary precautions to minimize the amount of noise and vibrations coming from construction and transportation activities, by all vehicles and equipment, through the use of modern vehicles and equipment and through good management and maintenance. The contractor shall ensure that all noise and vibration levels from all the Contractors Activities are in accordance with the applicable Laws. (Refer specifically to Decree of Minister of Environment No.48 Year 1996 regarding Noise Level Standard and Decree of Minister of Environment No 49 year 1996 regarding Level of Vibration.)		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
1.17.2.4 IMPACTS ON TRAFFIC, ADJOINING PROPERTIES AND UTILITIES						
(a) The provision given in Section 1.8, regarding Traffic Management and Safety shall apply.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				

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(b) Trenching or other excavation across the roadway shall be carried out using half width construction so that the road is maintained open to traffic at all times.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(c) The Contractor shall be responsible for all the consequences of traffic and shall prohibit such traffic when necessary by the provision of a detour or by half width construction.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(d) All the works shall be carried out with the least inconvenience to traffic and at least one traffic lane must be kept open at all times.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(e) At all times during the performance of the Works, the Contractor shall ensure that the pavement, shoulders and adjacent areas within the right-of-way shall be maintained free of construction material, debris or other such loose objects that may obstruct or endanger the free and safe passage of traffic. The Works shall also be maintained free of any unauthorized parking or street trading activity except in areas designated for such purposes.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(f) The Contractor shall be responsible for obtaining any existing information on the existence and location of existing underground utilities and for obtaining and paying for any necessary permits or other authorization for their diversion or temporary cessation. (Ref: This work shall be carried out in accordance with Section		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				

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1.19)						
(g) The Contractor shall be responsible for the care and protection of any existing serviceable underground piping, cables, conduit, or other subsurface lines or structures that may be encountered and for repairing any damage caused to them by his operations.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(h) All potholes in sealed pavements and holes in the finished Work made by density testing or otherwise shall be reinstated as soon as possible after damaged layers have been cut back, in order to avoid obstruction or hazards to traffic		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(i) At all times during the time for completion the contractor shall maintain vehicular and pedestrian access to all houses, commercial, industrial and all other uses. Temporary accesses must provided where construction will close permanent access for any period of over 6 hours and all affected owners and community members must be notified at least 24 hours in advance of any impact on accesses.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
1.17.2.5 HUMAN HEALTH AND SAFETY						
(a) Provisions given in Particular Conditions sub-clause 6.7. Health and Safety apply.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(b) The Contractor shall: (i) comply with all applicable safety regulations (<i>Refer specifically to Law No. 1 Year 1970 regarding Work Safety and Law No. 12 Year 1999 regarding Fire Safety in work sites</i>); (ii) take care for the		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources				

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safety of all persons entitled to be on the Site; and (iii) provide any Temporary Works (including roadways, footways, guards and fences) which may be necessary, because of the execution of the Works, for the use and protection of the public and of owners and occupiers of adjacent land.		Outside				
(c) The Contractor shall at all times take all reasonable precautions to maintain the health and safety of the Contractor's Personnel and shall appoint an accident prevention officer at the Site, responsible for maintaining safety and protection against accidents.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(d) The Contractor shall at all times take the necessary precautions to protect the Contractor's Personnel employed on the Site from insect and pest nuisance, and to reduce their danger to health.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(e) The provisions given in Article 3.1.1.5, regarding Safety of Excavation Works, shall apply.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(f) All gears, pulleys, chains, sprockets, and other dangerous moving parts of Mixing Plants shall be thoroughly guarded and protected.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(g) Adequate sanitary waste control facilities shall be provided for all project staff and workers and waste shall be collected regularly and disposed of in accordance with		Worksite AMP etc area Base Camp Haul Routes				

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applicable laws. (Refer specifically to Government Regulation (Peraturan Pemerintah) No. 82 Year 2001 regarding Quality Management and Water Pollution Control, and Law No. 1 Year 1970 regarding Work Safety).		Quarry, fill sources Outside				
1.17.2.6 IMPACT ON FLORA AND FAUNA						
(a) The cutting of trees shall be carried out only when absolutely necessary for widening either the carriageway or the shoulders or for the clear zone and will be specifically defined and agreed by all parties during the field investigation. Every tree felled should be replaced by two semi mature trees of the same or similar species. No new tree planting should take place within the clear zone. Tree planting shall be in accordance with Section 8.3 Site Preparation, of the Specifications and in accordance with pay item 8.3.5.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(b) The Contractor shall limit the movement of his employees and equipment within the sensitive environmental areas, such as the National Park, so as to minimize damage to natural vegetation and shall endeavor to avoid any damage to land. Further beneficial cooperation with locally authorized institution shall be undertaken.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
1.17.2.7 IMPACT ON SOIL						
(a) The Contractor shall ensure that pollutant discharge from the Contractor's activities shall not exceed the values stated in the prescribed applicable Laws (Refer specifically to Government Regulation (Peraturan Pemerintah) No. 82 Year 2001 regarding Quality Management and Water Pollution Control).		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(b) In order to avoid land sliding and erosion during		Worksite				

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excavation for borrow materials, the edge of a borrow pit shall be not closer than 2 meters from the toe of the embankment or 10 meters from the top of any cutting.		AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
1.17.2.8 DISPOSAL OF WASTE						
(a) The disposal of all solid and liquid waste from construction activities should only take place i) in accordance with Section 1.5 Transportation and Handling clause 1.5.3.4. as referred to below, and ii) in accordance with requirements and permissions of responsible institution at Province or Kabupaten/Kota.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(b) When any material is to be disposed of outside the Site, the Contractor shall obtain a written permit from the property owner on whose property the disposal is to made, which permit shall designate the disposal location and shall be submitted to the Engineer together with a request for approval to proceed.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(c) When material is disposed of as provided above and the disposal location is visible from a highway, the Contractor shall dispose of the material in a neat and uniform manner to the satisfaction of the Engineer.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
1.17.2.9.IMPACT ON CULTURAL HERITAGE						
See Sub Clause 4.24 GCC on fossils: Extracted as follows: All fossils, coins, articles of value or antiquity, and structures and other remains or items of geological or archaeological interest found on the Site shall be placed under the care and authority of the Employer. The Contractor shall take reasonable precautions to prevent		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				

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Contractor's Personnel or other persons from removing or damaging any of these findings. The Contractor shall, upon discovery of any such finding, promptly give notice to the Engineer, who shall issue instructions for dealing with it						
1.17.2.10 OTHER MATTERS						
(a) For all quarries and other sources of material (whether owned or not owned by the Contractor) the contractor must submit to the Engineer details of the location of the material source in accordance with Section 1.11 Materials and Storage, Clause 1.11.1.3. The contractor must also submit to the Engineer a Haul Route Plan in accordance with Section 1.5 Transport and Handling, Clause 1.5.2.1 defining the routes on which the material will be hauled from the location of materials. The Engineer may require that the relevant local government institutions confirm that the source location and operation, and the haul route operation is undertaken in an Environmental and Socially acceptable manner in accordance with all local and national regulations.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(b) All Quarries used must be licensed and have full legal authorization from the Local government.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(c) The extraction of any construction materials will not be allowed in any National Park or other officially		Worksite AMP etc area				

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protected sensitive area.		Base Camp Haul Routes Quarry, fill sources Outside				
(d) The contractor must ensure that the Base Camp is operated in accordance with good environmental practice and that adverse environmental impacts are kept to an absolute minimum and in accordance with this section, and that the local community is not disturbed by any of the activities of the Base Camp.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(e) In compliance with sustainable development practice, all timber materials for sheet piles, bearing piles, and mini timber piles, shall be purchased from a certified dealer (not from illegal logging). In Provinces where the Surat Keterangan Sahnya Hasil Hutan (SKSHH) (Letter indicating source from legal production forest) operates a certificate of its legal nature be attached to the purchase document for submission to the Engineer.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				
(f) All parts of the Site must be reinstated to its original condition prior to the commencement date of works.		Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside				

ADDITIONAL REQUIREMENTS in CONNECTION WITH INFORMING LOCAL GOVERNMENT

<p>Consultation with Kabupaten, Kepala Desa and other Government institutions: The contractor must ensure he informs appropriate officials at Kabupaten and at local level of the construction program and when activities take place within each area, and when accesses will be blocked and when other activities will take place. (Note: General consultation and socialization should be the responsibility of Kabupaten and other Government Agencies and the contractor should support as necessary)</p>	<p><i>All local officials to be informed of program at least 72 hours before construction commences</i></p>	<p>Worksite AMP etc area Base Camp Haul Routes Quarry, fill sources Outside</p>				
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I certify that this is a true and accurate record of Environmental Monitoring and Mitigation activities during the month of
for Contract No. Contract Name

Signed

Name

Position

Date

Received by Engineer:

Date

Signature

APPENDIX 5.4.A
FIELD PROCEDURE FOR USING
THE SCALA DYNAMIC CONE PENETROMETER
FOR CONSTRUCTION CONTROL OF
SOIL CEMENT BASE

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FIELD PROCEDURE FOR USING THE SCALA DYNAMIC CONE PENETROMETER FOR CONSTRUCTION CONTROL OF SOIL CEMENT BASE

1. Scope

This method describes a very rapid procedure for carrying out an evaluation of the in situ homogeneity, thickness and strength of Soil Cement Base, as required for construction quality control purposes, using the Scale Dynamic Cone Penetrometer. This instrument has been used by the Queensland Main Roads Department (and also by other Australian states) for over 20 years for the evaluation and quality control of road subgrades.

The test gives a continuous record of soil strength to a depth of up to 90 cm below the existing surface without the need to excavate to the depth at which the readings are desired.

The test is performed by recording the number of blows and resultant penetration of a metal cone driven through the soil by a falling weight. Then, by the use of correlation charts, the penetrometer readings are converted to an equivalent C.B.R. value or to an equivalent value of Unconfined Compressive Strength.

2. Apparatus

- (a) Standard dynamic cone penetrometer, (as shown on the Drawings), comprises:
 - (i) 9.07 kg (20 lb) drop weight falling through 50.8 cm (20 inch) on a 16 mm (5/8 in.) diameter shaft to strike an anvil.
 - (ii) 16 mm (5/8 in.) diameter steel rod with hardened steel point of 1.61 sq cm (1/2 sq.in.) are with 30° included angles.
- (b) Builder's extendable tape with positive locking device.
- (c) Standard forms (Refer to Volume 4 Drawings).

3. Procedure

- (a) One person operates the penetrometer, and another person, with the builder's tape, measures and records the amount of penetration with each blow.
- (b) The hammer is used to embed the cone tip until its widest diameter has just entered the pavement. This position is the datum position for the test and the builder's tape is extended and locked with the end of the tape adjacent to the underside of the anvil nut.
- (c) The end of the tape is moved to one side without moving the position on the ground of the tape body, and the penetration test is commenced.
- (d) The penetrometer is driven by blows of the drop hammer. When the material being tested is very hard (penetration less than about 0.2 cm/blow), a series of blows (say 5 or 10) should be given between each penetration reading. For softer material, a reading is taken after each blow.
- (e) Using the builder's tape, a record is kept of the depth in centimetres of the cone tip below the ground surface after each blow or series of blows.
- (f) The penetrometer is withdrawn by upward blows of the hammer on the Stop Nut (refer Drawing 1.10.3 in Volume 4 Drawings).

- (g) Since the upward blows used to remove the instrument can, over a period of time, cause a significant elongation of the steel shaft, the drop distance of the hammer must be checked periodically and the position of the Stop Nut adjustment, if necessary, to maintain the 50.8 cm drop distance.

4. Calculation of Scale Penetration Resistance (SPR) or Penetrability (SPP)

The recorded blow counts and depths can be used to plot a record of the variation with depth of either the ease of penetration of the soil (cm/blow) or the difficulty of penetration of the soil (blow/cm). The former of these measures is termed the Scala Penetrometer Penetrability (SPP) while the latter is termed the Scala Penetration Resistance (SPR), each measure being the inverse of the other, i.e.:

$$SPP = \frac{1}{SPR} \quad \text{or} \quad SPR = \frac{1}{SPP}$$

As the SPR is a measure of the soil strength it is the value referred to when comparing results with other measures of soil strength such as CRB or UCS values. However, during the test it is easier and more accurate to measure the penetration for each blow (cm/blow) than to measure the number of blows for a given penetration (blows/cm), and therefore less possibility of calculation error is involved if the SPP is plotted directly rather than the SPR. The standard forms for recording the test data are therefore provided with a scale, decreasing from left to right, to enable direct plotting of the soil penetrability (cm/blow). The graphed record produced on these forms then indicates increasing soil strength (SPR) from left to right, as is conventional for other measures of soil strength.

5. Calculation of Equivalent C.B.R. or Unconfined Compressive Strength

The graphed penetration test data can indicate the distribution with depth of either C.B.R. or Unconfined Compressive Strength if the relationship between these parameters and penetration blow count is known. To obtain the correct correlation for a particular soil type, penetrometer tests must be carried out at, or immediately adjacent to, locations where soil samples were taken at the time of construction. The results of C.B.R. or Unconfined Compression Tests carried out on these soil samples can then be compared against the penetrometer test results to establish the appropriate correlation. For soil - cement materials, it is important to ensure that the curing conditions of the laboratory C.B.R. or U.C.S. samples follow as closely as possible those occurring in the field and to carry out the penetration tests after the same period of curing that was applied for the laboratory tests.

APPENDIX 6.3

HOT ASPHALTIC MIXTURES

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APPENDIX 6.3.A

Marshall Modification for Large Aggregate (> 1” & < 2”)

Modification Marshall procedure (ASTM D5581) is basically the same as the original method (ASTM D1559 or AASHTO T245) except for these differences that are due to the larger specimen size that used :

- (1) The hammer weights 10.206 kg and has a 14.94 cm flat tamping face. Only a mechanically operated device is used for the same 45.7 cm drop height.
- (2) The specimen has a 15.24 cm diameter by 9.52 cm height.
- (3) The batch weights are typically 4 kg.
- (4) The equipment for compacting and testing (mold and breaking heads) are proportionately larger than normal Marshall to accommodate the larger specimens.
- (5) The mix is placed in the mold in two approximately equal increments, with spading performed after each increment to avoid the honey combing.
- (6) The number of blows needed for the larger specimen is 1.5 times (75 or 112 blows) for traffic more than 500,000 ESA than required of the smaller specimen (50 or 75 blows for traffic less than 500,000 ESA) to obtain equivalent compaction.
- (7) The design criteria should be modified as well. The minimum stability should be 2.25 time and the range of the flow values should 1.5 times from the normal size specimen.
- (8) Similar to the normal procedure, these values should be used to convert the measured stability values to an equivalent values for a specimen with a 9.52 cm thickness, if the actual thickness varies :

Approximate Height (mm)	Specimen Volume (cm ³)	Correlation Ratio
88.9	1608 - 1626	1.12
90.5	1637 - 1665	1.09
92.1	1666 - 1694	1.06
93.7	1695 - 1723	1.03
95.2	1724 - 1752	1.00
96.8	1753 - 1781	0.97
98.4	1782 - 1810	0.95
100.0	1811 - 1839	0.92
101.6	1840 - 1868	0.90

Note :

Important to note that to determine the void in mix at refusal density, it is recommended to use vibratory hammer than Marshall hammer. Crushing aggregate to be smaller fragments may be avoided in the mix.

APPENDIX 6.3.B

Test Procedure for Coarse Aggregate Angularity

(Pennsylvania DoT Test Method No.621 : Determining the Percentage of Crushed Fragments in Gravel)

1) General :

Aggregate properties with an angularity criteria is to ensure internal aggregate friction and resistance to rutting.

Coarse aggregate angularity is defined as the percent by weight of the aggregate particles larger than 4.75 mm (No.4) with one or more fracture face.

A fractured is defined as an angular, rough, or broken surface of an aggregate particles created by crushing, by other artificial means, or by nature.

Angularity criteria has a minimum value and functioned to the traffic level and position from surface of the road pavement.

A face considered fractured only if it has a projected area at least as large as one quarter of the maximum projected area (maximum cross sectional area) of the particle and also has sharp and well-defined edges.

2) Procedure :

- (a) Obtain the sample washed and dried coarse aggregate retained on 4.75 mm sieve (No.4) approximately 500 gram.
- (b) Separate the material on the 4.75 mm and discard all material passing 4.75 mm sieve then weigh (B).
- (c) Determine and collect all the nearest gram the weight of the crushed fragments in the sample obtained above (A).

3) Calculation :

Coarse Aggregate Angularity = $(A / B) \times 100$

Where:

A = weight of crushed fragments.

B = total weight of sample retained on the 4.75 mm sieve.

4) Report :

Report the amount crushed to the nearest percent.

APPENDIX 6.3.C

Test Procedure for Fine Aggregate Angularity

(AASHTO TP-33, ASTM Standard Method of Test C1252, Test Method for Uncompacted Voids Content of Fine Aggregate)
(as Influenced by Particle Shape, surface Texture & Grading)

1) General :

Aggregate properties with an angularity criteria is to ensure internal aggregate friction and resistance to rutting.

Fine aggregate angularity is defined as the percent of air voids present in loosely compacted aggregate that pass the 2.36 mm sieve (No.8).

Fine aggregate angularity is measured on the fine aggregate portion of the blended aggregate by AASHTO T-33, ASTM Standard Method of Test C1252, Test Method for Uncompacted Voids Content of Fine Aggregate (as Influenced by Particle Shape, Surface Texture and Grading)

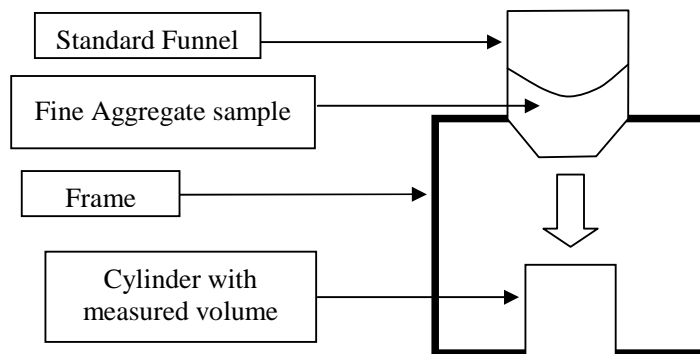
The higher air voids means more fractured faced present in fine aggregate.

2) Procedure :

- (a) Obtain the fine aggregate sample less than 2.36 mm, washed and dried then poured into small measured and calibrated volume of cylinder (V) passes standard funnel lied on the frame and definite distance.
- (b) Calculate and weigh fine aggregate (W) that filled measured volume of cylinder.
- (c) Measured Bulk Specific Gravity of fine aggregate (Gsb)
- (d) Calculate volume of fine aggregate using Bulk Specific Gravity of fine aggregate (W/Gsb).

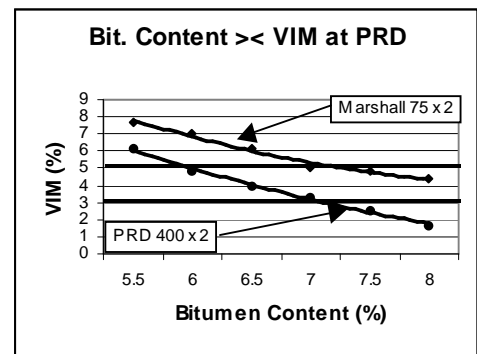
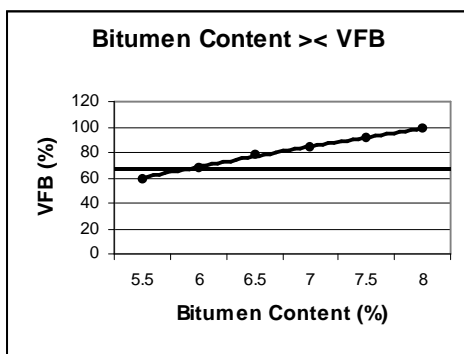
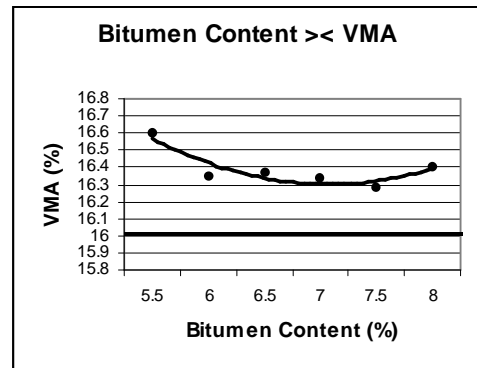
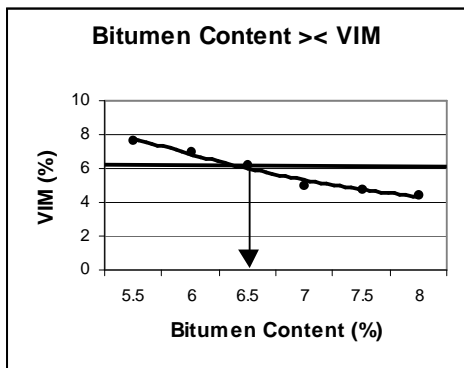
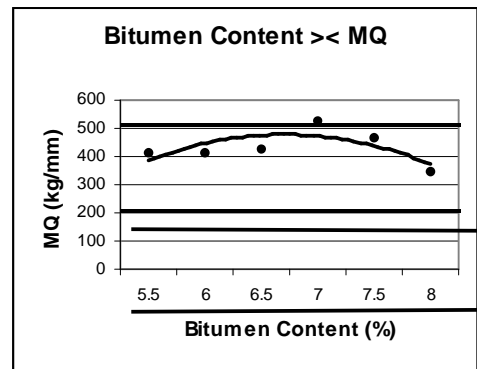
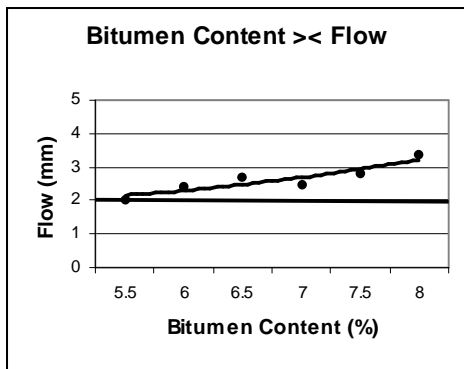
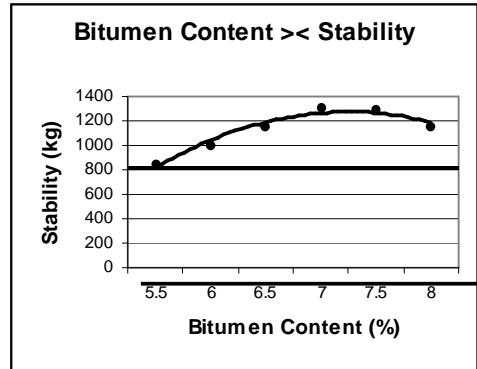
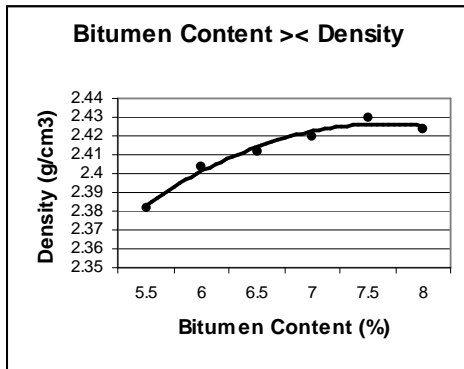
3) Calculation :

Calculate air voids content using the following formula :
$$\frac{V - (W/Gsb)}{V} \times 100\%$$



APPENDIX 6.3.D

Example Plot of Marshall Data



APPENDIX 6.3.E

Example Bar Chart for Presentation of Mix Design Data and Selection of Design Bitumen Content (AC-WC example)

Good Practice to limit to 75 to 80%.
See MS2 Table 5.2.
This is not specification requirement

Good practice to avoid “wet” or increasing side of VMA curve.
See MS2, Sixth Edition, page 71.
This is not a Specified

Mix Characteristics	Range of Total Bitumen Content Meeting the Specification																			
	4				5				6				7				8			
Voids in Mineral Aggregate(VMA)									=	=	=	=	=	=	=	=				
Voids Filled Bitumen (VFB)													=	=	=	=				
Marshall Stability									=	=	=	=	=	=	=	=				
Marshall Flow									=	=	=	=	=	=	=	=				
Marshall Quotient									=	=	=	=	=	=	=	=				
Retained Stability									=	=	=	=	=	=	=	=				
Voids in Mix and Void in Mix at Refusal													=	=	=	=				
Range satisfying all parametres													=	=	=	=				

Optimum bitumen content 6.75% but the bitumen content range is too narrow and the bitumen content is too high. The designer should try to lower the optimum bitumen content and widen the conforming bitumen content range. A grading with VMA close to 16 needs to be found

APPENDIX 6.3.F

Summary of AASHTO T283-89

Resistance of Compacted Bituminous Mixture to Moisture Induced Damage

Purpose	To identify mixes subject to water damage and to aid design of mixes with maximum resistance to water damage.
Equipment	Marshall machine (T245), vacuum pump (ASTM 2041), loading strips (new item see p 1030 Article 5.11)
Specimen Preparation	Mixes are cured for 16 hours at 60 °C before compaction. Sample size and compaction is same as Marshall. Specimens are compacted to 7% +/- 1% voids by adjusting the number of blows using trial samples to get the correct number of blow for 7% voids. 3 control and 3 test specimens are prepared for each mix type.
Preconditioning of Test Specimens	
	Control Set wrapped in plastic and stored
	Preconditioning Set saturate specimen to 55 to 80% of air voids saturated with water using a Vacuum pump. Place set in water at 60 °C for 24 hours Do not use freeze thaw cycle
Testing of Sets	Determine Indirect Tensile Strengths at 25 °C using Marshall machine, specimen is placed on its side in loading frame between loading strips. Note maximum compressive strength.
Result	Percentage of preconditioned sample strength to control sample strength. A minimum of 80% Index of Retained Strength is normally required.

APPENDIX 6.3.G

AC – WC Mixture Gradation and Control Point Example

