Обмен опытом –

Контроль качества на проекте по строительству дорог в Катаре

Design & Construct New Orbital Highway & Truck Route (P023)
Contract 2: Orbital Highway; Salwa Road to North Relief Road

Содержание

- **о стране**
- **о проекте**
- **о дорожной конструкции**
- **о системе качества**
- **об асфальтобетонной смеси (требования и испытания)**
- **о дороге с асфальтобетонным покрытием (требования и испытания)**

О стране

Санкт-Петербург: площадь 1 439 км²
население 5 222 347 чел.

Катар

Страна в Азии

Государство на Ближнем Востоке, расположенное на Катарском полуострове в северо-восточной части Аравийского полуострова. Граничит с Саудовской Аравией на юге, со всех остальных сторон омывается Персидским заливом. На северо-западе имеет морскую [...]

Площадь: 11 586 км²

Население: 2 168 673 чел.

Столица: Доха

Телефонный код: 974

Язык: Арабский язык

Главы: Тамим бин Хамад Аль Тани (Эмир), Абдулла бин Нассер бин Халифа Аль Тани (Премьер-министр)

О стране

Месяц	1	2	3	4	5	6	7	8	9	10	11	12
Макс. темп. [°C]	21.8	23.4	27.1	32.9	39.1	41.7	42.1	41.1	38.7	35.4	29.7	24.5
Сред. темп. [°C]	17.8	19.1	19.1	22.3	33	35.4	36.5	35.9	33.6	30.4	25.4	20.5
Мин. темп [°C]	13.8	14.8	17.4	21.9	26.8	29	30.8	30.6	28.5	25.4	21	16.4
Дождливые дни	5	3	5	3	1	0	0	0	0	0	2	3
Количество атмосферных осадков [мм]	14	5	10	2	4	0	0	3	4	1	11	11
Солнечных часов [ч/сут]	7	6	9	8	12	12	12	12	10	10	8	7
Влажность [%]	58	55	48	45	39	37	42	48	48	51	56	60

Источник: www.klimatabelle.info

Катар находится в засушливом регионе

- годовое количество осадков от 20 мм/г до свыше 300 мм/г
- отдельные штормы 124 мм/сут и 54 мм/3 часа

О стране

О проекте

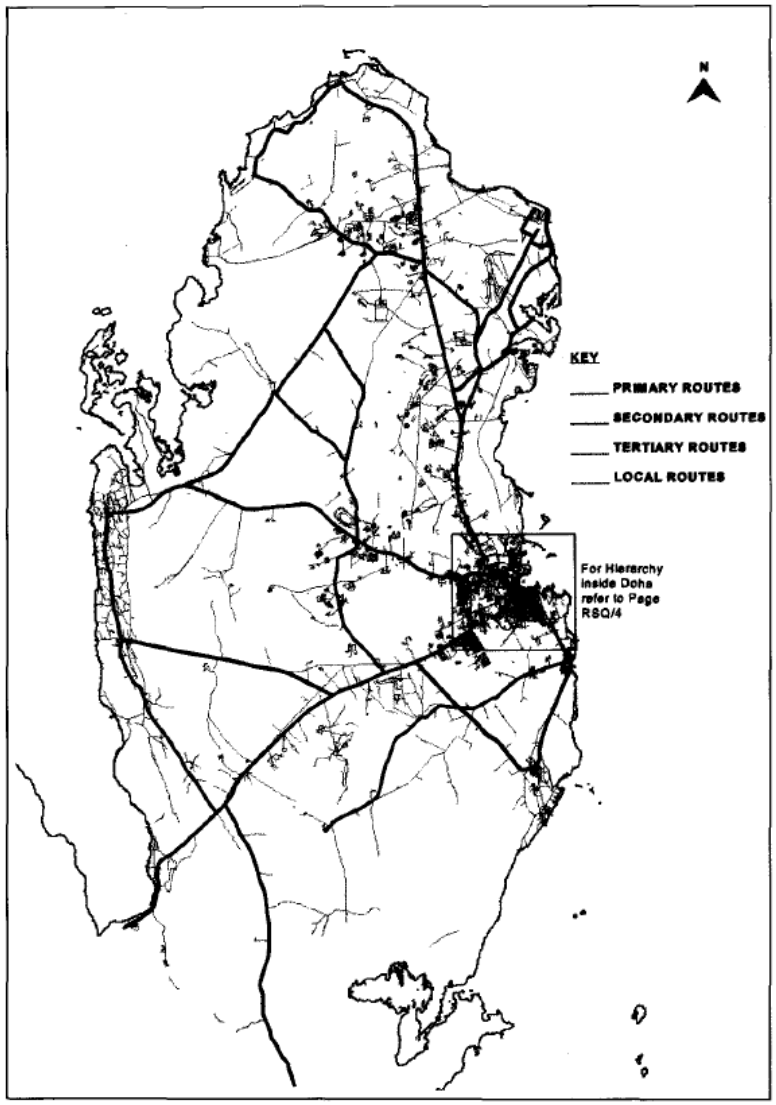
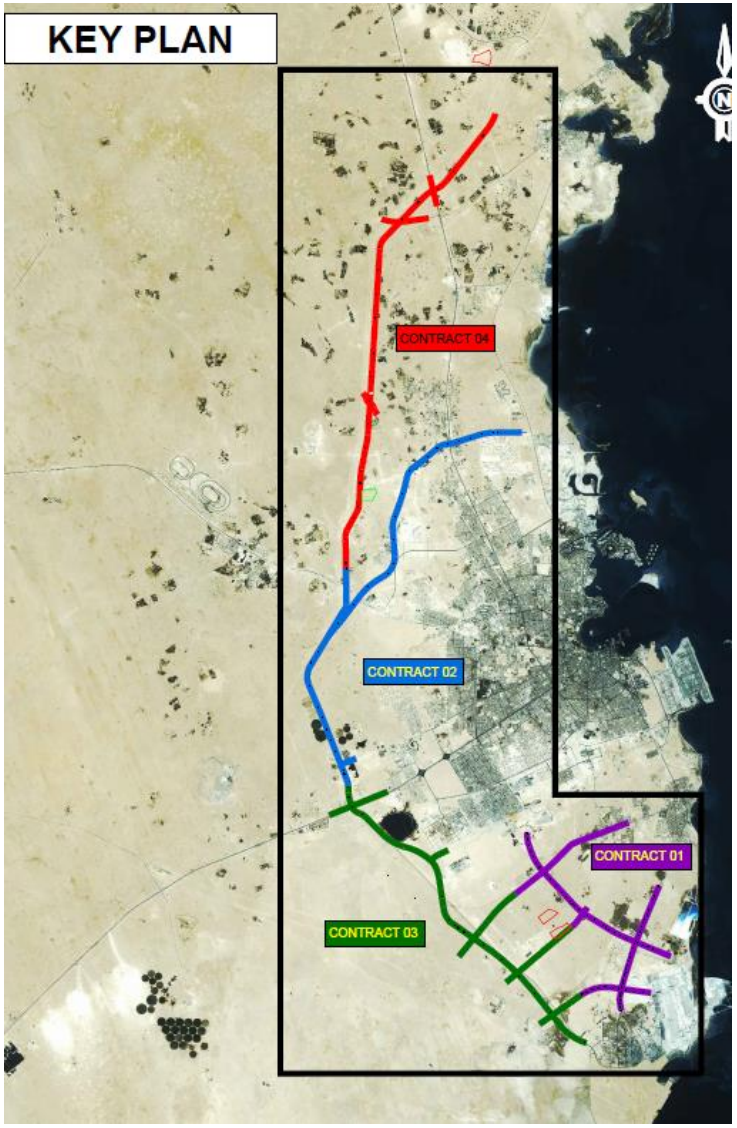
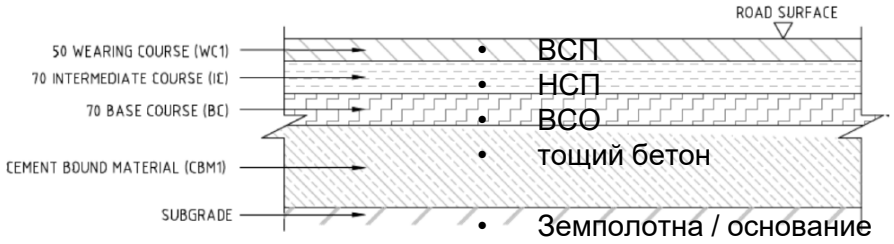


Figure 1 Road Hierarchy - State of Qatar



Design & Build Contract –
Схема проектирование-строительство

- Длина: 47 км – 2 x 5 полос для легковых автомобилей и 2 x 2 для грузовиков
- 3 400 000 m² верхний слой асфальтобетонного покрытия (включая все развязки)
- 8 развязок
- 6 путепроводов и 17 мостов



О дорожной конструкции

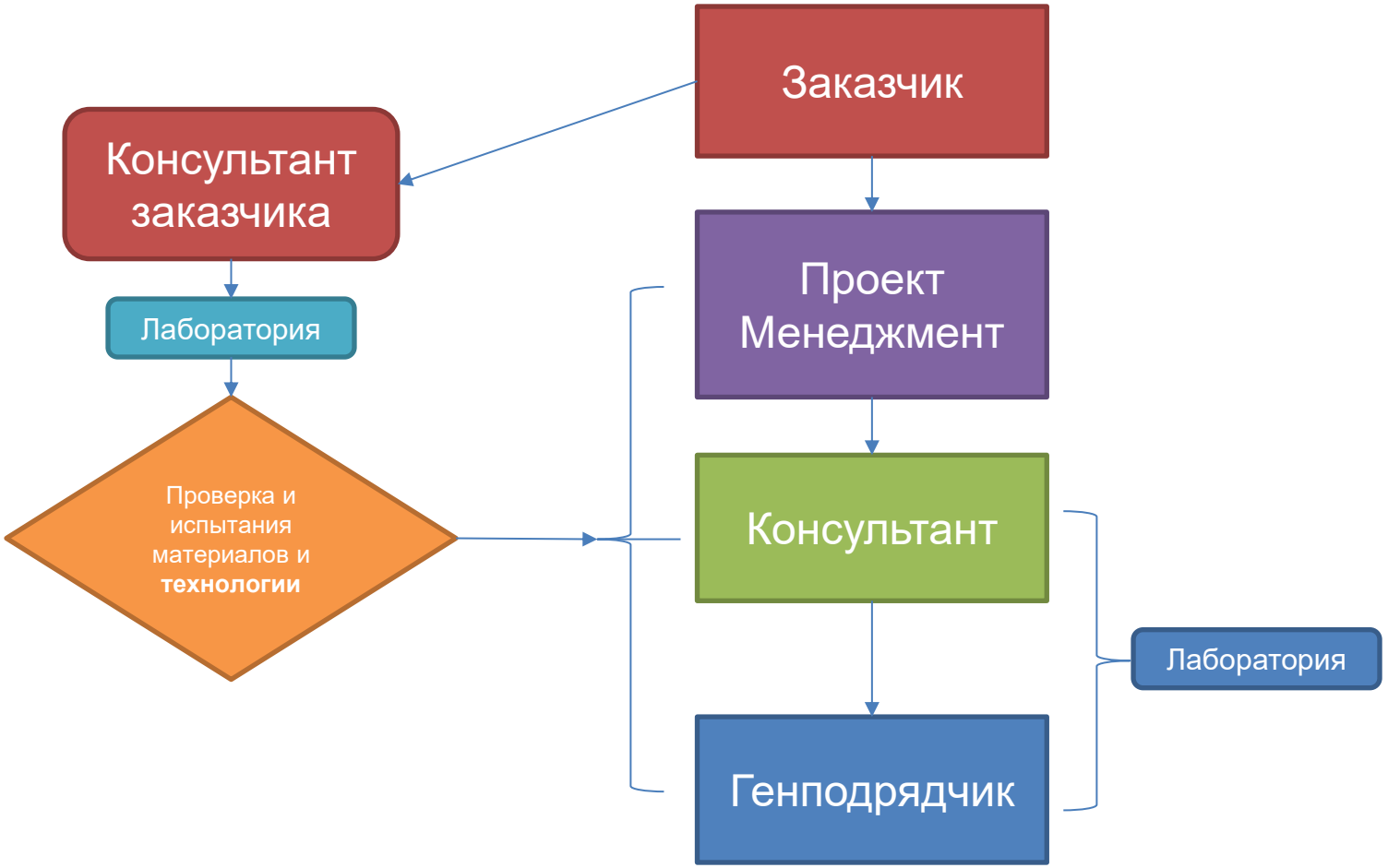
Traffic Category	Layer	Material	Design Layer Thickness (mm)
1 (15mESAL@40kph@97% Reliability Level)	Pavement Option		B1
	Wearing Course	Wearing Course - 19mm aggregate. (PMB PG76-10)	50
	Intermediate Binder Course	Intermediate Course - 19mm aggregate. (PMB PG76-10)	70
	Asphalt Base Course	Asphalt Base Course - ACP 25mm aggregate **PEN 60/70**	70
	Cement Treated Base	Cement Bound Material, Min CS 4.5MPa @ 7 Days (CBM1)	190
	Total		380

23 71@100kph@97% Reliability Level)	Pavement Option		B8
	Wearing Course	Wearing Course - 19mm aggregate. (PMB PG76-10)	50
	Intermediate Binder Course	Intermediate Course - 19mm aggregate. (PMB PG76-10)	70
	Asphalt Base Course	Asphalt Base Course - ACP 25mm aggregate **PEN 60/70**	70
	Cement Treated Base	Cement Bound Material, Min CS 4.5MPa @ 7 Days (CBM1)	270
	Total		460

- Срок службы 20 лет
- Осевая нагрузка, передаваемая через ось транспортного средства 8,2 т (в Германии 10 т, во Франции 13 т)
- Расчет по эмпирической, механистической методике (CIRCLY), AASHTO и Руководство по Катар Автомагистрали (QHDM)
- Доступный битум PEN 60/70 и PMB PG 76-10

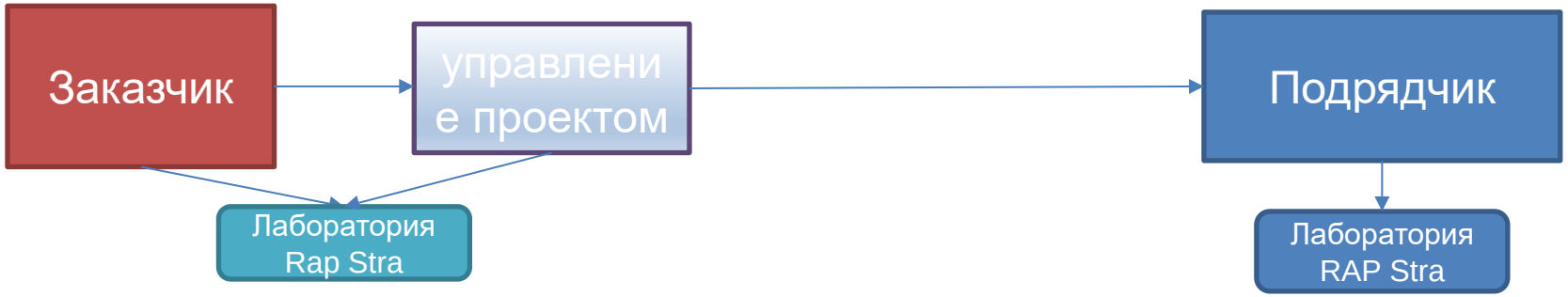
- Binder Grade Standard Designation “S” in most typical situations will be for Traffic Levels fewer than 10mESAL and more than the standard traffic speed (>70kph);
- Binder Grade Standard Designation “H” in most situations will be for traffic levels of 10 to 30mESAL or slow moving traffic (20 to 70Kph);
- Binder Grade Standard Designation “V” in in most situations will be for traffic levels of greater than 30mESAL or standing traffic (<20kph);
- Binder Grade Standard Designation “E” in in most situations will be for traffic levels of greater than 30mESAL and standing traffic (<20kph) such as toll plaza or port facilities.

О системе качества



О системе качества

Для сравнения: система контроля качества в Германии



Контрольные испытания
проводит заказчик

Собственные испытания – это испытания, которые проводит подрядчик или уполномоченное им лицо

Дополнительные контрольные испытания

Если предполагается, что результат одного контрольного испытания не отражает состояния всей площади, которую он представляет, то заказчик имеет право потребовать проведения дополнительных контрольных испытаний.

Независимые испытания

Независимое испытание – это повторение контрольного испытания, в надлежащем проведении которого у заказчика или подрядчика возникли обоснованные сомнения (например, на основе собственного исследования).

О системе качества

- Что проверит консультант заказчика?
  - АБЗ и оборудования
  - АБ смеси – согласует (пробный участок)
  - Процесс укладки
  - Характеристики материалов
  - ГП
  - Лаборатория

ROAD PAVEMENT QA/QC AUDIT MANUAL

- Как часто?

Material Type	Test	Standard (QCS 2010)	Standard (PWA Guide)	ANAS Sampling & Testing Frequency
Asphalt Mixtures (Marshall)	Extraction	BS EN 12697, Part 1	ASTM D2172	2,000 tons
	Gradation of Extracted Aggregate	BS EN 12697, Part 2, BS EN 933, Part 1	ASTM C136, ASTM D5444	
	Marshall/Volumetric Properties	BS EN 12697, Part 6, Part 8, Part 29, Part 34	ASTM D2726, ASTM D6926, ASTM D6927, MS-2	
	Gmm	BS EN 12697, Part 5	ASTM D2041	
	Core Density	BS EN 12697, Part 6	ASTM D2726	
	Core Thickness	BS EN 12697, Part 29	ASTM D3549	
	Retained Stability	CML 2-97	--	
	TSR	--	AASHTO T283	

О системе качества

هيئة الأشغال العامة
إدارة الجودة و السلامة
قسم المختبرات - وحدة مراقبة المختبرات

6. Road and Pavement Tests

No.	Test	Standard	Laboratory																
			Exova	ACES	ACTS	Gulf Lab	Tech Lab	QIL	Pioneer	Teyseer	ITL	QEL	DTL	Fugro	QGEC	JEL	Al Hai & M	BATLABS	ERI
ASTM / AASHTO TESTS – BINDERS																			
6.1	Sampling of Binders	ASTM D140	-	√	-	-	-	-	-	-	-	√	√	-	-	√	-	-	-
6.2	Distillation of Cutback Asphalt	ASTM D402	-	√	-	-	√	-	-	-	-	-	√	-	-	-	-	-	-
6.3	Application Rate of Bituminous Distributors	ASTM D2995	-	√	-	-	√	√	-	-	-	√	-	-	-	-	-	-	-
6.4	Determination of Density of Bitumen	ASTM D70	√*	√	-	-	√	√	-	-	√	√	√	-	-	√	-	√	-
6.5	Penetration of Bituminous Materials	ASTM D5	√	√	-	-	-	√	-	-	-	√	√	√	√	√	-	-	-
6.6	Determination of Softening Point (Ring and Ball Method)	ASTM D36	√	√	-	-	-	√	-	-	-	√	√	-	√	√	-	-	-
6.7	Flash Point, Cleveland Open Cup	ASTM D92	-	√	-	-	√	√	-	-	-	-	√	-	√	√	-	-	-
6.8	Ductility of Bituminous Materials	ASTM D113	-	√	-	-	-	√	-	-		-	√	-	√	-	-	-	-
6.9	Solubility in Trichloroethylene	ASTM D2042	√	√	-	-	-	√	-	-	-	-	√	-	-	-	-	-	-
6.10	Loss on Heating	ASTM D6	-	√	-	-	-	-	-	-	-	-	√	-	-	-	-	-	-
6.11	Determination of Viscosity of Asphalt	ASTM D2171	-	-	-	-	-	-	-	-	-	-	√	-	-	√	-	-	-
6.12	Viscosity Determination using Rotational Viscometer (RV)	ASTM D4402 AASHTO T316	√	√	-	-	√	-	-	-	-	-	√	√	√	-	-	-	-
6.13	Flexural Creep Stiffness using the Bending Beam Rheometer (BBR)	ASTM D6648 AASHTO T313	√	√	-	-	√	-	-	-	-	-	√	√	√	-	-	-	-

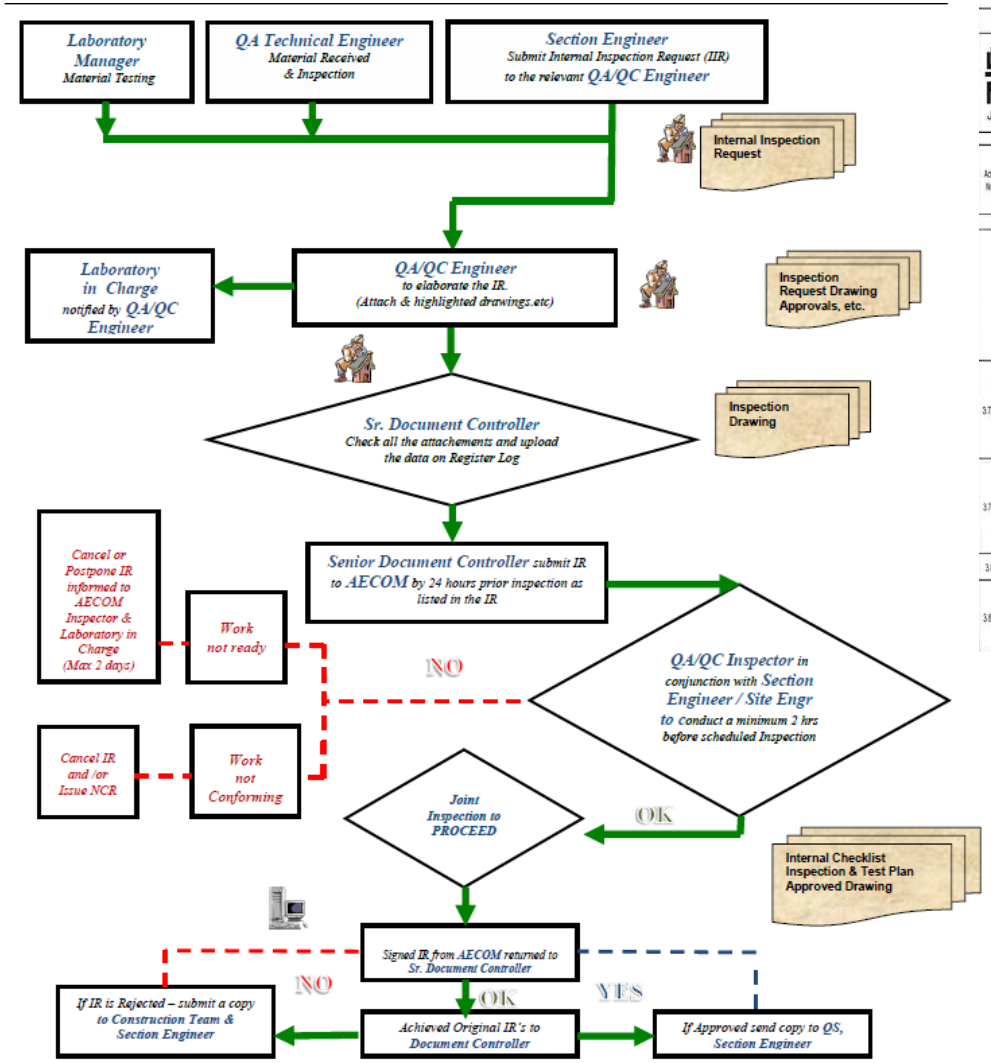
Tel: 44950200 – Fax: 44951200 – e. mail: Quality&Safety@ashghal.gov.qa

О системе качества

	Material /Section / Activity[1, 2] & the Required Tests	Method[3]	Minimum Frequency[4, 5]	Remarks
7.03	Extraction and Gradation of Bituminous Concrete Mix and Determination of Binder Content (or Asphalt Content) Also known as Mechanical Analysis of Extracted Aggregate	AASHTO T30, T37, T164, T168, T308, ASTM C136, D546, D2172, D5444, D6307, BS EN 933-1, BS EN 12697-1, BS EN 12697-2, BS EN 12697-39	• 1 test per day • 1 test per 200 t of asphalt mix • Every change in Job Mix Formula (JMF)	
7.04	Maximum Specific Gravity (GMM, ST)	ASTM D2041, BS EN 12697-5	• 1 test per day • 1 test per 200 t of asphalt mix • Every change in Job Mix Formula (JMF)	
7.05	Marshall Properties of Bituminous Concrete Mix (Stability, Flow, Air Voids, VMA) & Loss of Marshall Stability	AI MS-2, AASHTO T166, T209, T245, T269, T275, ASTM D1188, D2041, D2726, D3203, D6926, D6927, BS EN 12697-5, BS EN 12697-6, BS EN 12697-8, BS EN	• 1 test per day • 1 test per 200 t of asphalt mix	

О системе качества

Inspection Flow Chart



DESIGN & CONSTRUCT / ORBITAL HIGHWAY & TRUCK ROUTE CONTRACT: C2 – SALWA ROAD TO NORTH RELIEF ROAD (P023) Page 10 of 11

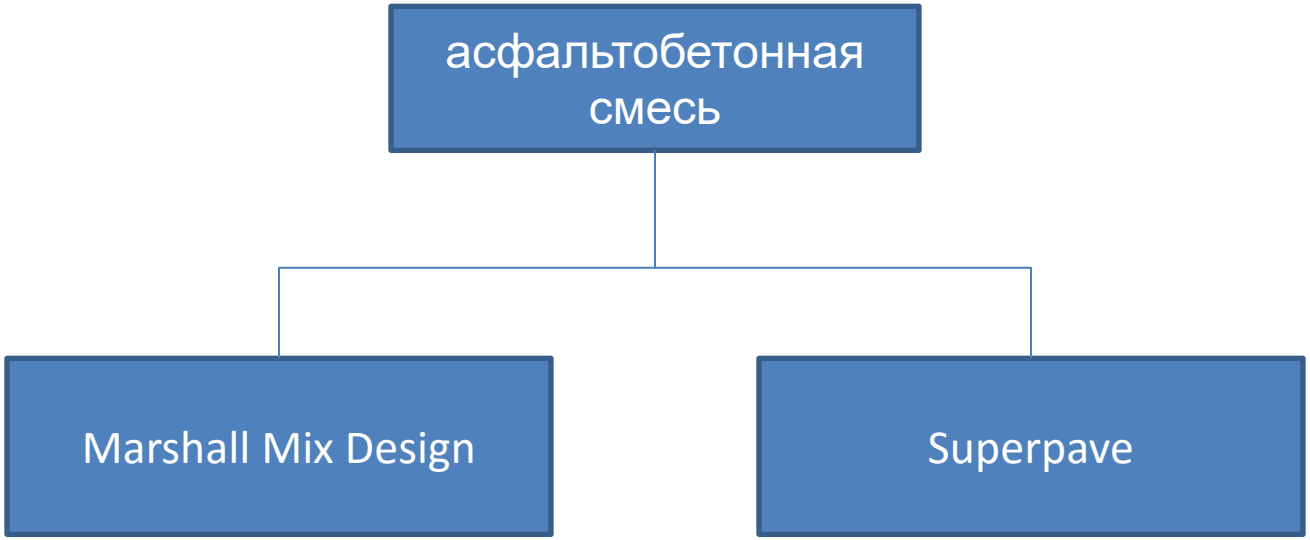
KBR AECOM

INSPECTION AND TEST PLAN FOR FLEXIBLE SURFACING (BASE COURSE, INTERMEDIATE COURSE & WEARING COURSE)

ITP Sequence No.: EXW-P023-0002-QW-QBJ-IT-00004 Revision : CC

Act. No	Activity Description / Item/Test	Inspection/Test Method	Acceptance Criteria	Reference Standard	Responsibility	Frequency	Level of Inspection Points: Sub-con	QDVC-BOTC JV	TPI	DSR	AECOM	Verifying Documents
	Los Angeles Abrasion Loss as determined by ASTM C131/C535	Laboratory Test	Maximum 25%	QCS 2010 Section 6 Part 5 Clause 5.2.2 Paragraph 5	Laboratory Technician / Material Engineer / QA/QC Engineer	Each source. Visible change in gradation. One test weekly. One test every 4000 cum.	N/A	H	N/A	I	W,R	Material Approval Request Test Report
	Aggregates crushing value as determined by BS 812: Part 110	Laboratory Test	Maximum 20%	QCS 2010 Section 6 Part 5 Clause 5.2.2 Paragraph 6	Laboratory Technician / Material Engineer / QA/QC Engineer	Each source. Visible change in gradation. One test weekly. One test every 4000 cum.	N/A	H	N/A	I	W,R	Material Approval Request Test Report
	Water absorption (tested in accordance with BS 812)	Laboratory Test	Not exceeds 1.5%	QCS 2010 Section 6 Part 5 Clause 5.2.2 Paragraph 8	Laboratory Technician / Material Engineer / QA/QC Engineer	Each source. Visible change in material, One test daily. One test every 1000 cum.	N/A	H	N/A	I	W,R	Material Approval Request Test Report
3.7.2	Daily Marshall Density	Test to BS EN 12697	Table 5.2 of PWA IAN 019 Rev. 3, Part 5, Clause 5.7.1	PWA IAN 019 Rev. 3, Part 5, Clause 5.7.1 requires design criteria for Marshall design mix for Polymer Modified Bitumen (PMB) & Standard Bitumen	Laboratory Technician / Material Engineer / QA/QC Engineer	Once test before starting Asphalt Base course, Daily Basis, One test / 200T of Asphalt Mix (4 standard Marshal specimens).	N/A	H	N/A	I	W,R	Inspection request Test Report
3.7.3	Spraying of tack coat	Verify and check temperature	The application rate shall be 0.30 to 0.5 liter/m² with temperature of 10°C to 60°C	PS Vol. 9 of 18 Section 6 Part 5 Clause 5.13.5	Section Engineer QC Inspector	During tack coat spraying	N/A	H	N/A	S	W	Inspection Request / Checklist
	FOR THE FULL DETAILS FOR TACK COAT APPLICATION REFER TO ITP : EXW-P023-002-QW-QBJ-IT-00014-CA											
3.8	FIELD TESTING											
3.8.1	Delivery of Asphalt at site	Checking temperature at delivery of asphalt at site	Temperature of mix at delivery to the paver shall not be more than 163°C and not less than 140°C and delivery temperature shall not exceed the max temperature specified for mixing at the plant	PS Vol 9 of 18 Section 6 Clause 5.9.1 Paragraph 5 & 6	Laboratory Technician / Material Engineer / QC Inspector	Each SC-Type 1 delivery	N/A	H	N/A	I	W	Inspection Checklist

Об асфальтобетонной смеси



Об асфальтобетонной смеси

Требования к щебню

Fine Aggregate Specifications for Marshall Mixes

Parameter	Standard	Specification Limits	Minimum
Plasticity i		4% max. (stockpile)	-
Sand equiv			
Soundness sulphate			
Acid solub			
Acid solub			
Clay lumps			
Organic Im			
Un-Compa			
Water Abs			

Coarse and Combined Aggregate Specifications for Marshall Mixes

Parameter	Standard	Specification Limits			Minimum Frequency
		Base Course (Class A)	Base Course (Class B)	Wearing Course	
One or more Fractured Faces	ASTM D5821	100% min.			- Each source - Visible change in material - 1 test every 2000m^3
Two or more Fractured Faces[(e)]	ASTM D5821	≥ 85%, ESAL:≤ 10M ≥ 90%, ESAL:10-30M ≥ 100%, ESAL:≥30M			
Gradation (Combined)	ASTM C136	Table 5.7, Job Mix gradation and Table 5.10 tolerances			
Flat and Elongated Particles (5:1)	ASTM D4791	15 % max.	15% max.	10 % max.	
Soundness (5 cycles by Mg SO_4)	ASTM C88	15 % max.	15% max.	10 % max.	
Los Angeles Abrasion	ASTM C131 ASTM C535	30% max.	30% max.	25% max.	
Water absorption	ASTM C127	2.0% max.	2.0% max.	1.5% max.	

Об асфальтобетонной смеси

Требования к битуму

Specifications for Polymer-Modified Asphalt Binder

Item	Property		Test Method	Criteria			
				PG76S-10	PG76H-10	PG76V-10	PG76E-10
1	20–Year Desig						
2	If Traffic Spee (Standing/Inte						
3	Flash Point, m						
4	Viscosity @ 13						
5	Dynamic Shea and 10 rad/s,						
6	Separation Te Difference bet 10 rad/s of To Specimens, m						
7	Time Stability measured in S 6) divided by t measured in (						
8	Particulate Re %[j]						
9	Solubility, min						
10	Polymer Cont						
		Rolling Thin Film Oven (RTFO) Residue					
	11	Mass Change, max, %	ASTM D2872	1.00	1.00	1.00	1.00
	12	Dynamic Shear, G*/sinδ, @ 76°C and 10 rad/s, min, kPa	ASTM D7175	2.20	2.20	2.20	2.20
	13	MSCR, $J_{nr3.2}$ @ 76°C, max, kPa^{-1}	ASTM D7405	4.50	2.00	1.00	0.50
	14	MSCR, Recovery $R_{3.2}$ @ 76°C and 3.2 kPa, %[l]		Report	Report	Report	Report
	15	MSCR, J_{nrdiff} @ 76°C, %[m]		Report	Report	Report	Report
		Pressurized Aging Vessel (PAV) Residue					
	16	PAV Aging Temp., °C	ASTM D6521	110	110	110	110
	17	Dynamic Shear, G*×sinδ @ 37°C and 10 rad/s, max, kPa	ASTM D7175	5000	6000	6000	6000
	18	Bending Beam, S @ 0°C and 60s, max, MPa	ASTM D6648	300	300	300	300
	19	Bending Beam, m-value @ 0°C and 60s, min	ASTM D6648	0.300	0.300	0.300	0.300

Об асфальтобетонной смеси

Combined Aggregate Gradation for Asphalt Concrete Mixes

	Percentage Passing (By Weight)		
ASTM Sieve Size			
37.5			
25.0			
19.0			
12.5			
9.5			
4.75			
2.3			
0.85			
0.42			
0.18			
0.07			

Design Criteria for Marshall Design Mixes

Parameter	Base Course (Classes A & B)	Wearing Course
Aggregate Properties	Tables 5.1 and 5.2	
Aggregate		
Num		
parag		
Binde		
toler		
Stabi		
Flow		
Mars		
Voids		
Voids		
Voids		
Voids		
optin		
Retained Sta		
(Filler/Binde		
Tensile Stren		
Asphalt Bind		
Tensile Stren		
Asphalt Bind		

Job Mix Tolerances for Field Mixtures and Blended Hot Bin Aggregates

Job Standard Mix Details:

Extra						
Extra						
Extra						
Extra						
Bind						
Spec						
blen						
Spec						
blen						

Marshall Criteria						
		Construction				
ASTM Sieve (mm)	Mix Design (%)	JMF Tolerances of Extracted Aggregates (%)		Specs Limits		Test Method
		Min.	Max.	Min.	Max.	
25.0	100	100		100		ASTM D5444 ASTM C117 ASTM C136
19.0	99	95	100	86	100	
12.5	85	81	89	69	87	
9.5	74	70	78	58	78	
4.75	51	48	54	40	60	
2.36	33	30	36	25	45	
0.850	17	15	19	15	30	
0.425	12	10	14	10	22	
0.180	7	5	9	6	15	
0.075[c]	4.3	3.3	5.3	2	8	

Retained Stability (%)	94.3	75	N.A.	75	N.A.	ASTM D6927 QCS2014
Theoretical Maximum Specific Gravity	2.720	N.A.	N.A.	N.A.	N.A.	ASTM D2041
Daily Bulk density (kg/m^3)	2555	2529	2581	N.A.	N.A.	ASTM D2726
Coarse Aggregate Specific Gravity	2.909	2.889	2.929	N.A.	N.A.	ASTM C127
Fine Aggregate Specific Gravity	2.838	2.818	2.858	N.A.	N.A.	ASTM C128

О дороге с асфальтобетонным покрытием

3.8	**FIELD TESTING**												
3.8.1	Temperature of bituminous mixture	Checking temperature at delivery of asphalt at site	Temperature in truck: ±10°C of JMF Temperature at paver: ≥135°C Temperature prior to rolling: ≥120°C as per BS EN 12697	QCS2014 Section 6 Part 5 Table 5.12	Laboratory Technician / Material Engineer / QC Inspector	Each truck	N/A	H	N/A	I	W	Inspection Checklist
	Daily Bulk density	Checking bulk density of asphalt at site	±1% of the Job Standard Density as per ASTM D2726 if water absorption ≤2% and ASTM D1188 if water absorption >2%	QCS2014 Section 6 Part 5 Table 5.12 Clause 5.3.3 paragraph 12	Laboratory Technician / Material Engineer / QC Inspector	Daily	N/A	H	N/A	I	W	Inspection Checklist
	Field density	Checking field density	Nuclear gauge: 98 - 101.8% related to the Daily Marshall Density as per ASTM D2950 2 cores: as per ASTM D2726 / ASTM D1188	QCS2014 Section 6 Part 5 Table 5.11 and 5.12	Laboratory Technician / Material Engineer / QC Inspector	at 50m intervals in alternate wheel tracks (nuclear gauge) 1 test per 100t per layer (2 cores)	N/A	H	N/A	I	W	Inspection Checklist
	Thickness	Checking thickness of the layer	Core diameter 150mm, full depth of the course Sample = pair of 2 adjacent cores (diameter = average of the 2) Shall not be less than specified by more than 5mm in case of a single layer construction. Total thickness of all paving courses shall not be less than specified by more than 10mm	QCS2014 Section 6 Part 5 Clause 5.11.1 paragraphs 1 & 2 Clause 5.3.3 Table 5.12	Laboratory Technician / Material Engineer / QC Inspector	Each completed Asphalt course 1 test per 100T per layer	N/A	H	N/A	I	W	Inspection Checklist

The IRI of the driving surface shall not exceed the following limits:
New Construction, Reconstruction and Pavement Rehabilitation (*Works include overlay, Mill and Inlay/overlay, or Partial Reconstruction works which include all asphalt layers and part of the aggregate base layer***):**

- Average value over a 400m section ≤ 1.00 m/km.

Directional ramps on bridges or interchanges and tunnels of minimum length of 400m shall be tested, unless otherwise instructed by the Engineer, and shall have an IRI not exceeding the following limits:

- **Flexible Pavement**: Average value over a 400m section ≤ 1.00 m/km
- **Composite and Rigid Pavement**: Average value over a 400m section ≤ 1.20 m/km [(ar)].

No more than two 25m sub-sections within any of the 400m section shall have IRI values greater than 1.5 m/km.
Any section with rideability exceeding the specified criteria shall be corrected or removed and replaced in accordance with the instructions of the Engineer and to his satisfaction at the Contractor's cost.
The minimum length of the rectification work undertaken shall be 100m. All rectified segments shall be re-tested following the completion of rectification work at no additional cost to the client.

Спасибо за внимание!