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Survey of Applied Bitumen based on PG, Climatic and Traffic Conditions (A case study)

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Abstract
Grading of bitumen is performed based on performance and it depends on the maximum and minimum location temperatures values of implementation pavement and traffic load. The objective of present research was survey of applied bitumen based on PG, climatic and traffic conditions as a case study. Using environmental conditions and an experimental study on hot asphalt, Marshall, aggregate and base layer samples were carried out in current research. These tests included temperature of pavement, Coarse and Fine Aggregate Angularity, Sand Equivalent, Coarse and Fine Aggregate and Los Angeles test, Resistance, Softness, Breakage, Deformation, Specific Gravity, Moisture of fine aggregate, Density, Aggregate Grading, LL, PL, PI, Empty space of asphalt, Compaction, Thickness of asphalt, Thickness of base layer, Space filled with bitumen, Bitumen/mixed asphalt, Bitumen / asphalt without bitumen, Empty space asphalt, aggregates and aggregate filled of bitumen. Using ESRI ARC GIS 10.2 Software a performance grading map was depicted to the Iran. According to the highest and lowest available temperature ranges of the asphalt, the country was divided into different zones. The asphalt properties with light, medium and heavy traffic were obtained in full agreement with required standard specification of asphalt for roads with heavy, medium and light traffic loads wearing course in case study. Therefore, locally asphalt or bitumen applied can be used without the need of modification in all parts of case study Province.

Keyword: Applied bitumen, Climatic and traffic conditions, PG.

Nomenclature	
PG	Performance Grade
SUPERPAVE	Superior Performance Asphalt Pavements
SHRP	Strategic Highway Research Program
SGC	Super-pave gyratory compactor
IMPWH	Iranian Ministry of Public Works and Housing
ASTM	American Society for Testing Materials
HMA	Hot-Mix Asphalt
LL	Liquid limit
PL	Plasticity limit
PI	Plasticity Index

Introduction
Bitumen is produced of crude oil distillation that is used as a binder for road pavements. Bitumen includes millions of the chemical composition and molecular structures which are known to affect their rheological and mechanical properties [1]. From major properties of bituminous paving mixtures can point out to the stability, durability, flexibility and skid resistance. To determine the properties of optimum bituminous paving mixtures with regard to stability and durability are used traditional mix design methods. It can be mentioned that these methods include Marshall, Hubbard-field, Hveem, Asphalt Institute Tri-axial method of mix design, etc. But there are widely agreement, the Marshall Mix and Hveem mix design method [2]. SHRP have focused on the establishment of performance-based asphalt binder and asphalt mix properties [3,4]. The main objective of SHRP was to develop that performance based asphalt binder properties and accelerated performance-based tests based on mixture design method [5]. SHRP is a unit of the National Research Council that was authorized by section 128

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of the Surface Transportation and Uniform Relocation Assistance Act of 1987 in the University of Texas in Austin and Washington, D.C [6].

Grading of bitumen is performed based on performance and it depends on the maximum and minimum location temperatures values of implementation pavement and traffic load. Maximum and minimum pavement temperatures values are measured based on the maximum and minimum ambient temperature [7]. The SUPERPAVE system contains of three interrelated areas: (1) PG asphalt binder properties and tests of temperatures based on the range of pavement; (2) aggregate properties and tests; and (3) a mixture design system to utilize the both a volumetric mixture design with a SGC (producing laboratory specimens of asphalt) and an analysis/performance prediction element [8,9].

Williamson has been performed some studies on pavement temperature measurement and the prediction since 1970 to 1975. Also, he made a first attempt to calibrate the Super-pave algorithms to use based on pavement temperature data recorded in Durban, Newcastle, South Africa and Pretoria. They found the Super-pave algorithms to provide a reasonable indication of maximum surface temperatures [10]. Viljoen (2001), used the datasets from studies and the data gathered by Williamson in different other local studies to develop temperature prediction equations for asphalt pavements in South Africa [11]. The objective of present research was survey of applied bitumen based on PG, climatic and traffic conditions as a case study. Data of meteorological stations were used for grading map using ESRI ARC GIS 10.2 Software. Super-pave tests were carried out on the hot asphalt and Marshall samples.

Experimental procedure

The work started with a literature review of available literature related to the research. In current study GIS image depicts using data of climatic condition and performed super-pave tests by IMPWH (2000). Aggregate and asphalt samples were collected and evaluation tests performed on samples. This experimental study was performed in the technical & soil mechanic laboratories and in site of implementation of projects of Hamta Rah Tasbit Aria Co, in Shiraz, Iran. Physical tests of the collected applied aggregates, hot asphalt and Marshall Samples was conducted in several technical & soil mechanic laboratory depend on available equipments in labs and performing project in the different locations. These tests of aggregates included coarse and fine aggregate angularity, sand equivalent (AASHTO T176), coarse and fine aggregate and Los Angeles test (AASHTO 96-51, ASTM C131, D5760). The applied aggregate gradation was in accordance with the IMPWH (2000) recommended gradation for light, medium and heavy traffic wearing course. Hot asphalt and marshal samples were collected from performing projects in different regions of Shiraz Province since 2012 to 2014. The study included tests from, Resistance and Softness (ASTM D-1559), Breakage (ASTM D-244 for asphalt, D-5812 and D-5821 for aggregates), Deformation (D1559), Specific Gravity (ASTM D2389 – 78, AASHTO T160, ASTM D1119 and AASHTO 84 to moisture of fine aggregate), Density (ASTM D-70), Aggregate Grading (ASTM D422, AASHTO 27-60), LL (AASHTO T289, ASTM D423), PL (AASHTO T90, ASTM D424), PI (PL-LL), Empty space of asphalt (ASTM D2041), Compaction (ASTM D1557), Thickness of asphalt (ASTM D5199), Thickness of base layer (ASTM D5199). In order to determine values of tests the space filled with bitumen, bitumen/mixed asphalt, bitumen / asphalt without bitumen, empty space (asphalt and aggregates) and empty space of aggregate filled of bitumen (AASHTO T305) were used [12,13]. The selected aggregate gradation was in accordance with the IMPWH (2000) recommended gradation for light, medium and heavy traffic wearing course. Figure 1 shows a flow chart of the experimental procedure followed in this research.

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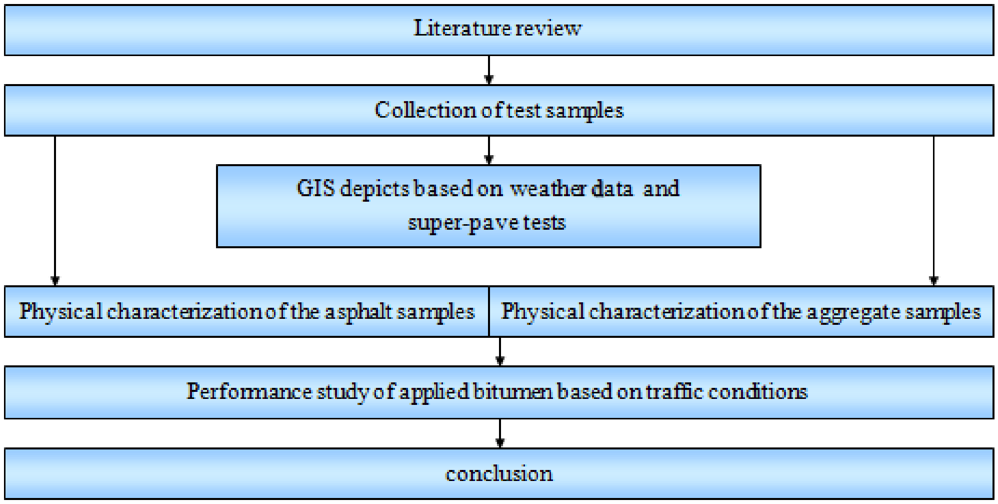

Figure 1 Flow chart of the followed work

Results and discussion

-PG of different regions based on climatic conditions in Iran

Table 1 represents the produced bitumen and PG from different regions of through Iran that has been calculated based on the both minimum temperature values and seven-day consecutive maximum air temperature values from the different weather stations located in the different parts of Iran and based on SHRP tests (Frass breaking point, Rutting, Fatigue and climatic conditions) the research of IMPWH (2000) in different areas from provinces.

Table 1 PG and produced bitumen based on the research of IMPWH (2000) in through Iran

Province	PG	Province	PG	Refineries	Bitumen
Zahedan	70-10, 64-16,	Khoram Abad	64-22, 64-16, 58-22	East Azarbaijan	85/100, 60/70
Kerman	64-22, 64-16, 70-10	Abadan	64-16, 70-10	Arak	60/70, 90/15
Bandar Abass	70-10	Kordestan	58-28, 64-22, 64-16	Tehran	70/60, 25/85
Mashhad	64-22, 58-22, 64-16	Sanandaj	68-34, 68-22, 54-28, 58-28	Shiraz	60/70, 90/15
Gorgan	64-10, 64-22	Sari	58-16	Abadan	70/60, 25/85
Semnan	64-16, 64-10, 70-10	Rasht	58-28, 68-16, 64-10, 58-34	Bandar Abass	90/15, 60/70
Yazd	64-16, 64-10, 70-10	Hamedan	64-16, 64-22	Isfahan	90/15, 60/70, 85/25
Shiraz	64-16, 64-10, 70-10, 64-22	Ghazvin	64-10, 64-16, 64-22		
Isfahan	64-16, 64-10, 70-10, 64-22, 58-22	Zanjan	58-28, 58-22, 64-22		
Shahr kord	58-22, 70-22	East Azarbaijan	64-22, 58-16, 58-22, 58-28		
Yasooj	70-10, 64-22	West Azarbaijan	58-22, 62-28, 58-16		
Ahvaz	76-10, 70-10	Mazandaran	64-22		
Arak	64-16, 64-28	Tehran	64-22, 64-16, 68-16, 64-22		

PG values are estimated using semi-empirical equations 1 to 4. Then, findings is matched based on SHRP (ISIRI, 12505) the Table 2.

Table 2 PG of bitumen based on temperature of pavement in SHRP (ISIRI, 12505)

PG	PG 46			PG 52							PG 58					PG 64			
	-34	-40	-46	-10	-16	-22	-28	-34	-40	-46	-16	-22	-28	-34	-40	-10	-16	-22	-28
1	<46			<52							<58					<64			
2	>-34	>-40	>-46	>-10	>-16	>-22	>-28	>-34	>-40	>-46	>-16	>-22	>-28	>-34	>-40	>-10	>-16	>-22	>-28
PG	PG 64		PG 70						PG 76					PG 82					
	-34	-40	-10	-16	-22	-28	-34	-40	-10	-16	-22	-28	-34	-10	-16	-22	-28	-34	
1	<64		<70						<76					<82					
2	>-34	>-40	>-10	>-16	>-22	>-28	>-34	>-40	>-10	>-16	>-22	>-28	>-34	>-10	>-16	>-22	>-28	>-34	

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1- 7- Day maximum average temperature 2- Minimum average pavement temperature.

$$T_{man,98\%} = T_{man,50\%} + 2\sigma \times High, Temp \quad \text{equation (1)}$$

$$T_{\min,98\%} = T_{\min,50\%} - 2\sigma \times Low, Temp \quad \text{equation (2)}$$

$$T_{\max,\, pav(20mm)} = (T_{\max,\, air} - 0.00618 \times Lat,\hat{}2 + 0.2289 \times Lat + 42.2)(0.9545) - 17.78 \quad \text{equation (3)}$$

$$T_{\min,\, pav(surface)} = 0.859 \times T_{\min,\, air} + 1.7 \quad \text{equation (4)}$$

In equations 1 to 4, $T_{max,\ pav\ (20\ mm)}$, $T_{max,\ air}$, Lat, $T_{min,pav\ (surface)}$, $T_{min,\ air}$ and σ are the maximum pavement temperature values at 20 mm depth (ºC), seven-day consecutive maximum air temperature (ºC), latitude of the pavement project site based on degrees, minimum pavement temperature, minimum air temperature (ºC) and standard deviation respectively [13,14].

To determine the maximum temperature of each zone, are used the data stations (data of 20 years). Then was calculated the mean and standard deviation of 7- day maximum average temperature values. To determine the minimum temperature of each zone is used from minimum temperature the coldest day of the years. The 7- day maximum average temperature and the minimum temperature of the years have confident confidence of 50%. Then mean air temperature and standard deviation of 7- day maximum average temperature and minimum air temperatures of different years are determined. In order to achieve confident confidence of 98% are used the equations 1 and 2 [15,16]. The maximum pavement temperature is determined at 20 mm depth from surface the asphalt pavement and minimum pavement temperature based on the surface pavement temperature by equations 3 and 4 [16]. This process can be carried out using software instead of equations. To convert the air temperatures into pavement temperatures can be used the Long Term Pavement Performance Program Bind software. In SHRP the PG are obtained from the both parameters, 7-day maximum average pavement temperature and the minimum average pavement temperature values (Table 2). To select the maximum and minimum temperatures the designers have to consider to confidence level using statistical charts in SHRP method. ***We can say that*** the confidence level is equal to the percentage probability that each year the actual temperature does not exceed the design temperature [17,18].

Table 2 is used in order to estimate PG values. The results of research were used to depict the grading map of PG using ESRI ARC GIS 10.2 Software.

Table 3 presents the PG for different regions of Iran. Figure 2 shows the GIS image of the different regions of Iran based on the PG. Table 3 represents the PG for different areas of Iran.

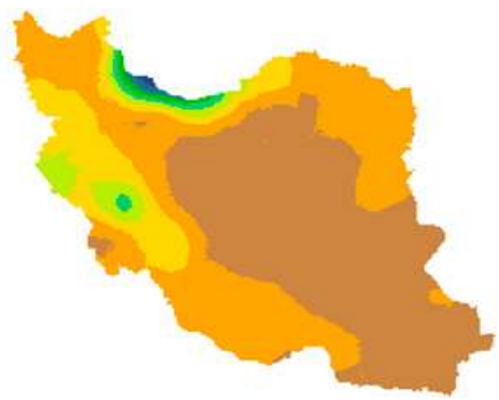

Figure 2 GIS image of the different regions of Iran based on the PG

Table 3 PG of different areas of Iran

	PG											
Green	58-16*	58-34*	58-22*	68-16	64-22	64-28						
Yellow	70-10	58-28*										
Brown **	70-10	64-16	64-22	58-16*	68-22	68-28	58-28*	70-28	64-10			
Orange	70-28	64-28	70-10	58-16*	58-34*	76-10	64-22	64-16	64-10	52-22*	58-28*	58-22*

*Cold areas (North and West North). ** Warm areas

The results of PG has some utilities such as deciding about the use of bitumen in a given climatic condition, obtaining the engineering properties and as well as grading of bitumen [19]. The performance of modified bitumen at high, intermediate and low temperatures is evaluated based on SHRP, super-pave

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tests. In the grading system, the physical properties are constant for all of the performance degrees, but the temperature at which the physical properties was obtained could be changed, depending on the atmospheric conditions of usage [20,21]. Table 4 shows the calculated PG for different zones of Iran.

Table 4 PG of different zones of Iran.

	PG						
Cold zones	58-16	58-34	58-22	52-22	58-28		
Warm zones	70-10	70-28	76-10				
Medium warm zones	64-28	64-16	64-22	68-16	68-22	68-28	64-10

Table 4 shows that were found 15 types of PG based on the SHRP for total area of Iran and three climatic zones. Prithvi et al. (1997), reported that highway agencies was undertaken to develop a method to select the PG of virgin asphalt binder based on the Super-pave PG grading system [22].

In the study of Abtahi et al. (2008), PG was determined using the minimum and maximum daily temperatures of 20 stations, the maximum and minimum pavement temperatures values for different regions of Isfahan Province, Iran. With respect to PG of zones, the suitable bitumen was determined for each region [23]. In the study of Asi (2007), a PG map was depicted using data of 20 years of continuous temperature of the eleven weather stations based on the highest and lowest temperature ranges of the asphalt in Hashemite Kingdom of Jordan. Based on obtained results the country was divided to several zones [24]. Shen et al. (2007), were used from SHRP (using the blending charts) for achieving to a suitable PG for reclaimed asphalt pavement [25]. Results research of Stelea, (2007), showed that using SHRP (based on PG and 7 consecutive days maximal temperature) to test on the highway bitumen results in high performance in asphalt mix design [26].

Performance study of applied bitumen based on traffic conditions (A case study)

-Applied bitumen based on heavy traffic conditions

Bitumen is used in road pavements as the binder of aggregates over the world. With regard to increase the road traffic and insufficient degree of maintenance, we need to study of applied bitumen based on traffic conditions as well as other properties. There was an accelerated and continuous deterioration of the road networks during the last two decades in Iran. Several types of measures may be effective to alleviate this process, e.g., ensuring investments for maintenance, suitable roadway design, use of suitable materials and construction methods. Asphalt pavements must tolerate heavy loads of traffic and unfavorable environmental conditions for an acceptable period of time. The both parameters of high-temperature rutting and low temperature cracking are the most limitations of unmodified asphalts. The PG was used for standard highway traffic conditions and the Marshal tests are performed to imitate loads travelling at 90 km/h. In some situations the binder should be selected of one grade step higher such as intersections, locations with slow or even standing traffic and uphill sections. The PG system provides upper and lower temperature limits to use and optimum utility. The binder with a reduction in the upper PG may be more susceptible to rutting and should only be used in areas with lower maximum temperatures. Similarly, an increase in lower PG classification shows that the binder is more susceptible to fatigue and low temperature cracking and had better only use in areas with higher maximum temperatures. Traffic conditions has also critical role in the selection of the type of bitumen. If the traffic rate at the equivalent standard axles (80KN) be more than 10^7, the designer has to select the bitumen with one degree more than available PG. For instance the bitumen with 70-16 PG would be used instead of 64-16. When there are high traffic loads over the design life of the surfacing, it is necessary that binder select of a higher PG grade in situations [27]. Table 5 represents size of sieve, properties of ranges and specification of asphalt with heavy traffic.

Table 5 Size of sieve, properties, ranges and specification of asphalt with heavy traffic

Size of sieve (In)	Size of sieve (mm)	Cumulative passing (%)	Ranges	Specification of asphalt with heavy traffic	
1	25	-	-	Temperature	120-163 ºC
3.4	19	100	100	Resistance	800 kg
1.2	12.5	97.70	90-100	Softness	2-3.5 mm
3.8	9.5	-	-	Breakage	90%
4	4.75	62.50	44-74	Empty space of asphalt (Topeka)	3-5%
8	2.36	37.90	28-58	Empty space of asphalt (Binder)	3-6%
50	0.3	10.50	5-21	Empty space of asphalt (Black base)	3-8%
100	0.15	6.80	-	Space filled with bitumen	65-75%
200	0.075	4	2-10	-	-

Table 5 shows the size of sieve, properties, ranges and specification of asphalt with heavy traffic. These parameters have to observe in properties of applied bitumen and asphalt in implementation of projects in construction road companies. Several parameters influence the performance of asphalt or bitumen e.g., the properties of the components (binder, aggregate and additive) and the proportion of hot asphalt in the manufacturing location. Bitumen can also be modified by adding different types of additive. It should be mentioned that the type of applied bitumen was 60/70 based on the softening point and penetration degree (products of Isfahan Refining) in these projects in Shiraz province, Iran. From properties this type bitumen can be mentioned to the density, softening point, penetration degree and ductility values that are about 703 g/cm^3, 51 ºC, 66 mm and 100 cm [28]. Tables 6 and 7 show the results of experimental studies as a case study based on performed tests on hot asphalt and Marshall Samples.

Table 6 Results of performed tests on hot asphalt and Marshall Samples

Hamta Rahe Tasbit Aria CO.				
Size of sieve (In)	Size of sieve (mm)	Cumulative passing (%)	Specification of used asphalt and Marshall	Values
3.4	19.05	98.18	Bitumen/mix asphalt	5.20
1.2	12.7	94.91	Temperature of pavement	150 ºC
4	4.76	58.45	Resistance	950 kg
8	2.38	33.96	Softness	3.4 mm
50	0.297	10.94	Density	2.27 g/cm^3
200	0.075	3.84	Breakage in two sides	95 %
			Breakage in one side	98 %
1	25	-	Bitumen/mix asphalt	5.17%
3.4	19	100	Temperature of pavement	150 ºC
1.2	12.5	97.70	Resistance	1350 kg
3.8	9.5	-	Softness	3.95 mm
4	4.75	62.50	Density	2.34 g/cm^3
8	2.36	37.90	Breakage in two sides	Total
50	0.3	10.50	Empty space of mix asphalt	1.76 %
100	0.15	6.80	Empty space between aggregates	13.75%
200	0.075	4	Empty space aggregate filled of bitumen	70.75%

Table 7 Results of performed tests on hot asphalt and Marshall Samples with heavy traffic

Hamta Rahe Tasbit Aria CO.				
Size of sieve (In)	Size of sieve (mm)	Cumulative passing (%)	Specification of hot asphalt and Marshall	Values
3.4	19.05	100	Bitumen/mix asphalt	5
1.2	12.7	98.64	Temperature of pavement	150 ºC
4	4.76	67.01	Resistance	990 kg
8	2.38	40.85	Softness	3.8 mm
50	0.297	11.26	Density	2.29 g/cm^3
200	0.075	4.14	Breakage in two sides	92%

			Breakage in one side	97%
3.4	19.05	100	Bitumen/mix asphalt	5.50
1.2	12.7	98.7	Temperature of pavement	150 ºC
4	4.76	61.55	Resistance	1159 kg
8	2.38	36.76	Softness	3.7 mm
50	0.297	8.95	Density	2.3 g/cm^3
200	0.075	3.22	Breakage in two sides	97 %
			Breakage in one side	100 %
			Bitumen / asphalt without bitumen	5.80
			Empty space of mix asphalt	2.9
3.4	19.05	100	Bitumen/mix asphalt	4.44
1.2	12.7	97.61	Temperature of pavement	160 ºC
4	4.76	54.57	Resistance	1560 kg
8	2.38	34.75	Softness	3.5 mm
50	0.297	9.69	Density	2.31 g/cm^3
200	0.075	3.55	Breakage	100 %
			Bitumen / asphalt without bitumen	4.65
3.4	19.05	100	Bitumen/mix asphalt	5.60
1.2	12.7	97.67	Temperature of pavement	160 ºC
4	4.76	68.76	Resistance	1017 kg
8	2.38	40.74	Softness	3.8 mm
50	0.297	12.73	Density	2.32 g/cm^3
200	0.075	4.4	Breakage in two sides	85%
			Breakage in one side	94%
			Bitumen / asphalt without bitumen	5.80
			Empty space of mix asphalt	2.8%
3.4	19.05	98.18	Bitumen/mix asphalt	5.20
1.2	12.7	94.91	Temperature of pavement	150 ºC
4	4.76	58.45	Resistance	950 kg
8	2.38	33.96	Softness	3.4 mm
50	0.297	10.94	Density	2.27 g/cm^3
200	0.075	3.84	Breakage in two sides	95 %
			Breakage in one side	98 %

Tables 6 and 7 showed that temperature, deformation, stresses and loading are effect on the performance of HMA in the pavement. Also, the permanent strains typically accumulate in HMA with increasing load applications [29,30]. Reducing pavement temperature significantly improves rutting performance. Therefore, pavement temperature is important to select binder content and invest the rutting performance at project location. The rut depth can be attributed to densification and shear. Therefore, analysis of layer thickness, volumes of material and air-void contents were used to evaluate so[30,31].

-Applied bitumen based on light and medium traffic conditions

The performance of in-service pavements presents that the condition of the bonding between pavement layers plays (Pavement layers are completely bonded or completely unbounded) an important role in the road structures performance [32,33]. Results of tests

on the base layer under the HMA showed that maximum values for three tests of LL, PL and PI, about 25%, 30% and 6% in the compaction operation respectively. Table 8 represents results of performed tests on base layer samples with light and medium traffic conditions in several locations with same results [34,35].

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Table 8 Results of performed tests on base layer samples with light and medium traffic conditions

Hamta Rahe Tasbit Aria CO.				
Size of sieve (In)	Size of sieve (mm)	Cumulative passing (%)	Specification of base layer with light and medium traffic	Values
2	50	84	Sand Equivalent	28%
3.8	9.5	34	LL	24%
4	4.75	24	PL	21%
10	2	19	PI	3%
40	0.425	9	D_{10}	0.5
200	0.075	6	D_{30}	7
			D_{60}	21
			Compaction (medium moisture 1.4% and density 2.1 g/cm^3)	96%
			Thickness of base layer (Medium)	13 cm
3	76.2	92	Sand Equivalent	18
2.5	63.5	86	LL	27
2	50.8	81	PL	21
1.	38.1	72	PI	6
1	25.4	59	D_{10}	0.08
0.75	19.05	52	D_{30}	4.9
0.5	12.7	44	D_{60}	23
0.375	9.53	39	Thickness of base layer (Medium)	18 cm
4	4.76	29	Compaction (medium moisture 2.3% and density 2.06 g/cm^3)	91%
10	2	21		
40	0.43	13		
200	0.075	9		

Results of Table 8 showed that all of values were matched with properties of base layer samples with light and medium traffic conditions. Table 9 shows results of performed tests on hot asphalt and Marshall Samples with light and medium traffic conditions in several locations. Figure 3 represents the professional experiences of company.

Table 9 Results of performed tests on hot asphalt and Marshall Samples with light and medium traffic conditions

Hamta Rahe Tasbit Aria CO.			
Specification of asphalt with light and medium traffic	Values	Specification of asphalt with light and medium traffic	Values
Bitumen	4. 5%	Specific gravity of asphalt	2.2 kg/cm^3
Temperature of pavement	150 ºC	Specific gravity of Marshall	2.31 kg/cm^3
Resistance	890 kg	Compaction	95%
Softness	3.1 mm	Thickness of asphalt (Medium)	6.2 cm
Specific gravity	2.36 g/cm^3	Aggregates values	19260 g
Breakage	87%	Sand Equivalent	29%
		LL	25%
		PL	-
		Thickness of base layer (Medium)	20 cm
		Relative compaction (Base layer)	97%
Bitumen	4.35%	Specific gravity of asphalt	2.1 kg/cm^3
Temperature of pavement	150 ºC	Specific gravity of Marshall	2.3 kg/cm^3
Resistance	899 kg	Compaction	98%
Softness	3.35 mm	Thickness of asphalt (Medium)	6.1 cm
Specific gravity	2.3 g/cm^3	Aggregates rates	19266 g
Breakage	83%	Sand Equivalent	27%
		LL	24%
		PL	-
		Thickness of base layer (Medium)	19 cm
		Relative compaction (Base layer)	97%

***Figure 3* professional experiences of company**

Saarenketo et al. (2000), have reported that Ground Penetrating Radar has been used to determine layer thickness, subsurface defects, base course quality and air void content instead of SHRP tests in road structure studies [36]. The study of Asi (2007), presented that total samples have lower permanent deformation values for SUPERPAVE samples than Marshall Samples in same stress level. Tapkın et al. (2009) have proposed using of artificial neural networks model for physical properties of standard Marshall Tests such as specimen height, unit weight, void in mineral aggregate, voids filled with asphalt, air voids and repeated creep test properties [37]. Ozgan et al. (2013) was determined some particle diameters of aggregates (0.56, 1, 0.18, 19, 8, 9.5 mm, etc.) the Marshall Stability and environmental temperature with the quantity of bitumen with 0.43 and 0.83 correlation coefficients increased and decreased the Marshall Stability respectively [38]. Al-Khateeb et al. (2014) were studied on the combined effect of the loading frequency, temperature and stress level on the fatigue life of asphalt paving mixtures, 60/70 and PG 64-10 and crushed limestone aggregate in heavy traffic loadings with two intermediate temperatures 20 and 30°C, four loading frequencies and truck speeds of about 12.5–45 km/h. results of research showed that that the increase in loading frequency lead to an exponential increase in the fatigue life at both temperatures [39]. Tao et al. (2011) were found especial rule to grad fine aggregates that play an important role in the graded aggregates to form balanced skeleton and tolerate external loading [40]. The paper of Mo et al. (2008), presented two meso-level mechanical models to analysis of ravelling resistance of porous asphalt concrete with main components aggregate particle, mortar, interfacial zone and air void. These models show the highest particle and different particle packing [41]. The results study of Park et al. (2009) reported that the high durability asphalt binder has a higher resistance about 15–30% greater than high durability asphalt mix against induced damages or pressures. But, high durability asphalt mix has high potential to decline permanent deformation. Despite in, aggregate gradation of both mixes is the same, but construction of the high durability asphalt mix increases rutting resistance [42]. These results of studies are in good agreement with results and study method from current research.

Conclusion

This research was conducted to find the adoptability of applied bitumen specifications to the Shiraz Province, specific materials, traffic and environmental conditions. A temperature zoning map was depicted for the Iran with different grade zones. It was obtained three climatic zones based on the PG results. Locally produced asphalt can be used without the need of modification in all parts of case study province. Local aggregate meet both requirement properties and source properties.

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