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Estimation of Volumetric Parameters of Bituminous Mix Using Digital Image Processing.

Problem Statement :

Bituminous concrete, as a material is distinctly heterogeneous and consists of aggregates, air voids, and bitumen as binder. Mix volumetric describes the relative volume proportions among these constituents of the bituminous mix. Conventional procedures used to quantify the volume proportions require a series of analytical and laboratory steps, which in turn depend on different specific gravity values of bituminous mixes. Although these conventional laboratory tests are based on basic definitions, they might be time consuming and sometimes inaccurate.

Objective:

The objective of the present study is to develop a systematic digital image processing method to estimate the volumetric parameters of bituminous mix using cross sectional image of Marshall samples. The Marshall samples are cut by stone cutter and photographs of cross section of the samples are taken. Having obtained the image the pixels are trained to classify the four components of the bituminous mix, viz. aggregate, bitumen, air-voids and background, and their area fractions are calculated. The area fractions of bituminous mix components are then converted to volume fractions by using principles of stereology. A good

correlation has been observed for the volumetric parameters between conventional laboratory method and digital image processing method, developed in the present thesis.

Methodology:

Considering the objective of the present study, a methodology was adopted as described in Figure 1. As described in the flow chart, the complete methodology was divided primarily into seven steps. The first step comprised of acquisition of sectional images of bituminous

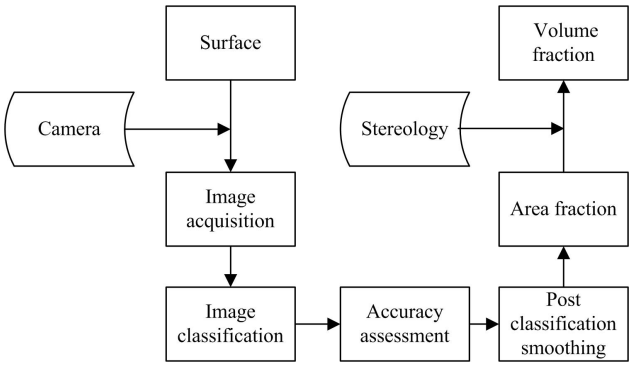

Figure 1: Methodology flow chart

mix samples in the digital form. Cross sectional digital images were classified in the second step. In the third step, accuracy assessment of classified image was done. In the fourth step, post classification smoothing was done to remove noise from classified image. In the fifth step, area fraction was estimated. Conversion of area fraction to volume fraction was done in the sixth step. The seventh step described estimation of volume fraction of bituminous mix by laboratory method.

Results:

Comparatione between conventional and DIP method of estimating mix volumetric parameters is shown in Table 1 and Table 2. Comparatione shows that estimated values of VA in

bituminous mix are matching nicely between both the methods, whereas, DIP method gives higher VMA in bituminous mix.

Table 1: Comparatione laboratory method of mix volumetric parameters estimation with DIP method

Sample number	Laboratory results			DIP results		
	VA (%)	VMA (%)	VFB (%)	VA (%)	VMA (%)	VFB (%)
5BT1	10.53	25.13	58.07	10.78	30.40	64.53
				SD	SD	SD
5BT2	4.67	20.22	76.90	4.45	25.23	82.36
				5.18	25.22	79.42
5BM1	6.98	22.16	68.48	8.40	28.17	70.18
				6.68	28.16	76.27
5BM2	9.64	24.39	60.44	9.57	29.95	68.02
				10.18	30.07	66.15
5BB1	10.52	25.12	58.10	8.37	31.11	73.06
				4.87	31.02	84.27
5BB2	10.29	24.93	58.69	10.55	29.93	64.74
				10.02	29.95	66.54
5.5BT1	10.43	25.97	59.85	10.24	31.99	67.98
				9.96	31.87	68.75
5.5BT2	11.2	26.61	57.91	11.13	31.61	64.78
				10.90	31.73	65.65
5.5BM1	8.48	24.37	65.17	8.48	30.36	72.06
				9.17	30.15	69.56
5.5BM2	10.86	26.34	58.73	10.60	31.55	66.37
				10.88	31.69	65.66
5.5BB1	12.22	27.45	55.49	12.08	32.82	63.17
				12.52	32.66	61.67
5.5BB2	10.04	25.66	60.85	9.85	31.30	68.52
				10.37	31.21	66.77

Table 2: (Continued Table 1) of mix volumetric parameters estimation with DIP method

Sample number	Laboratory results			DIP results		
	VA (%)	VMA (%)	VFB (%)	VA (%)	VMA (%)	VFB (%)
6BT1	9.24	25.86	64.26	9.07	30.76	70.49
				7.88	30.83	74.43
6BT2	8.24	25.04	67.08	SD	SD	SD
				8.15	29.72	72.56
6BM1	4.71	22.16	78.72	4.62	27.72	83.31
				.96	27.91	82.20
6BM2	4.65	22.11	78.95	4.75	28.12	83.08
				4.69	27.98	83.23
6BB1	5.81	23.06	74.79	5.68	28.75	80.23
				5.99	28.61	79.05
6BB2	4.30	21.83	80.26	4.45	27.05	83.55
				SD	SD	SD
6.5BT1	2.96	21.75	86.35	3.0	26.89	88.78
				2.89	26.78	89.20
6.5BT2	3.47	22.16	84.32	3.52	26.62	86.77
				3.31	26.83	87.63
6.5BM1	5.45	23.76	77.03	5.44	28.75	81.05
				6.29	28.66	78.02
6.5BM2	5.80	24.04	75.86	5.73	28.91	80.16
				5.65	29.03	80.52
6.5BB1	3.18	21.93	85.46	3.32	26.69	87.52
				3.04	26.68	88.59
6.5BB2	3.34	22.06	84.83	SD	SD	SD
				3.60	26.65	86.47