NATIONAL TRANSPORT RESEARCH CENTRE

.....

VARIOUS TYPES OF ASPHALTIC CONCRETE MIXES USED IN ROAD CONSTRUCTION

(A DESK STUDY)

NTRC-202

BASHIR AHMAD
Deputy Chief

December, 1996

LIST OF CONTENTS

EXECUTIVE SUMMARY

There are different types of asphaltic concrete mixes used in road construction depending upon the type of road and volume of traffic carried. The asphaltic concrete is very costly therefore its use should be made very carefully and judicially.

The type of asphaltic and asphaltic concrete mixes range from very expensive types such as mastic asphalt to relatively low cost measures as surface dressing. Mastic asphalt is an ideal form of bituminous mix. It has high stiffness and strength and is highly resistant to deformation. It is extremely durable and dense and is less susceptible to weathering to which bitumen are vulnerable in hot climates. Its disadvantages include low skid resistance and very high construction cost.

A good quality mix is a fine balance of quantities of aggregates and bitumen. Increase of bitumen content in the mix would result in impervious mix but susceptible to rutting. On he contrary mixes with low bitumen content would be prone to fatigue cracking under repeated loads and also the surface would be permeable.

The choice of mix, therefore must be done very carefully depending upon the intended use of the road. Various types of mixes described in the report would give a deep insight of the subject to the reader.

The choice and design of the mix therefore must be done very accurately and suiting to environment and traffic conditions.

Various types of asphaltic concrete mixes used in road construction have been discussed in the report. There are many types of premixes which have been evolved in different countries to suit local and environmental circumstances and it would be useful to have help from this report while making use of any mix.

There are different properties of the mix such as flexibility, stability, workability, impermiability, stiffness, skid resistance and Raveling etc. All these properties depend upon the quality and quantity of aggregate and bitumen. A table giving summary of requirements of Asphaltic mixes is given at the end of the report.

LIST OF FIGURES

1 : OBJECTIVE OF THE STUDY

The objective of the report is to compile at one place various types of asphaltic concrete mixes used in road construction. As there are different types of mixes used as a wearing course and as base/sub-base in road construction, but their use depend on many factors such as traffic, environment and economics. However, it is rare to find description of various types of mixes, their composition etc. at one place. This report gives description of various types of asphaltic concrete mixes so that the reader may have information about mixes at one place.

2 : METHODOLOGY

This is basically a desk study. Therefore literature has been referred from different sources. Relevant books from NTRC library and M.Sc thesis of NTRC officers who undertook laboratory studies were also consulted while writing the report.

3 : INTRODUCTION

Various types of mixes are used in road construction depending on the stability of the mix according to load induced stresses on the road. Asphalts or hot process asphalts are mixtures of mineral aggregate, filler and bitumen which are processed at temperatures as high as 230 C. In-situ, asphalts distribute traffic stresses primarily through the fine aggregates /filler /bitumen mortar. Therefore, to resist deformation under the imposed stresses, the mortar must have high stiffness; this is achieved by using a relatively hard bitumen and a high filler content. In service, asphalts are impermeable and very durable. Two types of asphalts are used namely Hot Rolled Asphalt (HRA) and mastic asphalt. HRA is widely used in the surfacing of major roads, whereas the use of mastic asphalt in road construction is limited to specialist applications, e.g. to provide resistance to abnormally heavy loadings, to provide a waterproof membrane, etc.

4 : MASTIC ASPHALT

Mastic asphalt consists of a mortar of bitumen and fine aggregate and a proportion of coarse aggregate. First hand-laid mastic asphalt was applied successfully as a covering to foot ways in Paris in 1835. This was followed by its introduction into London the following year. There are records of a number of important streets in the City of London laid with mastic asphalt between 1870 and 1873, including Lombard Street, Moorgate Street and Carter Lane. Following the success which was achieved using mastic asphalt, its use grew and in the years following the 1914-18 war it was applied extensively on town and country roads as well as city streets.

The aggregate gradation of mastic asphalt consists of fines between 40% to 55% passing the 75 micron sieve and no more than 3% retained on the 2.36 mm sieve. The percentage of coarse aggregate added varies depending upon the application. Normally the aggregate is mixed with either a 25 per or 15 pen bitumen.

The manufacture of mastic asphalt is somewhat complex. It can be carried out in a single process only when the material is to be used immediately; in such a case all the aggregate is combined with the bitumen in a large mixer equipped with slow-moving blades. Otherwise only the fine aggregate is mixed with the bitumen, producing a mortar which is cast into 25 kg blocks and left to cool. These blocks can be stored and supplied to sites when required. They are then re-melted in a special mastic mixer, together with the desired proportion of coarse aggregate.

Mastic asphalt is normally hand-laid by skilled and experienced `asphalters' who use wooden floats to `work' the material at temperatures between 175 C and 230 C until it has stopped flowing. Thicknesses may vary between 20 mm and 50 mm, according to the intended end use. Its impermeability is assured by the fact that the void content of the laid material is generally below 1%. These stringent requirements - and the relatively small areas normally laid at any one time - have in the past ruled out machine-laying.

The high percentage of fines in mastic asphalt gives a smooth surface with poor skid-resistance properties. To increase the latter, a variety of treatments may be applied. Rolled-in pre-coated chippings are used for busy road surfaces in the same way as with rolled asphalt: the chippings are applied while the material is still plastic enough to allow partial but secure embedment and are rolled in using either hand or light power-rollers. On foot ways and other lightly-trafficked surfaces, the desired finish may be obtained by applying sand, using the floats. Another method, particularly used for multistory car park surfaces, is to roll the surface with a medium size roller while it is still hot. .

In many ways mastic asphalt is the ideal form of bituminous premix. It has a high stiffness and strength and is highly resistant to deformation. It is extremely durable and being dense and voidless, is less susceptible to the weathering to which bitumens are vulnerable in warmer climates. It has two disadvantages for use on roads. One is its smooth surface which becomes very slippery when wet. This disadvantage can be overcome by rolling precoated chippings into the surface whilst the asphalt is still warm, by surface dressing, or by the application of some other anti-skid treatment. The other disadvantage is its relatively high cost.

5 : ASPHALTIC CONCRETE

The design of asphaltic concrete mixtures starts with the assumption that the particle size distribution of the aggregate should be such as to produce the highest possible compacted density in the aggregate fraction of the mix. For this purpose the aim is normally to use a continuously graded aggregate following a Fuller curve.

The Fuller curve is derived from the formula

$$P = 100 \times (d/D)^{0.5}$$

Where P is the percentage of aggregate passing sieve size d, and D is the maximum size of aggregate in the mixture. This formula was derived by Fuller and Thompson (1907) in an investigation of the relationship between the compacted density of Portland cement concrete and the grading of the aggregate used in its manufacture. Typical grading limits for aggregate in asphaltic concrete, as recommended by the Asphalt Institute. The bitumen used for asphaltic concrete is normally in the range 60-100 pen.

Mixtures of aggregate of the chosen grading and bitumen of the selected penetration grade are evaluated using the Marshall testing procedure. This testing procedure has been standardized both in the USA and in the U.K. The relevant standards are:

COMPOSITION OF ASPHALTIC CONCRETE (ASPHALT INSTITUTE)

Sieve Sizes	37.5	25.0	19.0	12.5	9.5
	Percentage by Mass of Total Aggregate Passing				
50	100	-	-	-	-
37.5	90-100	100	-	-	-
25	-	90-100	100	-	-
19	56-80	-	90-100	100	-
12.5	-	56-80	-	90-100	100
9.5	-	-	56-80	-	90-100
4.75	23-53	29-59	35-65	44-74	55-85
2.36	15-41	19-45	23-49	28-58	32-67
1.18	-	-	-	-	-
0.60	-	-	-	-	-
0.30	4-16	5-17	5-19	5-21	7-23
0.15	-	-	-	-	-
.075	0-5	1-7	2-8	2-10	2-10
Asphaltic Cement,Weight % of Total Mixture	3-8	3-9	4-10	4-11	5-12

In considering the total grading characteristics of an asphalt paving mixture the amount passing the 2.36 mm (No.8) sieve is a significant and convenient field control point between fine and coarse aggregate. Gradings approaching the maximum amount permitted to pass the 2.36 mm (No.) sieve will result in pavement surfaces having comparatively fine texture, while gradings approaching the minimum amount passing the 2.36 mm (No.8) sieve will result in surface with comparatively coarse texture.

The material passing the No.200 sieve may consist of fine particles of the aggregates or mineral filler, or both. It shall be free from organic matter and clay particles.

The quantity of asphalt cement is given in terms of mass percent of the total mixture. The wide difference in the specific gravity of various aggregates, as well as considerable difference in absorption, results in a comparatively wide range in the limiting amount of asphalt cement specified. The amount of asphalt required for a given mixture should be determined by appropriate laboratory testing or on the basis of past experience with similar mixtures, or by a combination of both. One method being the ASTM D1559 "Marshall Testing Procedure" and the other is BS 598 (1985) "Sampling and Examination of Bituminous Mixture for Roads and other Paved Areas. Part 3, Methods for Design and Physical Testing".

The two methods are similar, the British being more detailed in an attempt to improve the consistency of result obtained from this rather complex testing procedure. The results of the Marshall Test are shown graphically in Figure 5.1. A range of mixtures is prepared in the laboratory and compacted by a standard method (a dropping hammer) in a cylindrical test mould 101.6 millimeters in diameter and 87.4 millimeters high. The compacted density is then measured. Therefore, the specimen at a test temperature of 60 C, is mounted horizontally between special jaws and a compressive load is applied at a constant rate of strain of 50 millimeters per minute. The maximum load (the Marshall Stability) and the amount of strain at maximum load (the Flow Value) are recorded. Careful temperature control is necessary at all stages since compactability, stability and flow are all influenced by changes in the viscosity of the bitumen in the mixture.

Tests are done with mixtures containing a range of bitumen contents, triplicate tests at each bitumen content, to derive mean values of density, stability and flow. A typical set of results is illustrated in Figure 5.1. These are used to derive an optimum bitumen content and an indication of the density to which the asphalt should be compacted on the road.

Asphaltic concrete derives its strength and stability primarily through aggregate interlock and to a lesser extent through the sand/filler/bitumen mortar. The composition of asphaltic concrete is determined by the U.S.A. Asphalt Institute Marshall mix design procedure the object of which is to arrive at an optimum bitumen content for maximum stability and density. This results in an economical blend of aggregate and bitumen having high stability under traffic and good durability in service, while at the same time being sufficiently workable to lay and compact to a typical void content of 3% to 5%. Bitumen contents are similar to those of dense and close-graded Macadams but harder bitumens are generally used, i.e. 70 pen and 100 pen. During laying, the compaction of the material has to be carefully controlled to ensure that the maximum compacted density is achieved.

Fig 5.1 MARSHALL TEST GRAPHS

6 : HOT ROLLED ASPHALT

Hot Rolled Asphalt (HRA) surfacings were traditionally made with natural sands with varying proportions of larger crushed stone particles added according to the use intended. The essential feature of rolled asphalt surfacings is that they consist of a matrix of fine aggregate and bitumen in which coarser aggregate is incorporated i.e. the aggregate is gap-graded as opposite to the continuos grading of asphaltic concrete. The matrix provides a dense, impermeable and flexible quality to the surfacing. Its stability and resistance to deformation is enhanced by using some what harder bitumens than are used in asphaltic concrete. The proportion of coarse aggregate affects the surface texture of the material when laid. With mixtures containing 30 per cent or less of coarse aggregate, the compacted surface is smooth and rough surface texture, which is needed to produce an adequate resistance to skidding on high speed roads, is provided by rolling in precoated chippings to give a complete cover over the surface Figure 6.1. This provides an adequate texture depth and also contributes to resistance to deformation. It is this material which is needed for the surface of motorways and other busy roads. On more lightly trafficked roads, mixtures containing 45 - 50 per cent of coarse aggregate are used. These have a coarse surface texture providing an adequate resistance to skidding without the use of precoated chippings. The composition, mixing and laying of rolled asphalt mixtures is prescribed in the following British Standards:

BS 594 (1985) Hot rolled asphalt for roads and other paved areas.

Part 1 Constiuent materials and asphalt mixtures.
Part 2. Transport, laying & compaction of rolled asphalt.

This specification includes surfacings, base-courses and bases of rolled asphalt, and the composition of these defined in terms of grading of aggregate, hardness of bitumen and bitumen content. In this current British Standard there is an alternative method of designing rolled asphalt surfacings using the Marshall testing regime and the method of carrying out the test and reporting the results. Typical compositions for rolled asphalt surfacing mixtures are shown in Table 6.1.

In countries with different climates, it will be desirable to employ the Marshall testing procedure to obtain an indication of the likely suitable range of bitumen contents, refining the specifications as experience is gained in practice Changes in the nature of the fines fraction, particularly between natural sand and crushed rock fines, can have a large influence on the required bitumen content.

It is generally recognized that these mixtures are more durable and flexible than the continuously graded asphaltic concretes. They are also less sensitive to minor variations in bitumen content and they are easier to lay and compact to their final density on the road. These are advantages that recommend their use in hot climates but they can be more sensitive to deformation under heavy traffic in hot weather and careful design of the mixture is necessary to avoid this risk.

Fig 6.1 PRE - COATED CHIPPINGS

Fig 6.2 SURFACE TEXTURE OF ITOT ROLLED ASPHALT (HRA)
(HEAVILY CHIPPED)

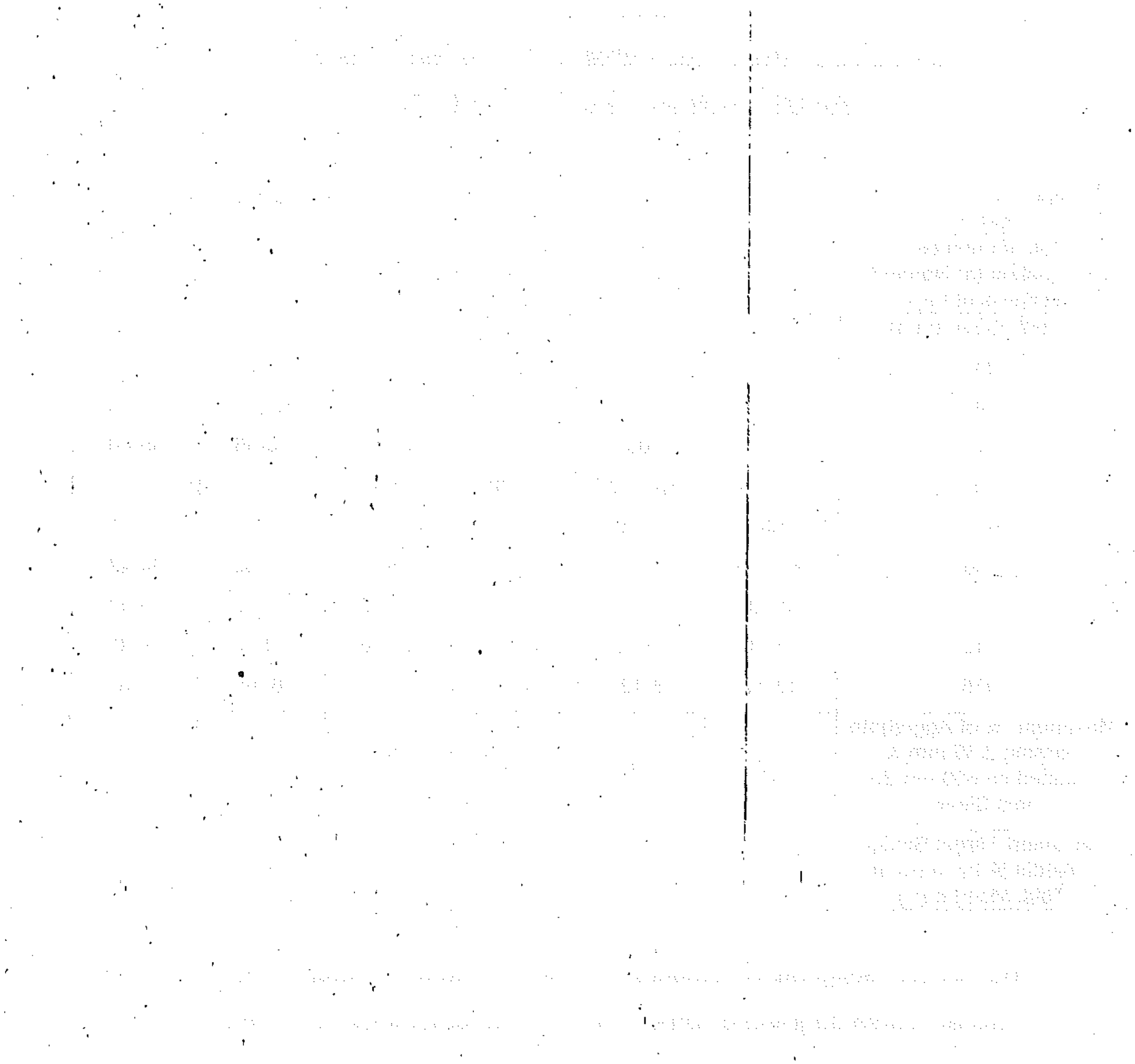

Fig 6.3 HOT ROLLED ASPHALT (LIGHT CHIPPED)

Table 6.1

ROLLED ASPHALT WEARING COURSE MIXTURES

(TAKEN FROM BS 594, 1985 PART 1)

Composition of Design Type F	Percentage by Mass of Total Aggregate Passing Test Sieve					
Column number Designation (a) Nominal Thickness of Layer	7 0/3 (b)	8 30/10	9 30/14	10 40/14	11 40/20	12 50/20
BS test Sieve (mm)						
28	-	-	-	-	100	100
20	-	-	100	100	95-100	95-100
14	-	100	85-100	90-100	50-95	35-80
10	-	85-100	60-90	50-85	-	-
6.3	100	60-90	-	-	-	-
2.36	95-100	60-72	60-72	50-62	50-62	34-47
.6	80-100	45-72	45-72	35-62	35-62	25-47
.212	25-70	15-50	15-50	10-40	10-40	5-30
.075	13-17	8-12	8-12	6-10	6-10	4-8
Maximum % of Aggregate passing 2.36 mm & retained on 600 um BS test Sieve	22	14	14	12	12	9
Minimum Target Binder Content % by mass of Total Mixture (C)	9	7.0	6.5	6.3	6.3	5.3

a) The mixture designation numbers (e.g. 0/3 in column 7) refer to the nominal coarse aggregate content of the mixture/nominal size of the aggregate in the mixture, respectively

(b) Suitable for regulating course.

(c) In areas of the country where prevailing conditions are characteristically colder and wetter than the national average the addition of a further 0.5% of binder may be beneficial to the durability of the wearing courses.

With gap-graded rolled asphalt surfacings, it is the properties of the sand-filler bitumen mortar which dominate the properties of the total mix. The nature of the sand is particularly important in determining the resistance to deformation of the mix. Wheel-tracking tests have demonstrated that there are large differences in both the resistance to deformation and the optimum bitumen contents of mixtures made with different sands, all conforming to the grading limits of BS 594 Brien (1978) has developed a method of using the Marshall testing procedure for evaluating the sand-filler-bitumen mortar which is particularly useful in evaluating the potential of locally available natural sands and crushed rock fines for use in rolled asphalt surfacings. Optimum bitumen contents are determined from tests on sand-filler-bitumen mixtures and the qualities of the mixtures with different sands are compared by using the Marshall Quotient i.e. the ratio of Marshall Stability to Marshall Flow. Mixes using crushed rock fines generally have a higher stability than those made with natural sands but they are less workable and more difficult to compact. There are some circumstances in which it is useful to use mixtures of crushed rock fines and natural sand to produce adequate resistance to deformation combined with ease in spreading and compaction.

Rolled asphalt bases and basecourses are specified in terms of aggregate grading, hardness of bitumen and bitumen content. With all forms of asphalt premix, satisfactory compaction requires that the maximum size of aggregate in the mixture should never exceed half of the thickness of the layer in which the mixture is used. Laboratory studies and full scale road experiments have established that rolled asphalt bases are extremely strong, durable and superior to other forms of base.

7: COATED MACADAMS

Coated Macadams made with tar are the oldest form of coated material used. The earliest record of its use was in Gloucestershire in 1832 and in Nottinghamshire in 1884. Bitumen macadam began to be used when bitumen became available at the turn of the century. The term macadam perpetuates the memory of the famous Scottish road engineer, John Loudon McAdam. McAdam understood that to optimize the strength of a layer of crushed aggregate it was necessary to use aggregate of a mixture of sizes, i.e. a graded aggregate. Using this technique macadam appreciated that the spaces between the larger aggregate would be filled with smaller aggregate producing a layer of relatively open-textured interlocking aggregate. It was the manufacture of open-textured bitumen and tar macadam mixes, a development of McAdam's principle, that was the foundation of the growth of the coated materials industry in the middle of the twentieth century.

The composition of coated macadam is shown diagrammatically in figure 9.1. The mixture can be divided into three aggregate fractions and the bitumen. The functions of the constituents can be summarized as follows.

- coarse aggregate; providing the main skeleton of interlocking aggregate to distribute the traffic loads;
- fine aggregate; fills or partially fills the voids in the coarse aggregate skeleton;
- filler; increases the viscosity of the binder thereby reducing the risk of bitumen draining from the aggregate; combined with the bitumen the filler assists to fill small voids.
- bitumen; acts as a lubricant during compaction and also as a waterproofing and bonding agent in service; in dense Macadams it also assists to fill the voids and provide strength to the mix.

8 : OPEN AND MEDIUM-GRADED MACADAMS

These are used for both base-course and wearing course mixes. The main feature of these mixes is that they have a low fines content which results in good workability during laying, who void contents after compaction of 15% to 25%. To prevent ingress of water into the road structure a waterproof membrane such as a surface dressing is necessary.

The strength of the material is provided in the main by aggregate interlock and only to a limited extent by the bitumen. One of the main functions of the bitumen is to provide tensile strength at the top surface, to prevent loss of the fine aggregate from the surface, when heavily stressed by traffic. The mix is usually bound by 200 pen or 300 pen bitumen or a cutback bitumen, the choice of bitumen depending on the intensity of traffic and the time of year the material is laid.

The texture of a wearing course plays a major role in its skidding resistance. Open and medium-textured Macadams provide satisfactory texture for light and medium traffic conditions, e.g. private drives, car parks, playgrounds, etc. This type of material does not contribute significantly to the strength of the overall road structure.

The permeable nature of this type of mix has been used to advantage on airfield runways and on heavily trafficked roads to prevent aquaplaning and reduce spray. These are known as friction course when used on airfields and pervious macadam when used on highways. Pervious Macadams were introduced into BS 4987 for the first time in the 1988 revision of this standard.

9 : DENSE AND CLOSE-GRADED MACADAMS

Dense macadam roadbases and basecourses have been used in substantial quantities in the last 25 years in major road construction and are suitable for the heaviest traffic conditions. The high fines content results in a dense material, typically 5% to 10% void content, which has good load spreading properties, high resistance to deformation and is sufficiently flexible to resist cracking under repeated loading.

In BS 4987: 1973 14 mm and 10 mm `dense' macadam wearing courses were specified. However, these two materials (figure 9.1) have a relatively high void content and are certainly not impermeable. In the 1988 edition of BS 4987 these two materials have been renamed `close'-graded macadam and a news 6 mm dense wearing course mix of lower void content was introduced. Dense and close-graded wearing course mixes are only suitable for light and medium traffic categories as they do not possess the long-term durability nor the high-speed skid resistance required for the heaviest traffic categories. Dense and close graded Macadams are diagramatically shown in figure 9.1.

Fig 9.1 DENSE MACADAMS WEARING COURSE

10 : HEAVY DUTY MACADAM

Dense bitumen macadam has served well as a high strength roadbase and basecourse on most heavily trafficked roads for a quarter of a century. However, to cope with the predicted increase in traffic loads, even stronger roadbases will be required, with greater resistance to permanent deformation than traditional roadbases. One such material is heavy duty macadam (HDM) which is based on dense bitumen macadam roadbase but incorporates a harder grade of bitumen (50 pen) and a higher filler content (8%).

These two changes in the composition increase the dynamic stiffness by a factor of up to 3. This enables a 10% to 15% reduction in roadbase thickness to be made to that used for conventional dense macadam roadbase, for equivalent performance. Reduced thickness with equivalent performance is attractive for reconstruction work where existing levels, shallow service ducts of limited bridge headroom may dictate the use of thinner than normal constructions. Alternatively, retaining the same thickness will result in a correspondingly longer life.

11 : FINE-GRADED MACADAMS

Prior to the introduction of BS 4987:1988 this material was called fine cold asphalt. However, despite this name this material falls within the macadam category. The majority of fine-graded Macadams are manufactured using 200 pen or 300 pen bitumen or 100 pen cutback bitumen and therefore they require to be laid and compacted at 80 C to 100 C. However, heavily cutback grades are produced for cold laying and depot storage.

When newly laid, fine-graded macadam has a high void content and it is thus susceptible to the effects of water. Therefore, care should be taken in the selection of the aggregate. The void content gradually reduces under traffic and the mix ultimately becomes impervious. The material is usually laid 15 mm to 25 mm thick and will thus remove small irregularities in the road profile when used as an overlay. The material provides little additional strength to the road structure. In view of these points a sound and preferably impervious surface is required. In addition, a base of good regularity is required beneath the material as it is prone to problems if laid at variable thickness.

12 : SURFACE DRESSINGS

Surface dressing is a simple process. It comprises the spraying of a film of bitumen or tar on the road surface followed by the application of a layer of stone chippings. The bituminous film seals and binds the road surface and the chippings provide a durable and non-skid running surface for traffic. Surface dressings do not restore the riding quality of an uneven road surface nor do they make a direct contribution to the structural strength of a pavement. In new construction their purpose is to provide a durable and waterproof running surface. In maintenance they have several functions. One is to restore the non-skid properties of a surfacing that has become slippery, but the most important lies in their use to preserve the structural integrity of flexible pavements against the destructive action of traffic and weather.

In hot climates it is usually the upper layers of pavements that deteriorate most rapidly. The bitumen binder in the surfacing weathers more rapidly in the prevailing high temperatures than in temperate zones. This weathering is particularly rapid in bituminous premixes in which the bitumen is present as only a thin film on the aggregate. In an asphaltic concrete made with 80 - 100 penetration grade bitumen, the bitumen near the exposed surface can weather to less than 20 pen. within two or three years. Such weathering frequently becomes evident as a network of fine cracks in the surface of the asphalt. The asphalt loses its ability to accommodate the strains imposed by the transient deflections of the pavement under heavy traffic loads and, in climates stresses. It is quite common for such signs of pavement distress to appear within the first five years of the life of a new pavement.

In arid climates these cracks may spoil the appearance of the road surface but they are of no immediate engineering significance. But in climates where the annual cycle includes periods of heavy rain, failure to seal these cracks can have expensive consequences. Water, entering through the cracks, accumulates in the upper layers of the pavement. Before it has time to drain away, powerful hydrodynamic stresses are generated under traffic loads, potholes develop and spread rapidly. Much of the value of the investment in the road can be lost in early disintegration of the pavement.

Herein lies the particular value of surface dressing. In surface dressings the bitumen is present in much thicker films than those in premixed bituminous surfacings. Several advantages follow from this. Surface dressings are immediately effective in sealing any cracks against the entry of water. because the bitumen film is relatively thick, the surfacing is better able to accommodate film in surface dressing protects the bitumen in an underlying premix from the rapid weathering that can occur in exposed premixes.

In many developing countries, the large investment in new road building over the last four decades has not been backed upto with a comparable effort in maintenance to prevent the road pavements from deteriorating. Surface dressing is the most important component in such preventative maintenance. It seems likely that, because of the more rapid weathering of bituminous surfacings in hot climates, surface dressing has an even more important role than it has had in building up the networks of bituminous surfaced roads in countries with more temperate climates. There are reasons why preventative maintenance has been inadequate in many countries. One is that transport economists find difficulty in assessing its value in the systems they have developed for determining priorities in road maintenance and rehabilitation.

SUMMARY OF REQUIREMENTS OF ASPHALTIC MIXES

Requirements For	Aggregate	Binder Grade	Binder Content
Stability	Dense Grading High Texture	Hard	Low
Flexibility	Dense Grading	Soft (for thin carpet)	High
Workability	Rounded	Hard (for thick Carpet)	High
Durability	Dense Grading	Soft	High
Impermeability	Dense Grading	*	High
Stiffness	Dense Grading	*	Low
Safety(Skid (Resistant.)	Hard Texture	Hard	Low
Revelling	*	Soft	High

RECOMMENDATIONS

Based on the study of literature on various types of asphaltic concrete mixes, following recommendations are made:

1. Intended use of asphaltic mix must be kept in mind while designing the mix; for example, light duty traffic or heavy duty traffic, the road has to serve.

2. Various factors such as loading, temperature and quality of aggregate used in the asphaltic mix must be taken into account.

3. Normally, asphaltic concrete having dense grading with hard grade bitumen should be preferred on heavy duty roads especially in hot climates. Alternatively, gap graded mixes with slightly higher bitumen content may be used.

4. A good quality asphaltic mix is fine balance of aggregates and bitumen, therefore, care must be exercised in selection of binder grade and binder content e.g. mix stiffness increases when hard grade bitumen is used with relatively less binder content and dense grading. Summary table provides a good guide line for the mix properties.

REFERENCES

1. Road Building in Tropics, State of the Art, Review-9 by R.S. Millard, 1993.

2. The Shell Bitumen Hand Book, Shell Bitumen, UK, 1990.

3. Highway Pavements, Training Course prepared by Prof. Gilbert Y. Baladi, Organized by National Highway Authority, 1995.

4. Resistance to Deformation of Bituminous Mixes by changing Course Aggregate and keeping Course to Fine Aggregate Ratio Constant, M Sc Thesis by Mohammad Naeem, 1993.