FIELD TESTING AND CONTROL OF BITUMEN-RUBBER

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INTRODUCTION

The binder which results from mixing bituminous materials and fine rubber particles is particularly suitable in applications such as stress relieving membrane, crack or joint filling material, waterproofing membrane or as a binder in asphalt. The addition of rubber tends to increase its adhesion properties, decrease the temperature sensitivity of the binder, slow down ageing, increase flexibility and therefore to increase the fatigue life.

The quality of bitumen-rubber binder is a function of the quality of rubber, bitumen and other additives as well as of the process used in blending the ingredients. Quality control of the different ingredients should therefore enhance the quality of bitumen-rubber. It has however been found that field control of the rubber, bitumen and other additives is very difficult because of limited facilities and time.

An important consideration in the field control of bitumen-rubber is the different processes used by different suppliers. Since these processes have been developed through privately sponsored research, it cannot be expected that suppliers must provide this information. It is therefore the aim to eventually develop techniques for testing and control of the final product based on performance criteria.
This paper will first discuss the more important properties of bitumen-rubber and their possible relation with performance and then some practical aspects in field control and testing will be referred to.

PERFORMANCE OF BITUMEN-RUBBER

The amount of rubber, reaction time and reaction temperature are some of the most important factors influencing the properties of bitumen-rubber. The relative influence of these can be illustrated as shown in Figure 1 where the vertical scale can represent resiliency, viscosity, stiffness, resistance to flow etc. This figure indicates that improvements in the properties of bitumen-rubber are to be expected if more rubber is added and if reaction is allowed to take place for an optimum period of time. The lower the reaction temperature, the longer and less critical the reaction time but it is expected that the same maximum levels of engineering properties will not be attained.

It is therefore obvious from Figure 1 that one would like to control the reaction time, reaction temperature and rubber content in order to be able to obtain the optimum benefit. However, engineering properties not only depend on the above factors but also on the properties of the bitumen itself, the particle size and type of rubber used, the type and quality of extender oil or other additives as well as on the blending techniques, most of which are under the control of the supplier.

Experience worldwide indicates that bitumen-rubber generally performs better than bitumen alone. There has therefore been a tendency to aim for the optimum values of the measured properties of bitumen-rubber and the trends shown in Figure 1 have been used as a guide in this respect. Several attempts have been made (1,2) to test for the quality of bitumen-rubber and to relate it to performance. One of these is the ring and ball softening point determination: other tests include resiliency, stiffness, flow, brittleness and viscosity.

Field testing and control of bitumen-rubber
The bitumen-rubber industry together with the NITRR, roads departments and consulting engineers are currently involved in a study in which bitumen-rubber applications are closely monitored and tested in order to relate test results to field performance.

FIELD TESTING

Tests presently being investigated and which can be used for field control include

1. Ring and Ball softening point
2. Viscosity
3. Resiliency or compression and recovery
4. Flow
5. Fracture.

Figure 1 The relative relationship between reaction time, reaction temperature, rubber content and engineering properties of bitumen rubber
The ring and ball temperature is measured using standard methods and equipment \( (3) \). Viscosity can be measured in many ways but it has been found that a Haake type viscometer can be used in the field for routine testing and is presently in use on many sites. The resiliency of the bitumen-rubber is measured by forcing a standard penetration ball into the material and recording the recovery after releasing the force. The flow of the material, at a standard angle and at a standard temperature, is measured and the material is inspected to observe changes in texture and separation of rubber and bitumen. Compression and recovery relate closely to resiliency. Fracture under cold temperature conditions is considered important on sites where low temperatures are expected.

All of the above testing methods are being standardized and used for testing to evaluate the bitumen-rubber \( (4) \). The general relationships \( (2) \) of some of these test results are depicted in Figure 2, 3 and 4. In Figure 2 the relative influence of the type of rubber and the viscosity of binder on the flow is indicated. This figure indicates the general trend but it has been found that deviations are possible, especially when extender oils or diluents are added with certain types of rubber. The resiliency of bitumen-rubber is also dependent on the additives in the mix, as indicated in Figure 3, where it may be seen that additives such as extender oils or diluents tend to decrease resiliency. Figure 4 indicates that an increase in ring and ball softening point temperature increases the fatigue life; under certain conditions a 100% increase in fatigue life is possible by increasing the ring and ball temperature from 50\(^{\circ}\)C to 60\(^{\circ}\)C.

An important parameter is the viscosity of the bitumen-rubber. Figure 5 shows a plot of the temperature/viscosity relationship of several types of binder. Also included is the bitumen-rubber where a specific type of rubber, binder and blending technique was used. The position of the curve for bitumen-rubber will most probably change and depends on factors such as rubber type and content, reaction time and temperature, additives, blending technique etc. The slope of the
Figure 2 The relative influence of type of rubber and viscosity of bitumen on the flow of bitumen rubber

Figure 3 The relative influence of type of rubber and additive on the resiliency of bitumen rubber
Figure 4  The relative influence of ring and ball softening point on fatigue life

Ring and ball temperature $RB_1 > RB_2 > RB_3$

Figure 4  The relative influence of ring and ball softening point on fatigue life
curve for bitumen-rubber is not, however, expected to vary to any 
great extent. From this figure it is clear that bitumen-rubber is 
less temperature sensitive and has the same viscosity as other binders 
at temperatures below 80°C. Also included in the figure are the 
requirements of various countries for the use of different binders in 
seals at the expected road surface temperatures. Due to a more stable 
temperature range in that country, the requirements for seals in 
Australia are for higher viscosity binders. It should also be noted 
that lower viscosity binders are generally required where traffic is 
expected to use the facilities directly after the sealing operation 
has been completed.

FIELD CONTROL

Bitumen-rubber can be used as a binder for seals and in asphalt and 
also as a water proofing membrane on roofs, in dams and for 
stabilizing subsoil moisture. The discussion in this section 
concentrates on the field control of bitumen-rubber as used in 
pavements.

The first section of the paper has illustrated the importance of 
rubber content and of ensuring that the bitumen and rubber react at 
the optimum temperature and time. It is therefore generally desirable 
to have the viscosity as high as possible to ensure a tough, resilient 
material with a long fatigue life. (There may be instances where a 
high flow, low stiffness bitumen-rubber is desirable but these are 
more specialised cases which are not discussed in this paper.)

In the construction of a seal, a material of low viscosity is required 
in order to be able to achieve a uniform spray. The binder for a seal 
is usually sprayed from a tanker which applies the binder under 
pressure through suitable nozzles. The uniformity of spray is 
therefore a function of nozzle size, pressure and viscosity of the 
material. Since different technologies are being used in blending 
bitumen-rubber binders, it can be expected that different requirements
will be placed on viscosity, spray bar nozzles and pressure. Generally, however, it was found that limits could be placed on the viscosity of the material at different temperatures in order to obtain acceptable uniformity of spray applications for a specific tanker. A typical requirement for a specific tanker and a specific binder is shown in Figure 6. In this particular case it was found that non-uniform application of binder resulted when the viscosity rose above 2 800 centipoise. A viscosity below 1 000 centipoise is unacceptable from a quality point of view and desirable engineering properties are sacrificed below this level.

![Viscosity Graph](image)

*Figure 6 Example of requirements that may be placed on a specific supplier for a specific bitumen rubber binder for seals*

When bitumen-rubber is used in the mixing of hot asphalt, viscosity has been found not to be critical and increasing the viscosity to ensure improved engineering properties is considered desirable.
However, proper coating of the aggregate, workability of the mix as well as ease of paving and compaction are aspects which need to be considered in the design and construction of bitumen-rubber asphalts.

CONCLUSIONS

The general trend in the use of bitumen-rubber in South Africa has been to accept the product of the suppliers and to depend on their past experience in this regard. The need for proper specifications, site control and testing has however been recognised and research is currently being undertaken to develop testing procedures in collaboration with clients, consulting engineers, contractors and suppliers (4).

An interim specification has already seen the light and the various suppliers have already drawn up guidelines to be used in the application of bitumen-rubber. These guidelines include limitations on the weather conditions, use of construction equipment, distance between spray tanker and chip spreader, rolling operations and other practical aspects.

Site testing for the quality of bitumen-rubber at present concentrates on resiliency, flow, viscosity, ring and ball softening point and temperature measurements. The quality control of the different ingredients of bitumen-rubber is however of great importance, especially since their engineering properties and their relationship with field performance have not been established as yet. The quality of the ingredients is at present controlled by the supplier who must ensure that his name is associated with a uniform, high quality bitumen-rubber material.

REFERENCES


   Field testing and control of bitumen-rubber


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