BM/191

REPRINT

1977

Investigation on sealants based on bitumen

S. M. SINGH and L. K. AGARWAL

Central Building Research Institute, Roorkee.

44

SUMMARY

Bitumen which is a major component of bituminous sealant, runs and sags on vertical surfaces during summer. Fillers such as chalk, aluminium silicate and magnesium silicate do not completely check the flow at 70°C even when added up to 40 percent by weight of bitumen. Asbestos powder and saw dust stop the flow at 30 to 40 percent of their additions but they make the product difficult to work with. A mixture of rubber and powdered and fibrous filler is found most effective. On the basis of these investigations bituminous sealants for joints in buildings as per IS: 1834-1961 have been formulated. These compositions develop good adhesion with concrete and perform excellently.

INTRODUCTION

MODERN sealants consist of pigmented and unpigmented synthetic elastomers such as silicones, polysulphides and acrylics. These synthetic elastomers are costly and are not indigeniusly available in India. Bitumen based sealants have been used in the past and are still in use. A sealant consists generally of bitumen, rubber, extenders and fillers. It is a hot poured type and is largely used in high-ways. On vertical jo'nts it sags and sometimes flows down during summer.

The demand of sealants has cons'derably increased with the use of prefabricated components in buildings. The ind'genous products fa'l in one or the other requirements specified in IS: 1834-1961 for sealants for build'ng joints (Table 1). An investigat'on on the formulation and development of sealants based on b'tumen was, therefore, taken in this Institute and the results are reported in this paper.

MATERIALS

Bitumen and rubber constitute two major components of a sealant compos'tion. These materials possess excellent resistance to water. Residual b'tumen and b'own bitumen are normally used. Blown bituman is less susceptible to temperature and has higher softening point compared to residual bitumen. Coal tar is also used where solvent resistance is necessary. As such coal tar is not preferred as it has a steeper viscosity temperature slope[1] than most bitumen.

Rubber is added in the bituminous sealant to improve the viscosity temperature characteristics[2] and solvent resistance. Rubber latex, crumb rubber and pulverised rubber are normally used. Neoprene and certain other synthetic polymers show better solvent resistance than natural rubber and are therefore preferred in sealants resistant to jet fuel[3].

The third major component of the sealant composition is the filler. Fillers may be reinforcing or non-reinforcing type. They may also impart specific beneficial properties such as stabilization of binders, protection against U.V. radiations and control of shr'nkage and thermal expansion. These properties are governed by the

TABLE — 1
PROPERTIES OF PROPRIETARY SEALANTS

Sample No	Pour point (pt.) °C	Softening point (S. Pt.) °C	Increase in S. Pt. °C	Flow	Extens'bility	Flash pt. °C	Penetration 1/100th of cm	Filler Settlement
SSC 1	125	74	4	No flow	No failure	160	18	Below 10%
SSC 2	115	61	3	„	„	148	30	„
MSC 3	125	73	5	„	„	134	15	„
MSC 4	115	65	6	„	„	174	18	„
JSC 5	120	67	3	„	„	123	10	„
L — 6	120	71	3	„	„	136	10	„
L — 7	140	81	6	„	„	107	9	„
L — 8	140	80	5	„	„	105	9	„
L — 9	More than 200	More than 80	—	„	„	100	10	„
Requirement as per IS : 1834-1961	180 Max.	70° Min.	5° Max.	5% Max	Extended 6 mm	Min. 200	15—50	10% Max.

TABLE — 2

FLOW CHARACTERISTICS OF COMPOSITIONS CONSISTING OF BITUMEN, RUBBER AND FILLER

Formulation No.	Bitumen	Asbestos	Aluminium silicate	Magnesium silicate	Chalk	Rubber crumb	Rubber dust	Flow time at 70°C
1.	60	—	40	—	—	—	—	2 hrs.
2.	60	—	—	40	—	—	—	3 hrs.
3.	60	—	—	—	40	—	—	½ hr.
4.	80	—	—	—	—	20	—	½ hr.
5.	60	—	—	—	—	40	—	Remains in liquid form
6.	80	—	—	—	—	—	20	½ hr.
7.	60	—	—	—	—	—	40	½ hr.
8.	80	20	—	—	—	—	—	8 hrs.
9.	60	40	—	—	—	—	—	No flow
10.	60	10	30	—	—	—	—	No flow in 10 hrs, but flowed in 24 hrs.
11.	60	10	—	30	—	—	—	No flow in 12 hrs, but flowed in 24 hrs.
12.	60	10	—	—	30	—	—	2½ hrs
13.	60	20	20	—	—	—	—	No flow in 12 hrs, but flowed (6 cm) in 24 hrs.
14.	60	— 20	—.	20	—	—	—	No flow in 12 hrs, but flowed (2 cm) in 24 hrs.
15.	60	20	—	—	20	—	—	No flow in 10 hrs, but flowed in 24 hrs.
16.	60	—	20	—	—	20—	—	1 hr
17.	60	—	—	20	—	20	—	2 hrs.
18.	60	—	—	—	20	20	—	½ hr
19.	60	20	—	—	—	20	—	6 hrs.
20.	60	10	—	20	—	10	—	No flow in 6 hrs, but flowed in 24 hrs.

TABLE — 3

FLOW CHARACTERISTICS OF COMPOSITIONS CONSISTING OF BITUMEN, RUBBER & FILLERS

Formulation No.	Bitumen	Asbestos	Saw dust	Magnesium silicate	Rubber crumb	Rubber dust	Flow at 70°C in 24 hrs
21.	50	10	—	30	10	—	No flow
22.	50	10	—	20	10	—	Flowed
23.	50	20	—	20	10	—	No flow
24.	50	—	10	30	10	—	No flow
25.	50	—	25	—	25	—	Flowed
26.	50	—	30	—	20	—	Flowed
27.	50	—	35.0	—	15.0	—	No flow
28.	50	—	32.5	—	17.5	—	No flow
29.	50	—	25	—	—	25	Flowed
30.	50	—	30	—	—	20	Flowed
31.	50	—	35	—	—	15	No flow
32.	50	—	32.5	—	—	17.5	No flow
33.	80	—	20	—	—	—	Flowed in 12 hrs.
34.	60	—	40	—	—	—	No flow

particle size, shape and their distribution. Fibrous particles impart strength while flaky particles increase durability and flexibility. Fibrous particles also have better levelling, suspension and flatness properties compared to granular particles[4,5]. The flaky particles such as micas are effective agents for the adjustment of consistency.

Considering the above factors bitumen-rubber compositions together with fillers were studied.

EXPERIMENTAL

Calcium carbonate, chalk, magnesium silicate, aluminium silicate, asbestos powder and saw dust were used as fillers. They were thoroughly mixed with 80/100 bitumen at 75°C. In compositions containing rubber, rubber was first mixed followed by the fillers. These mixtures were examined for their flow characteristic as per BS:3712-1964. In this test the material is filled in an aluminimum channel of size 20.0 x 1.6 x 1.1 cm. and the flow is recorded at 70°C at the end of 24 hours. The results are given in Tables 2 and 3.

On the basis of these results seven compositions of sealants were formulated and examined as per IS : 1034-1961 (Table 4). The compisitions passing IS:1834-1961 were tested for their application and durability on concrete blocks. Concrete blocks with straight and zig-zag cavities of 25 x 2.5 x 0.6 cm and 25 x 2.5 x 1.2 cm were cast. The openings were filled with sealant compositions. A 2.5 cm water head was maintained at the top of the block. The treated blocks were then exposed to outdoor conditions.

TABLE — 4
COMPOSITION AND PROPERTIES OF THE SEALANTS

No.	Composition: Bitumen	Rubber crumb	Rubbre dust	Saw dust	Asbestos	Mg. silicate	Properties: Softening Pt. °C	Penetration	Increase in S. pt. °C	Extensibility	Filler settlement	Flowal 70°C	Pour Pt. °C
1.	50	10	—	—	10	30	62	94	5	Passes the test	Nil	No	95
2.	50	10	—	—	20	20	95	65	3	—do—	Nil	No	170
3.	50	10	—	10	—	30	72	75	5	—do—	Nil	No	125
4.	50	17.5	—	32.5	—	—	82	18	4	—do—	Nil	No	134
5.	50	15.0	—	35.0	—	—	86	40	3	—do—	Nil	No	160
6.	50	—	17.5	32.5	—	—	80	19	3	—do—	Nil	No	125
7.	50	—	15.0	35.0	—	—	Becomes very hard and is not workable						
Requirement as per IS : 1834-1961							75° min	15-50	5° ma	Extended to 6 mm	10% max.	5% at 45°C	180° Max.

There was no water leakage or perceptible appearance of dampness at the end of one year.

DISCUSSIONS

A sealant should be resilient and should not flow from the joints at summer temperatures, which goes upto 70°C. It should at the same time be so thick as to resist sinking into the joints. Bitumen flows at 70°C when exposed vertically for 24 hours. Addition of fillers to bitumen, controls the flow. The structure and the particle size of the filler greatly affect the viscosity and thixotropic properties of the system. It is observed that fillers such as chalk, aluminium silicate and magnesium silicate when added even upto 40 per cent by weight of bitumen do not completely check the flow. However, aluminum and magnesium silicates (Fn 10, 11, 13 & 14) are more effective than chalk (Fn. 12 & 15). Similar behaviour is observed for magnesium silicate in formulations containing rubber (Table 2). Fibrous fillers such as a asbestos (Fn. 9) and saw dust (Fn. 34) stop the flow of bitumen at 40 per cent of their addition. But, the products obtained are stiff and difficult to work when such a large quantities are added. The investigations on the mixed filler show that 20 — 30 per cent of aluminium silicate or magnesium silicate (Fn. 10, 11, 13 & 14) with 10 — 20 per cent of fibrous fillers check the flow.

Another important property of a sealant is its capability to seal the joints during its repeated cycle of expansion and contraction with changes in temperature. It depends mostly on its cohesive and adhesive forces. Bitumen shrinks and becomes hard on ageing. This results in cracking and loss of adhesion with the substrate. Addition of fillers controls the shrinkage but severely affects its elasticity. Thinning with solvent is not good as on the evaporation of solvent, it is likely to show appreciable volume shrinkage. Rubber when added into bitumen not only improves the viscosity temperature characteristics but also its cohesive and adhesive properties[3]. It is, however, observed from the Table 2 that rubber addition even upto 20 per cent does not affect the flow tendency of bitumen at the temperature of the test. Therefore, addition of fillers become necessary. Fibrous fillers stop the flow at their 30 35 per cent loading with 15 to 20 per cent rubber (Table 3) and the composition remains workable.

It can be seen from the Table 4 that formulations 1, 2 and 3 fail in softening point and penetration. Being thermoplastic in nature bitumen necessitates judicious control on the addition of fillers. It is only formulations 4, 5 and 6 (Table 4) that meet the requirements specified under IS:1834-1961 for sealants. The observations reveal that rubber dust* can be used in bituminous sealants and the results are comparable with those containing crumb rubber.

ACKNOWLEDGEMENT

The paper is published with the permission of Director, Central Building Research Institute, Roorkee.

REFERENCES

1. R. L. Dunning and W. C. Simpson, Unpublised data, Shell Development Company Ltd., 1960.
2. Adolfas Damusis, 'Sealants', Reinhold Publishing Corporation, New York (1967), pp. 321-324.
3. H. R. Beck and R. S. Ditzick, U.S. Patent 2,697,697 (1954).
4. J. S. Amstock, Adhesive Age, 36, (Nov. 1964).
5. H. W. Sieshiltz and L. H. Cohan, Ind. Eng. Chem., 41, No. 2, 39 (1949).

* M/s Madras Rubber Factory Ltd., Tiruvottiyur High Road Madras

REPRINTED FROM POPULAR PLASTICS VOL. XXII NO. I JANUARY 1977, P.P. 26-33