Modification of Bitumen and Asphalt with VESTENAMER®/GTR **in the Laboratory**

Basic Principles

VESTENAMER®/GTR is a solid mixture used in road construction for modifying bitumen and asphalt by means of a process patented by EVONIK INDUSTRIES.

VESTENAMER®/GTR consists of:

100 parts by weight of crumb rubber (GTR, ground tire rubber) and
4.5 parts by weight of VESTENAMER® (TOR, polyoctenamer)

The crumb rubber has particle sizes between 0.2 and 0.8 mm. The worldwide largest producer of crumb rubber produced from scrap tires scrap tires (of passenger vehicles and trucks) in a recycling process is the company GENAN.

VESTENAMER® (VESTENAMER® 8012) is a semicrystalline polyoctenamer from EVONIK INDUSTRIES.

When VESTENAMER®/GTR is measured out, attention must be given to the units of the quantities specified. The units are commonly parts by weight (PW) or percentage mass (% m/m). Please note the difference between parts by weight and percentage mass. Example: 17.5 PW VESTENAMER®/GTR added to 100 PW bitumen is approximately the same as 14.9 % m/m VESTENAMER®/GTR (binder content); 17.5/(100+17.5)=0.1489.

Methods

In the laboratory, there are basically two processes for modification with VESTENAMER®/GTR: the wet and dry processes. In the wet process, bitumen is modified to give a *modified binder*, whereas in the dry process the rock is mixed with VESTENAMER®/GTR and bitumen to give what can be regarded as a *modified asphalt*.

In the wet process the mass of VESTENAMER®/GTR is apportioned to the binder content; that is, in the setting up of the suitability test, VESTENAMER®/GTR is to be regarded as a binder additive. The total amount of binder normally contains a VESTENAMER®/GTR proportion of 10.0 to 17.5 % m/m (corresponding to a bitumen proportion of 90 to 82.5 % m/m). The above proportions have been arrived at from considerations of practicability.

In the dry process, on the other hand, the mass of VESTENAMER®/GTR is included in the mass of the aggregate, VESTENAMER®/GTR being treated simply as a mineral material. The VESTENAMER®/GTR is added to the rock, that is, the quantity (e.g., 17.5 PW) of

VESTENAMER®/GTR to 100 PW bitumen is mixed "dry" with the rock. To ensure homogeneous distribution of VESTENAMER®/GTR in the mixture, the bitumen is mixed in only at the end.

Please note once again that the wet and dry processes are to be distinguished from each other.

Modification in the Wet Process

The bitumen is placed in a container (preferably a steel bucket) and heated to 180°C by means of an electronically controlled hotplate. The steel bucket should be heated not directly but indirectly, for example, by a silicone oil bath. After the bitumen has been heated to a temperature of 180°C, VESTENAMER®/GTR is added (in several small portions, if required) and stirred into the bitumen. Homogenization is carried out by means of a slowly rotating mechanical agitator at approx. 150 rpm.

For the binder to be processable (pumpable), the viscosity of the modified binder must not exceed a certain limit. Viscosities between 2,000 and 3,000 mPa·s (as measured by a Haake viscometer at 177°C) have proven to be suitable for processing. The reaction time of VESTENAMER®/GTR varies according to the bitumen used, however, and must be determined anew for every bitumen of different hardness and provenance. The reaction time is preferably determined at several different temperatures (150–190°C). If no increase in the viscosity is detectable over a period exceeding one hour, the reaction can be regarded as complete. Our own experience has shown that two hours of agitation time at 180°C for a 50/70 bitumen is adequate for this purpose.

Note

Because the rubber tends to swell, and as a result of the air introduced by the agitator, the bitumen is likely to overflow. For this to be avoided, the container must be filled with bitumen to no more than 2/3 of the maximum filling height. The volume partially subsides again after some time.

Modification in the Dry Process

In the dry process, the rock is first heated to 170°C and VESTENAMER®/GTR is then added and mixed in thoroughly over 90 seconds. Tempering and mixing (by a pug mill mixer) can be carried out by means of, for example, a mixer from FREUNL. The bitumen is then added, and mixing continued for a further 90 seconds. After the mixing process, the material is al-

lowed to stand in a conditioning cabinet at a temperature of 150°C for one hour, to allow further reaction.

Production of Test Specimens

The Marshall test specimen is produced for both the wet and the dry processes by the Marshall process at a temperature of 150°C.

Viscosity of the Binder

A rotation viscometer (from, e.g., HAAKE, see Fig. 1) is used to determine the dynamic viscosity. The viscosity is determined at exactly 177.0°C, the homogeneity of the binder temperature having previously been established. The measured viscosity values are expected to lie in the range of 0–4000 mPa·s, and an appropriate hollow rotating cylinder ("cup") is to be used (see left side of picture in Fig. 1).

Fig. 1: View of a rotation viscometer (Viscotester VT-02, from HAAKE) with the appropriate hollow rotating cylinder of type 1 ($d_o \approx 24$ mm, $d_i \approx 22.5$ mm, $h \approx 53$ mm)

Purchase of measuring equipment

To purchase the above rotation viscometer, the manufacturer, Thermo Electron Corporation, can be contacted at, for example, the following address:

Thermo Electron Corporation
Laboratory Equipment Division
Robert-Bosch-Strasse 1
63505 Langenselbold
Germany
Phone: 0800 - 1 - 536 376
Fax: 0800 - 1 - 112 114
Web: www.thermo.com