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THE WIBAU DUSTLESS ASPHALT PLANT: THE PERFORMANCE OF EUROPEAN INSTALLATIONS

by

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THE WIBAU DUSTLESS ASPHALT PLANT:
THE PERFORMANCE OF EUROPEAN INSTALLATIONS

ABSTRACT

In the Wibau dustless (SL) asphalt plant the binder is added to the aggregate before it is dried and heated in contrast to a conventional plant in which the sequence of events is reversed. This new process virtually eliminates the discharge of dust into the atmosphere without the need to provide expensive dust collecting equipment and has other possible economic advantages deriving from its ability to carry out production in two stages.

A group representing the Department of the Environment's Transport and Road Research Laboratory and Engineering Intelligence Division, and the Asphalt and Coated Macadam Association have visited five plants in Western Europe in order to assess their ability to produce satisfactory bituminous materials. It was found that a wide range of dense materials containing penetration grade bitumen binders was being produced satisfactorily on the Wibau SL plant at output temperatures above 120°C. This suggests that the process could be employed to manufacture many of the dense bituminous mixtures used in Great Britain. Although the limited evidence available suggested that materials produced by the SL process should have an adequate road performance, for full acceptance further evidence of the performance under traffic is required. The use of the process for a wider range of materials and its use in the two-stage form requires further investigation.

1. INTRODUCTION

The development by Wibau Matthias and Co Kg of the SL* process, as used in the Wibau dustless asphalt plant for the manufacture of bituminous materials, has aroused great interest both in Great Britain and elsewhere in Western Europe. The "Wibau SL" plant mixes the binder and aggregate with the latter in its normal wet stockpile condition in contrast to the conventional plant in which the aggregate is first dried and heated before mixing with the binder. An adhesion promoting additive, "Adhistab", is added to the cold, wet binder/aggregate mixture during or after mixing. It is claimed that this mixture can be stockpiled for a considerable length of time at this point in the process, before it is dried and heated. Throughout the SL process the

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* SL is an abbreviation for the German word meaning "dustless".

aggregate is either damp or coated with binder; the dust emission from the plant is therefore reduced to negligible proportions and the need to provide expensive dust collecting equipment is eliminated.

To assess the ability of the Wibau SL plant to manufacture satisfactorily the bituminous road materials most commonly produced in Britain, visits were made to plants in Switzerland, Denmark and France by a combined team from the Department of the Environment and the Asphalt and Coated Macadam Association.

The members of the party were:-

G D Goodsall – Transport and Road Research Laboratory
B W Ferne – Transport and Road Research Laboratory
A D Hogan – Engineering Intelligence Division
Department of the Environment

C R Curtis – Amalgamated Roadstone Corporation
I R Baker – Tarmac Roadstone Holding Co Ltd
Representing ACMA

This report gives details of the information gathered during the visits and expresses opinions, agreed by the party, on the observations made. Observation of the SL plant in full production over a period of time was not possible as the demand for material was at a low level at the time of the visits, made at the end of the 1971 construction season. For this and other reasons detailed comments cannot be given on certain aspects of the performance of the SL plant.

2. BRIEF DESCRIPTION OF THE WIBAU SL PROCESS AND PLANT

A schematic diagram of the Wibau SL plant is shown in Figure 1 and the numbers used in the following description refer to that diagram. A photograph of one of the plants visited is shown in Plate 1.

The wet aggregate is proportioned as in a conventional plant by volumetric feeders (1) (see Fig 1). After passing over a scalping screen (2) to remove over-size material the aggregate is conveyed into a surge hopper (3). The aggregate is then batched into a weigh-hopper (4) where probes sense the moisture content of the aggregate and adjust the wet aggregate batch-weight to give the required dry aggregate weight. When necessary, filler (5) can be batched into another weigh-hopper. These two mix components are discharged into the mixer (6) where the required quantity of binder is added (7).

The hot binder solidifies when it comes into contact with the cold, wet aggregate and becomes distributed throughout the mix in the form of small globules, some containing a proportion of the finer aggregate particles. This premixed material is free flowing and relatively inhomogeneous.

The additive, an adhesion agent called "Adhistab", is added either during the mixing period (8a) or later during transfer of the premixed material to the activator (8b), a modified continuous dryer. This premixed material can be stored for a considerable length of time if required. In the activator (9) the aggregate is dried and coated with binder, probably simultaneously, and then further heated to the required output temperature; the additive is claimed to assist both the drying and coating. As both these processes take place together dry uncoated aggregate is never present and the dust problem associated with normal plants does not arise. The hot bituminous mixture can then be either discharged into a lorry for transport to the laying site or conveyed to hot storage bins for later use (10).

3. PLANTS VISITED AND MATERIALS USED

Five Wibau SL plants were visited during two trips to Western Europe in September and October 1971. Two of the plants were in Denmark at Aalborg and Kindertoft, two near Strasbourg in France at Colmar and Hagenau, and one in Switzerland at Thun. All had capacities of 150 Mg/h except the plant at Kindertoft which had a capacity of 200 Mg/h. All the plants were relatively new, having been in operation for from 3 to 15 months at the time the visits took place. Only a very brief time was spent at Hagenau.

Whilst in the area of Strasbourg the opportunity was taken to visit a Mr E Muntzer, who developed the additive, "Adhistab", and subsequently what is now known as the SL process.

The aggregates used were in a range of sizes up to 35 mm and mainly consisted of a variety of uncrushed and crushed gravels, but a granite aggregate was also processed at two of the plants. Where necessary additional limestone filler was used. Only penetration-grade petroleum bitumen binders were used in a range of penetrations from 60 to 700. A variety of dense basecourse and wearing course bituminous mixtures were produced by the plants. Further details are given in Appendices 1, 2 and 3.

4. DESCRIPTION OF PLANT

The general layout of a typical SL plant is shown in Figure 1; in practice, minor variations were noted and are included in the following detailed description.

4.1 Plant control system

The operation of the plant was carried out by an electronically based system. Once started, the plant would continue to produce material until either the required pre-set quantity had been manufactured or the plant was stopped manually. Some of the more important operations carried out by this particular control system are described in later sections. It was also possible to execute all plant operations under manual control.

4.2 Cold aggregate feed system

At each site visited the arrangements for the feed of the cold, wet aggregates had been well considered and an adequate number of feed hoppers provided to ensure flexibility of production. Each type and size of aggregate was proportioned by a volumetric belt feeder. Individual feed rates could be readily adjusted over a wide range by varying the speed of the electric drive-motors. The gate openings of the feeders were calibrated for each material and then set to the optimum positions that covered the full range of feed rates required by the specifications to be met. The total feed rate of the combined aggregates could be varied by a single adjustment of the control system without affecting the relative proportions being delivered from each feed hopper. To protect the proportioning system material-presence switches were fitted at the outlets from the feed hoppers. These switches stopped the whole feed system when absence of material was detected on any one running feeder. Quick-release levers on the gates facilitated the clearance of any obstruction. All the plant operators appeared well satisfied with the system.

Feed hopper arrangements at different sites

Thun – six medium feed hoppers of about 20 Mg capacity.

Aalborg and *Kindertoft* – six medium and two large feed hoppers of about 20 Mg and 30 Mg capacity respectively.

Colmar – six medium-capacity feed hoppers. At this plant the speed settings of the six belt feeders could be quickly adjusted for different specifications by means of a "patchboard" system.

4.3 Scalping screen

At Thun, Aalborg and Kindertoft a conventional vibrating screen was fitted between the feed system and the cold aggregate surge hopper to remove any aggregate larger than the overall maximum size used at the plant.

At Colmar and Hagenau this screen was replaced by a Mogensen sizer which could be set to reject a predetermined size depending on the maximum size of aggregate permitted in the material being produced.

4.4 Cold aggregate surge hopper

After passing the scalping screen the cold, wet aggregate was stored in a small surge hopper until drawn off into the aggregate weigh hopper. Level probes in the surge hopper prevented overfilling. Normally only one hopper was provided but at both Colmar and Hagenau there were four. The use of multiple hoppers was said to be advantageous when quick changes are required from one specification to another.

4.5 Aggregate weigh hopper and moisture compensation system

The automatic control system discharged cold aggregate from the surge hopper into the weigh hopper. Two capacitance moisture probes fitted at the bottom of the weigh hopper were used to detect the moisture content of the aggregate as it filled the hopper. When the moisture signal became stable the control system adjusted the required weight of the wet aggregate to allow for the weight of water in the batch. The weight of dry aggregate in each batch was thus maintained constant and, when a pre-set amount of binder was later added, the percentage binder content therefore also remained reasonably constant.

4.6 Addition of binder

The required quantity of binder, measured by a volumetric meter, was added to the aggregate in the mixer through an "atomizing" spray bar. The addition of the binder was automatically controlled by the sequencing system.

4.7 Addition of filler

This was carried out using a conventional arrangement of silos, screw feeders and a weigh hopper, all regulated by the control system. There were no significant technical differences between the plants visited.

4.8 Mixer

The mixer was of a conventional pugmill type, although Wibau use a higher paddle-tip speed in their design, 2.8 m/sec, than almost all other manufacturers. The mixer at the Kindertoft plant had a batch-weight capacity of 1500 kg; all the other mixers were of 1200 kg capacity. The mixing-cycle time used was normally around 30 sec, the binder being added to the mix during 10–15 sec of this period, the exact time depending on the binder content. At Colmar the material was discharged from the mixer after a particularly short mixing time which produced a visibly inhomogeneous premixed material. Despite the state of this material the output material from the activator appeared homogeneous and well coated.

Immediately below the mixer door a surge hopper of just over single-batch capacity was mounted. The base of the hopper consisted of a feed belt fitted with an adjustable gate. In use the gate was set so that the premixed material could be discharged from the surge hopper at a suitable rate to ensure continuous and uniform delivery of the material by a transfer conveyor to the activator.

4.9 Addition of additive

The additive is a water-soluble, metal-acid salt, which becomes active above 80°C and is stable up to 320°C. Approximately 400 g of the additive, usually dissolved in 1400 g of water, is required to treat every megagramme of mixture. In its liquid form the additive is corrosive and is therefore stored in a stirred fibreglass tank and conveyed to the point of addition in plastic pipework. Two basic methods of addition were used:

(1) Spraying on to material on the transfer belt between the mixer and activator, used at Thun and Colmar. At the latter plant the system was particularly crude and uneven in its distribution.

(2) Spraying on to material in the mixer. This method was used on the later plants at Aalborg and Kindertoft and, because of the low concentration of additive in the mix, was said to cause no corrosion.

At Hagenau the feasibility of introducing the additive on the transfer belt between the mixer and the activator in a powder form, claimed to be entirely non-corrosive, was being investigated. No actual evidence of corrosion was seen on any of the plants, although, as described above, simple precautions against corrosion had been taken where they were considered to be necessary.

4.10 Activator

4.10.1 General The activator was basically of a construction similar to the continuous dryer of a typical British asphalt plant. The activator at Thun is shown in Plate 1. The main difference between the activator and a continuous dryer was that the activator was of a uni-flow type with the burner at the aggregate feed end, unlike the contra-flow system normally found in this country.

As the premixed material was fed into the activator it was kept away from the centre of the oil flame by means of a spiral feed section. As the material passed along the activator it was lifted and cascaded through the hot gases by means of deep buckets fixed to the inner wall of the activator. A surge hopper at the end of the activator discharged hot mixed material into a skip at forty second intervals.

The activator of the plant at Thun, which was the earliest production model, was smaller than seen elsewhere. The drum, inclined at an angle of 3° to the horizontal, rotated at a speed of 8 rpm and operated with an exhaust gas temperature of about 400°C. At Aalborg, in order to improve thermal efficiency, the activator dimensions had been increased to a diameter of 2.2 m and a length of 8 m, the change bringing about a reduction in exhaust gas temperature to between 160 and 240°C. In the 200 Mg/h plant installed at Kindertoft, the newest plant visited, the dimensions had been increased to a diameter of 2.6 m and a length of 11 m, mainly to accommodate the higher output. The residence time of this latest activator was said to be of the order of 5½ to 6 minutes, an increase over earlier versions.

The primary and the secondary air for the activator were supplied by the same fan and a single remote control was used to vary both the air proportions and the total oil flow to the burner. Also provided was a remotely-controlled damper in the exhaust duct which could be adjusted to obtain a recommended depression below atmospheric pressure inside the activator.

4.10.2 Temperature control A two-stage control was exercised over the heating process. On start-up a fixed supply of fuel and air was maintained until a predetermined exhaust temperature had been reached. At this stage burner control was taken over by an automatic controller responding to the temperature measured by a sensor mounted in the activator output surge hopper. This sensor appeared to have an insufficiently fast response to be effective in controlling short-term temperature variations.

4.11 Hot-mix storage

Mixed material from the activator discharge was delivered by skip to conventional insulated storage hoppers. The hoppers varied in number from two to seven and in capacity from 40 to 60 Mg at the plants visited. At all plants a facility was available for direct discharge from the skip into a lorry.

5. TESTS AND OBSERVATIONS

5.1 Moisture meter

At the Thun plant, as a rough check on the aggregate moisture meter, two samples were taken from the same aggregate passing through the plant. One sample was taken from the aggregate on the conveyor belt delivering to the cold aggregate surge hopper and the other from the aggregate/bitumen mixture being discharged from the mixer. At the same time recordings were taken of the moisture content of the aggregate in the weigh hopper as indicated in the control cabin. The moisture content of both the samples was found to be 3.1 per cent (by weight) whilst the readings taken in the control cabin were in the range 3.2 to 3.5 per cent.

At the Aalborg plant the company operating the plant was not satisfied with the performance of the moisture meter for all materials. With gravels from local pits the accuracy was satisfactory but with granite fines from the Bornholm quarry the indicated moisture content showed a marked discrepancy from the true value. For example true moisture contents of about 5 per cent were indicated as 10 per cent by the meter. At Kindertoft measurements on the same material were also known to be inaccurate. The discrepancies in the moisture contents were probably caused by the presence of minerals in the granite that affect the electrical properties of the materials being measured. Wibau are aware of this problem and are considering the possibility of fitting alternative equipment that is more universally applicable.

5.2 Moisture compensation system

During a production run at Thun the wet aggregate batch weights and their corresponding moisture contents, as indicated in the control cabin, were recorded for fifteen consecutive batches. These readings are shown graphically in Figure 2, together with figures for the weight of dry aggregate batched when calculated both with and without the moisture compensation. By holding the dry aggregate weight reasonably constant and batching a constant amount of binder the overall binder content is kept steady. The effect of this system on the binder content of the mix produced is shown in Figure 3 by values calculated from the readings shown in Figure 2. A range of 0.04 per cent in binder content was calculated for materials produced with moisture compensation compared with a range of 0.17 per cent without compensation. It should be noted that for a normal mix a change of 1 per cent in moisture content of the aggregate will give rise to a change of approximately 0.05 per cent in the binder content if left uncompensated. The existing British requirements for the binder content of most bituminous mixtures are that they should be within 0.5 per cent of the specified value.

5.3 Fuel consumption

Theoretically a uni-flow dryer or activator should be less efficient in transferring heat from the hot gases to the cold aggregate than a conventional contra-flow dryer, but quoted fuel consumption figures of 8.0 l/Mg of mixed materials at Thun, 6.3 l/Mg at Kindertoft and 5.5 l/Mg at Colmar indicate that the overall efficiency of the two systems is not appreciably different. Some or all of these fuel-consumption figures include the fuel used in maintaining the binder temperature but since this amount is relatively small the figures can be used to indicate that the fuel requirements for the two systems are comparable.

5.4 Temperatures of mixed materials

Generally the temperatures at which the mixed materials were produced were rather higher than those permitted in this country for the same grade of bitumen. Table 1 summarises the temperature data obtained.

5.5 Hardening of the binder

Several tests have been carried out to ascertain the extent to which the binder hardens during the SL process. The results of three of these tests are given in Table 2.

The first set of results were obtained by the Swiss Federal Institute of Material Testing (EMPA);[1] no details of the recovery process used are known. The second set were obtained by the Transport and Road Research Laboratory on dense wearing course material sampled, shortly after the visit to Thun, by the Frutiger Sohne company, who own the plant. The mixture was extracted with dichloromethane and the bitumen recovered by a vacuum distillation procedure. The third set of results were obtained from samples taken by members of the party during their visit to Kindertoft. The binder recovery was carried out on a small scale and tested using a sliding-plate viscometer by Philmac Oils Limited; the viscosity results were converted to penetration values.

5.6 Mix composition

During the visit to Thun, members of the party took several samples of material each representing the different stages of the process. Results of the analyses of these samples, carried out at the Transport and Road Research Laboratory, are given in Table 3 and the gradings plotted in Figures 4 and 5.

6. DISCUSSION OF THE PLANT AND PROCESS

6.1 Aggregate proportioning

The aggregate grading of the finished product from a Wibau SL plant is controlled solely by the volumetric feeders. The quality of this finished product is therefore dependent on the accuracy and consistency of the feeders and, more important, of the feed materials. It is therefore most important that the grading, stockpiling and handling of the raw materials are carried out efficiently.

6.2 Addition of binder

Fine dispersion of the binder in the mix does not appear to be essential to the efficiency of the process. At the various sites visited it was evident that the degree of dispersion in the premixed material varied considerably from fine drops to quite large accumulations of binder. However, when the paddle tips became worn on the Aalborg plant, after producing 90,000 Mg of material, the binder passed through the plant in large agglomerations that did not disperse in the activator, indicating that some mixing is required for efficient operation of the process.

6.3 Additive

The need for an additive to prevent 'stripping' of the gravels produced in the Strasbourg area encouraged Mr Muntzer to develop "Adhistab" and subsequently the SL process.

This additive was included in all the materials being produced during the visits, although both in Denmark and in Switzerland the feeling was expressed that the additive was not needed in the layers below the wearing course and was only required in that course as a precaution.

It is understood that Wibau will accept responsibility for the efficiency of the SL process and the performance of the material produced only if the additive is incorporated in the mix. In this respect the performance of the material is 'guaranteed' to be equivalent to the performance of a similar material produced by conventional means. The additive used at Thun was paid for directly by the Canton of Berne, the purchaser of the mixed materials. The producer in this case therefore had no financial advantage in omitting the additive. In Denmark the use of adhesion-promoting additives for mixtures prepared with soft binders and the indigenous aggregates is common practice and consequently they readily accept the use of "Adhistab".

Published literature[2, 3, 4, 5] suggests that the use of "Adhistab" would lead to an additional cost of between 2.5 p and 10 p per Mg. However the literature also suggests that the capital investment and running costs of an SL plant should be less than those of a conventional plant and savings in the range 8 p to 18 p per Mg have been predicted for German conditions.[5]

6.4 Minimum moisture content of aggregate for dustless operation

For dustless operation of the plant Wibau recommend a minimum moisture content of the combined aggregate of two per cent and this view appeared to be confirmed by the various plant operators. Mr Muntzer, however, considered that the process could be satisfactorily used with moisture contents as low as 0.5 per cent. Wibau consider that this apparent discrepancy is due to the inevitably uneven distribution of the moisture in the mix, which therefore necessitates a higher overall moisture content to ensure that all parts of the mixture have a moisture content above the minimum of 0.5 per cent.

6.5 Minimum recommended output temperature from the activator

To ensure satisfactory operation of the process a minimum temperature of 110°C for the output materials from the activator is recommended by Wibau. Mr Muntzer's view was that 80°C was adequate to enable the additive to be fully effective.

Below an output temperature of around 120°C it is probable that a significant proportion of the original moisture will remain in the mix after leaving the activator. Although the additive should enable the bitumen to coat the aggregate in the presence of this residual water, this water could possibly adversely affect the handling, laying and road performance of the material. Mr Muntzer claims that the 'latest' form of "Adhistab" has the property of stiffening such mixes so that they handle normally.

6.6 Temperature of mixed materials

In Section 5.4 it was mentioned that production temperatures of mixed materials much higher than those permitted in this country were acceptable in Europe. The temperatures observed by the party were generally in accordance with the recommendations given in each country.

Although it was expected that drainage of the binder from the aggregate might be a problem at those high temperatures, in practice it was understood that drainage only occurred with the open-textured mixes. Most of the specifications of materials produced on the SL plants were however dense, eg over 40 per cent passing the 3.35 mm sieve, and no evidence was seen to suggest that drainage occurred with these materials.

6.7 Hardening of the binder

Excessive hardening of the binder during the passage of the mixture through the activator might be expected. The evidence shown in Table 2 suggests that this fear is unfounded. Even when using "mixing" temperatures some 20°C higher than would be permitted in Great Britain, the degree of hardening is acceptable and is probably less than would occur if mixed in a conventional plant at normal temperatures.

At Kindertoft it was stated that a 700-penetration-grade binder hardened appreciably more when mixed for one minute at 140 to 145°C in a conventional plant than when subjected to the same temperature in the SL plant. The difference in the binder behaviour observed in the two cases may be due to one or more of the following causes:-

(1) The presence of water and water vapour in the activator may reduce the evaporation of oil from the binder and also act as a controlling influence over the temperature in the hot zone near the burner flame.

(2) At the discharge end of the activator, where the water has been removed, the use of the uni-flow type of burner system will reduce the gas temperatures to which the binder is exposed.

(3) The absence of free oxygen in any appreciable concentration in the activator atmosphere, suggested in References 2 and 4, may lead to a reduction in the risk of oxidation of the binder.

(4) The 'cascading' mixing action of the material in the activator may reduce the time of exposure of thin films of binder to the hot gases to considerably less than the residence time of the material.

(5) The bitumen produced on the Continent may be less susceptible to hardening than the United Kingdom equivalent.

From earlier comments it would appear that the fifth possibility is unlikely to be substantiated.

Experiments[6] carried out in America support the third hypothesis. They indicated that hot storage of mixed material in an oxygen-reduced atmosphere caused significantly less hardening than when the material was stored under normal conditions.

Although samples of pitch-bitumen supplied by Tarmac Ltd to Wibau Matthias and Co. Kg. for test purposes have not so far been used, Wibau do not expect to encounter any serious difficulty in mixing this type of binder in the SL plant. Some doubt was however expressed about the potential ability of the plant to mix tar that contained any appreciable quantity of light oil.

6.8 Operation of the activator

Some of the plant operators suggested that when starting or finishing a production run of a particular material on the SL plant it was sometimes necessary to reject some of the output material because of incorrect grading. This is probably caused by the different sizes of aggregate passing through the activator at dissimilar rates although the range of effective sizes will be reduced by the continual presence of a liquid, either water or bitumen, binding together the smaller particles in the mix.

It was noted at all the plants visited that no significant accumulation of bitumen or bitumen and aggregate mix could be seen inside the activators.

During visits to two of the SL plants the premixed material was being fed to the activator at an unusually low rate and this naturally caused a substantial increase in the temperature of the material leaving the activator. In turn this resulted in the surface binder igniting but this did not create a serious hazard in what were highly untypical operating conditions.

6.9 Production of coated chippings for rolled asphalt

Although it appears that open-textured coated macadam is not normally produced on any of the plants, a small quantity of 12–14 mm coated chippings were produced on the Aalborg plant for a rolled asphalt trial mentioned later in Section 7.2. From the appearance of the chippings there seemed to be some contamination with sand but there was no sign of coking and the chippings were evenly coated with 1.3 per cent of binder.

6.10 Environmental pollution

At Thun it was noted that the plant emitted a small amount of grit, of approximately 1 mm diameter, from the exhaust chimney (see Plate 2). More recently installed plants at Aalborg and Colmar had been fitted with a simple cyclone to remove these particles from the exhaust gases before they were discharged into the atmosphere. The need for this cyclone is eliminated on the latest plants, such as at Kindertoft, by an increase in the length of the activator combined with a redesign of the exhaust ducting at the output end of the drum in the form of an expansion box as shown on Plate 3. Apart from this single instance at Thun the operation of the activator appeared to be dustless, based on observations of the exhaust discharge and of the general cleanliness of the sites visited.

The general noise level of the SL plants did not seem to be markedly different from conventional plants of the same output. There was also no evidence that the general level of fumes emitted was any higher than from conventional plants.

6.11 Mix composition

6.11.1 Residual moisture content The results shown in Table 3 confirm that with the particular aggregates used at Thun the residual moisture content in the hot mix is acceptably low. Similar figures (of 0.08 – 0.10 per cent) have been quoted by the operating company. No figures are available for the moisture content of the mixes produced at other plants visited but it was noted at Colmar that the hot mix appeared to be losing moisture through the binder film immediately after activation at a final temperature of between 140 and 170°C.

This phenomenon is not uncommon when producing gravel mixtures on a conventional plant. It occurs especially when the aggregate contains a substantial amount of absorbed water.

6.11.2 Maximum aggregate size The largest nominal-size material produced on the plants visited was 35 mm at Thun, although a more common figure was in the range 20 to 22 mm. It is understood that no practical difficulties, such as segregation, were experienced when using these large sizes of aggregates on the SL plants.

6.11.3 Variability In general, the permitted tolerances in the Swiss and Danish specifications are more severe than similar British specifications (for further details see Appendix 4) but from all available information it would appear that there has been no undue difficulty in complying with these more stringent requirements.

At Thun, Aalborg and Kindertoft a brief examination of the records of routine test results clearly showed that the variability of the materials produced was well within the values expected from materials produced by conventional plants. In Figures 4, 5 and 6 it can also be seen that the plant can be controlled to produce the material intended. It is of interest that the plant at Thun was purchased on the understanding that the manufacturer would replace it with a conventional plant if it failed to produce material meeting the Swiss specifications.

At Aalborg the opinion was expressed that the end product from the SL plant was less variable in composition than the product from the conventional plant they were operating at the same time. The reason for the reduced variability was thought to be the use of the cold feed to control the grading without re-screening after drying. It must however be emphasized that the consistency in grading of the output material depends greatly on the uniformity of the grading of the feed materials.

6.12 Plant outputs

At three of the plants visited the hourly rated output was 150 Mg and at the fourth 200 Mg. Figures for the maximum daily output of the 150 Mg/hr plants ranged from 1200 to 1500 Mg and the 200 Mg/hr Kindertoft plant had produced 28–30 000 Mg of mixed material in two months of intermittent production. At no time during the visits however was a plant in operation at its rated output for any substantial length of time.

6.13 Two-stage SL process

One of the advantages claimed for the SL process is that the cold binder/aggregate mixture can be prepared in advance of, and at a separate location from, the activation process. It is understood that at present there is only one SL plant which has worked in this way and this plant is located in Germany. During the visits there was no opportunity to examine this plant.

The use of the two-stage process should enable production to be carried out in a more economical and convenient way. The production of premixed material does not need to be organized to satisfy the immediate demands of the paving programme and some savings in labour costs could therefore be envisaged as a result of the consistent output conditions which would then be possible. Furthermore the activation process for a particular area may be undertaken close to the laying site which may be separated in time and place from the premixing site. In this way the activation process can be more effectively organized to allow for local adverse weather conditions.

The problem that is most likely to arise is the possibility of segregation during handling between mixer and activator, especially when materials containing aggregate of 40 mm maximum size are being processed. Segregation of the finer particles during storage may also occur if the premixed material is exposed to heavy rainfall for an extended period. This latter effect will probably be reduced to an acceptable level by the limited binding together of the finer aggregate particles by the bitumen present. A further possible drawback could be the vulnerability of the binder in the premixed material to atmospheric attack, but this is not expected to be a serious problem for the storage periods envisaged.

It is of interest to note that Wibau have carried out limited tests of the two-stage process at their works. They premixed and stored approximately 8 Mg of material for a period of 8 months from August until April in the open air without any cover or protection before activation. Tests to determine the Marshall stability of this material and of the same material activated immediately after premixing gave similar results.

Clearly, if the optimum benefit is to be derived from the two-stage process, the production programme must be critically examined and the whole operation thoroughly organised to maintain a maximum overall efficiency.

7. ROAD SITES VISITED

Road sites where material manufactured by the SL process had been laid were inspected in Switzerland, Denmark and Eastern France. Further details of these sites are given in Appendix 5.

7.1 Near Thun, Switzerland

Four different road sites were visited in Switzerland. One site was a trial of rolled asphalt wearing course with coated chippings. A conventional dense bituminous mix was used at the other three sites. At one of these the dense wearing course AB 10 material had been laid in three sections. These sections compared the production of the material on the SL plant, with and without additive, with production on a conventional plant. At none of the sites was there any appreciable traffic and all the materials appeared normal and satisfactory.

7.2 Near Aalborg, Denmark

Visits were made to two road sites in Denmark, one surfaced with a fine cold asphalt containing 700 pen bitumen which appeared to be a very stable material. The other site was another trial of wearing course rolled asphalt, in this case laid as a section of a new motorway. The material appeared durable although only light traffic was using the motorway.

7.3 Near Strasbourg, France

Two road sites were visited in France. A dense wearing course material was used at both sites. At one site the material was being laid on a minor road; at the other site the material was being heavily trafficked on the N4 national route from Strasbourg to Paris. At this latter site two sections had been laid, one with material manufactured on the SL plant and the other on a conventional plant. Under heavy traffic both sections had deformed in the wheel tracks to the same extent, with maximum deformations of about 4 mm. In fact there was no visible difference between the condition of the two sections. Equality of performance under traffic of the material made by the two processes is thus indicated at this site.

8. ATTITUDE OF CERTAIN COUNTRIES TO THE WIBAU SL PROCESS

8.1 Germany

It is understood that at present there is only one SL plant on production work in Germany. The main reason for this is the reluctance of the authorities to accept material without an unconditional five-year guarantee. Wibau are willing to accept that the product should be comparable, in all respects, with the same material produced on a conventional plant. However they decline to accept the added risk, implicit in an unconditional guarantee, that failure of the material on the road may be attributed to the use of the SL process when the cause could well be that the material is unsuitable in type or thickness for its in-service conditions.

8.2 Denmark

Danish producers are prepared to accept that they should guarantee mixtures made with soft binders for three years and with hard binders for five years irrespective of the method of production.

8.3 Belgium

Towards the end of 1971 the Belgian authorities issued regualtions permitting the use of the SL plant to produce bituminous mixes. The main restrictions on its use concern:-

(1) a maximum limit on the natural filler content of the aggregates in order to supplement each mix with sufficient quantity of high-quality filler.

(2) the necessity for regular tests of "stripping resistance" on samples of mix, by the Riedel and Weber method.

9. REQUIREMENTS OF BRITISH STANDARDS

The requirements of current British Standards for bituminous mixtures that:-

(a) the aggregate shall be 'dry' before coating,

(b) the aggregate and binder shall be separately heated to the appropriate temperature,

cannot be complied with when producing material by the SL process. All relevant British Standards include the first requirement and the majority include the second one.

The requirements of current British Standards with regard to the mixing temperature of many bituminous materials may also require to be modified if the SL process is to be used in this country.

10. CONCLUSIONS

1. The latest Wibau SL plants do not emit a significant amount of dust and therefore justify the description "Dustless".

2. The general noise level of the Wibau SL plants visited did not seem to be markedly different from conventional plants of the same output. There was also no evidence that the general level of fumes emitted was any higher than from conventional plants.

3. A wide range of dense bitumen-coated materials has been produced by the Wibau SL process and it is expected that the following materials can be produced successfully and without difficulty:-

   (a) rolled asphalts containing penetration-grade bitumen.

   (b) dense bitumen macadams containing penetration-grade bitumens and mixed at a temperature above 120°C.

   (c) cold asphalt containing penetration-grade bitumen and mixed at a temperature above 120°C.

4. There is little evidence as to the likely future road performance of materials mixed by the SL process; most of what was seen on the visits had only been lightly trafficked for a short period of time. However, on one heavily trafficked road, lengths of dense asphaltic concrete which had been mixed by both conventional and SL plants were examined. Comparison of the condition of the sections suggest that no serious road performance problems should be encountered as a result of using material produced by the SL process.

11. RECOMMENDED FUTURE WORK

1. If the single-stage SL process is to be used to produce the full range of bituminous road materials covered by British specifications, certain aspects of this process will require further investigation. These are:-

   (1.1) The ability to produce,

      (a) open-textured materials;

      (b) materials coated with tar, fluxed bitumen or pitch-bitumen which are widely used in this country and of which no examples were seen during the visits.

   (1.2) The ability to manufacture the full range of road materials at the mixing temperatures required by the specifications, particularly when these temperatures are below 120°C. If production at the recommended British temperature does not prove to be possible the ability of the SL plant to manufacture some or all of the materials at higher temperatures should be investigated.

2. If use is to be made of the possible economic advantages of operating the SL plant in two-stage form, the effect on the final product of stockpiling premixed materials for up to one year should be studied.

3. Further evidence of the performance under traffic of materials mixed by the SL process is required. It will therefore be necessary to observe the behaviour of trial lengths laid on heavily trafficked roads. Laboratory experiments on the behaviour of these materials under repeated loading would provide useful supporting evidence.

12. ACKNOWLEDGEMENTS

Throughout the visits the party was shown every co-operation by the various producers; also the success of the visits to Denmark and France was ensured by the presence of Mr Lorenzen of Wibau Scandinavia. The basis of Figure 1 was provided by Wibau Matthias and Co. Kg.

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14. APPENDIX 1

PLANTS VISITED

14.1 Thun, Switzerland — 21 to 23 September 1971

Frutiger Sohne A–G operate an SL plant with an output capacity of 150 Mg/hr at Thun, near Interlaken. The plant has produced over 50 000 Mg of material for the hard shoulder and slip roads of a section of the Berne-Interlaken Motorway since June 1970. The operation of the plant was discussed with Mr M Blumer, the Chief Road Engineer at Frutiger Sohne A–G and Mr H Grunbaum, the Chief Chemist.

This plant was the second production SL plant installed.

14.2 Aalborg, Denmark — 18 to 19 October 1971

Dansk-Dammann Asphalt operate a 150 Mg/hr SL plant at Aalborg which has been in use since June 1970. The operation of the plant was discussed with Mr T Beck-Hansen, the Chief Chemist of Dansk Dammann Asphalt and their Road Engineer for Aalborg Mr Beck-Nielsen.

14.3 Kindertoft, Denmark — 20 October 1971

Dansk Dammann Asphalt also operate a 200 Mg/hr SL plant at Kindertoft, near Copenhagen. This plant was installed in June 1971 and at present is the largest SL plant in operation. It is anticipated that full use will be made of the plant when a new motorway is constructed in the area. The operation of the plant was discussed with Mr P S Jeppesen, the Technical Manager, and Mr G Backstrom Nielsen, the Technical Engineer.

14.4 Colmar, France — 21 October 1971

L'Entreprise Schubel (now owned by la Société Routière Colas) operate a 150 Mg/hr SL plant at Colmar, near Strasbourg. This has been working since October 1970. The operation of the plant was discussed with Mr Bauer, the plant manager.

14.5 Hagenau, France — 22 October 1971

A brief visit was made to a 150 Mg/hr SL plant at Hagenau. No detailed discussion took place.

15. APPENDIX 2

RAW MATERIALS USED AT THE PLANTS VISITED

15.1 Thun

The aggregate was obtained from a morainic-gravel pit that was being worked to provide material solely for use in the motorway construction. The bulk of the gravel was washed and screened to produce stockpiles of a wide range of sizes of both crushed and uncrushed stone. An unwashed sand was also stockpiled. The aggregates, which appeared to be very clean and uniform, were stored under good conditions.

Aggregates used were:-		size range mm
washed round gravel		16 – 32
" " "		8 – 16
" " "		4 – 8
washed crushed stone		10 – 16
" " "		6 – 10
" " "		3 – 6
washed crushed sand	(1)	0.2 – 4
unwashed crushed sand	(2)	0 – 4
washed mixed * sand	(3)	0 – 4
washed round sand	(4)	0 – 4

* 70% round + 30% crushed.

The washed crushed sand (1) was used in the wearing course mixes, the unwashed crushed sand (2) or the washed mixed sand (3) were used in the basecourse mixes and the washed round sand was only used in the rolled asphalt trial material. Gradings of all these four sands are given in Figure 7.

Only a 80–100 penetration grade bitumen was used at Thun.

15.2 Aalborg

Locally occurring pit gravel, sea-dredged gravel and a crushed granite from Bornholm were the three main sources of aggregate. Stocks were also kept of calcined flint and Synopal for use in wearing course mixtures.

Storage tanks were provided for 60, 200, 500 and 700 penetration grades of binder. When necessary other grades of binder were produced by blending in the mixer.

15.3 Kindertoft

Locally occurring gravels and a crushed granite from Bornholm were the two main sources of aggregate. Stocks were also kept of calcined flint and Synopal for use in wearing course mixtures. Two grades of bitumen, 60 and 700 penetration, were stocked other grades being produced by blending these in the mixer.

15.4 Colmar

Locally occurring unwashed graded gravel was used as the main source of aggregate. Two grades of fine aggregate were stockpiled; a natural 0–5 mm sand, containing 12 per cent filler, and the same material after milling producing a 0–3 mm sand, containing 20 per cent filler. The sand was milled, apparently, to avoid the need to add filler.

Two grades of bitumen were used.

16. APPENDIX 3

MIXED MATERIALS PRODUCED AT THE PLANTS VISITIED

16.1 Thun

16.1.1. Details of normal production materials A range of dense basecourse and wearing course mixtures was produced as listed below:-

Type	Designation	Max size of aggregate mm	Nominal % passing 3.35 mm sieve	Figure showing aggregate grading limits	Range of bitumen content %
Basecourse[7]	HMT	25	40	4	3.8 – 4.8
Wearing Course[8]	AB16	16	45	8	5.4 – 6.2
" "	AB10	10	60	8	5.8 – 6.6
" "	AB6	6	75	5	6.4 – 7.2

The basecourse materials are designated either HMT A or HMT B with identical grading limits but HMT A may contain 100 per cent rounded aggregate whereas HMT B must contain more than 35 per cent by weight of crushed aggregate.

16.1.2 Details of rolled asphalt manufactured for trial sections The rolled asphalt was basically a wearing course rolled asphalt manufactured according to British Standard BS 594[9] with 30 per cent of coarse aggregate and 7.8 per cent of binder. This binder consisted of 5 per cent of 180 – 220 penetration grade petroleum bitumen and 2.8 per cent of soluble bitumen from 50/50 refined lake asphalt powder. The grading of the sand used is shown in Figure 7, curve 4, and the full grading of the mix is shown in Figure 6 together with the appropriate grading limits given in British Standard BS 594[9]. The mix was made up as follows:-

10 to 16 mm crushed stone (washed)	27.0%	
0 to 4 mm round sand (washed)	54.0%	
Filler	4.0%	
50/50 refined lake asphalt powder	10.0%	(5.0% filler & 5.0% RLA powder)
180 – 220 pen Bitumen	5.0%	
	100.0%	

Other data on the mix was given as:-

Marshall stability at 60°C	700 kg
Marshall flow at 60°C	9 mm
Marshall void content	1.6% of volume

16.2 Aalborg

A range of mixed materials was produced at Aalborg including two basecourse materials, GAB1 and GAB2, and a wearing course asphaltic concrete.

The mean aggregate gradings for the two basecourse materials and for the asphaltic concrete are shown in Figure 9. The components of these mixes are shown in Table 4.

16.3 Kindertoft

The range of materials produced at this plant was similar to that produced at Aalborg with the addition of a continuously-graded dense wearing course material with a maximum aggregate size of 8 mm, approximately 65 per cent passing the 2.36 mm sieve and a nominal bitumen content of 5.9 per cent.

16.4 Colmar

A range of dense materials, of limited maximum size, was produced at this plant including two wearing course materials with aggregates of 10 mm and 6 mm maximum size, 6.5 per cent and 6.0 per cent of 80 penetration grade bitumen respectively and filler contents of 10 and 20 per cent.

17. APPENDIX 4

TOLERANCES ALLOWED BY SWISS AND DANISH SPECIFICATIONS

17.1 Swiss Specifications

The specification for wearing course materials[8] requires that with respect to the agreed mix each sample should be within the tolerances given in Table 5.

The requirements for basecourse materials[7] are that the gradings of each sample should be within the limits shown in Figure 4 and each sample should be within the tolerances given in Table 6 of the average value of all the samples.

The binder content of each sample should be within 0.3 per cent of the average and this average should be within 0.2 per cent of the desired composition.

17.2 Danish Specification

The specification requires that with respect to the agreed mix

95% of the samples should be within ± 0.3% for the binder content

90% of the samples should be within ± 6.0% for the aggregate components greater than 25 mm

90% of the samples should be within ± 4.0% for the aggregate components less than 25 mm

90% of the samples should be within ± 2.0% for the filler content.

18. APPENDIX 5

ROAD SITES VISITED

18.1 Near Thun

18.1.1 Site T1 A road to the SW side of the Berne-Interlaken Motorway at the Thun South access point.

The full pavement consisted of 110 mm of basecourse placed in two layers, 40 mm of binder course, and 30 mm of AB10 wearing course material.

This wearing course was a dense material of 10 mm nominal maximum size which had been laid as three trial sections:

Section 1	Material produced by a conventional plant
Section 2	Material produced by the SL plant with the use of additive
Section 3	Material produced by the SL plant without the use of additive.

(Details of the AB10 material are given in Appendix 3).

The material was about one year old and had been subjected to only light traffic. From a visual examination of the surfacing it was impossible to distinguish between the three sections, but it must be emphasized that the material had not been trafficked appreciably.

18.1.2 Site T2A Hard shoulder of the Berne-Interlaken Motorway east of Kiesen. This is open to traffic.

Site T2B Hard shoulder of the Berne-Interlaken Motorway west of Kiesen which was under construction.

At both sites the construction was the same ie 80 mm of basecourse, HMT A material, covered by 20 mm of wearing course AB6 material. (Details of HMT A and AB6 materials are given in Appendix 3).

At site T2B the material was being laid at an estimated temperature of 150°C which is at the maximum allowed in British specifications for mixing of 80 – 100 penetration grade bitumen. The appearance of the material and the handling were normal in all respects.

18.1.3 Site T3A The slip road at Kiesen from the north bound carriageway of the Berne-Interlaken Motorway. This is open to traffic.

Site T3B The north side of the road that passes under the Berne-Interlaken motorway at Kiesen. This was not yet open to traffic.

At both sites the material laid was equivalent to a 30 per cent coarse-aggregate content wearing course rolled asphalt with coated chippings. It had been laid as a trial to examine the resistance of rolled asphalt to studded tyres. (Details of the composition of the rolled asphalt are given in Appendix 3.)

The rate of application, by hand, of the coated chippings was somewhat variable probably due to the inexperience of the laying gang. The chippings were generally well embedded in the asphalt.

The material at site T3A had been subjected to medium traffic for three months and the material appeared to be behaving quite normally. Nevertheless there was some variability in appearance; in the centre of the trafficked lane there were signs of some "fatting up" of the binder which probably occurred during laying. This could also be due to a shortage of coated chippings. Members of the party thought that the laying temperature may have been rather higher than required during part of the job.

At site T3B the asphalt looked a little leaner than at site T3A but otherwise very similar.

As a whole, the rolled asphalt at both sites was of reasonable appearance and will probably perform quite satisfactorily at these sites.

18.1.4 Site T4 The access road to the plant depot of Frutiger Sohne A–G. Six short trial sections, two each of basecourse, binder course and wearing course materials, were laid at the request of the Dutch Authorities; each section containing pulverised fuel ash as a filler. One section of each material was produced on the SL plant and one on a conventional plant.

The appearance of comparable sections was not identical. All the sections produced with the SL plant appeared to have a more open texture. No information was available on the temperatures at the time of laying. Results of tests, which the Dutch Authorities were to make on cores taken from these trials, should be available in due course.

18.2 Near Aalborg

18.2.1 Site A1 A housing estate road in Aalborg

The material was similar to fine cold asphalt and was manufactured on the SL plant with 700 pen bitumen. After 14 months on the road the material looked in first class condition and appeared to be very stable.

18.2.2 Site A2 A section of motorway near Aalborg.

Two sections of the new motorway had been surfaced with rolled asphalt wearing course. One section was supplied by a contractor using a conventional plant and the other from the SL plant. These sections were laid as trials to study the durability of chipped rolled asphalt under the action of de-icing salts and studded tyres. The composition of the asphalt was 7.2 per cent of binder, 8.5 per cent of filler and 40 per cent of coarse aggregate.

The trial sections appeared typical of asphalt laid by gangs inexperienced in spreading and rolling coated chippings, otherwise the asphalt appeared quite normal. The motorway had only been opened for a short period and the traffic was very light. There was no apparent reason why the material should not be durable.

18.3 Near Strasbourg

18.3.1 Site S1 A minor road improvement scheme in a village centre south of Colmar. A dense wearing course macadam material, which had been produced on the SL plant at Colmar, was being laid by machine in a confined space at a road junction. The material appeared to behave normally in all respects.

18.3.2 Site S2 A section of the national route N4, Strasbourg to Paris, just south of Saverne.

The material laid was a dense wearing course material with a maximum aggregate size of 6 mm, a high filler content of 20 per cent and 6 per cent of bitumen. Two sections had been laid, one with material produced on the SL plant and one with material from a conventional plant.

TABLE 1

Output temperature of mixed materials

Plant	Penetration Grade of Bitumen	Recommended Mixing Temperature	Temperature in Activator Surge Hopper (1)	Temperature in Skip (2)	Temperature in Lorry (3)
Thun	80 – 100	140 – 160	–	–	150 – 180
Aalborg	80 – 100	170	140 – 160	160 – 190	150 – 185
Colmar	80 – 100	–	140 – 170	–	–
Kindertoft	700	120	–	135 – 160	–
Britain	90 – 110	120 – 140	–	–	–
	700	60 – 80	–	–	–

(1) Readings taken from the indicator in the control cabin

(2) Measurements taken by portable radiation pyrometer of material in skip

(3) Measurements taken by Rototherm or portable electronic thermometer of material freshly discharged into lorry

TABLE 2

Penetration of bitumen samples before and after SL process

	Location of SL plant	Original penetration of bitumen at 25°C	Penetration of original bitumen at 25°C after treatment by recovery process	Penetration of recovered bitumen at 25°C after SL process	Activator output temperature °C
1	Thun	95	–	93	–
2	Thun	96	–	80	165
3	Kindertoft	720	670	580	135 – 160

TABLE 3

Analyses of samples taken at Thun, Switzerland

Sample number	1	2	3	4	5
Mix code	AB6	AB6	AB6	HMT A	HMT A
Position of sampling	Cold feed	After mixer	After activator	After mixer	After activator
Water content per cent	3.1	3.1	0.1	2.4	0.2
Binder content per cent	–	7.3	7.2	4.2	4.1
Grading:-					
% passing 25.4 mm (1″)	–	–	–	100	100
19.1 mm (¾″)	–	–	–	91	91
12.7 mm (½″)	–	–	–	80	80
9.5 mm (⅜″)	–	–	100	63	69
6.35 mm (¼″)	–	100	99.5	52.5	56
3.17 mm (⅛″)	73.5	72	72	39.5	41.5
1.20 mm (No 14)	–	41	42	23	24
300 μm (No 52)	–	19	20	10.5	11
75 μm (No 200)	–	7.9	9.2	5.0	4.9
Activator output temperature range °C	–	–	150 – 180	–	150 – 180

The times at which samples 1, 2 and 3 were taken were chosen such that the samples came from roughly the same material passing through the plant.

TABLE 4

Composition of mixes produced at Aalborg

	Asphaltic concrete		GAB 1		GAB 2	
	% by wt	size mm	% by wt	size mm	% by wt	size mm
	type of aggregate		type of aggregate		type of aggregate	
	18	8/12	21	8/16	15	20/40
	Synopal		sea-dredged gravel		gravel	
	12	8/12	21	4/8	85	0/20
	Bornholm granite		sea-dredged gravel		gravel	
	30	5/8	54	sand		
	Bornholm granite					
	38	0/2	4	filler		
	Bornholm granite		limestone			
	2	filler				
	limestone					
Bitumen Grade	100 pen		100 pen		60 pen	
Nominal Bitumen Content %	5.4		4.7		4.2	

TABLE 5

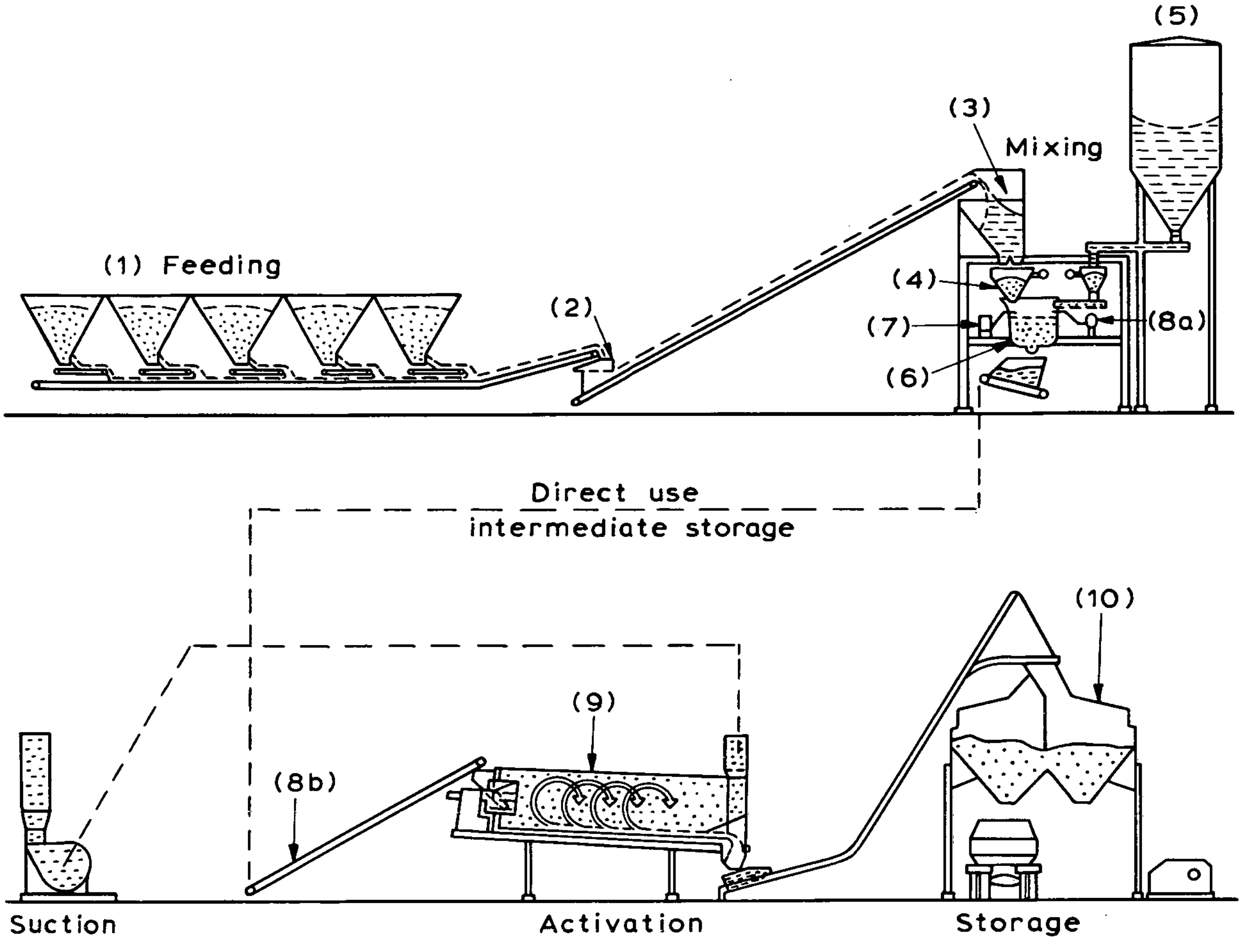
Specified grading tolerances for Swiss wearing course materials

Approximate sieve size mm	Tolerances (±) in per cent by weight on amount passing sieve		
	AB6	AB10	AB16
5.0	5	5	5
2.5	5	5	4
1.2 & 0.63	4	4	3
0.315 & 0.16	3	3	2
0.08	1.5	1.5	1.5
Binder content	± 0.4 per cent		

TABLE 6

Specified grading tolerances for Swiss basecourse materials

Approximate sieve size mm	Tolerances (±) in per cent by weight on amount passing sieve	
	HMT A	HMT B
32, 25 & 20	10	6
13 & 8	7.5	5
5 & 2.5	6	4
1.2 & 0.63	4.5	3
0.315 & 0.16	3	2
0.08	1.5	1



(1) Cold aggregate feed system
(2) Scalping screen
(3) Cold aggregate surge hopper
(4) Aggregate weigh hopper
and moisture measurement
(5) Filler addition
(6) Mixer
(7) Binder addition
(8) Additive addition (a) at mixer (b) on transfer
(9) Activator
(10) Hot-mix storage

Fig. 1. SCHEMATIC DIAGRAM OF WIBAU SL PLANT

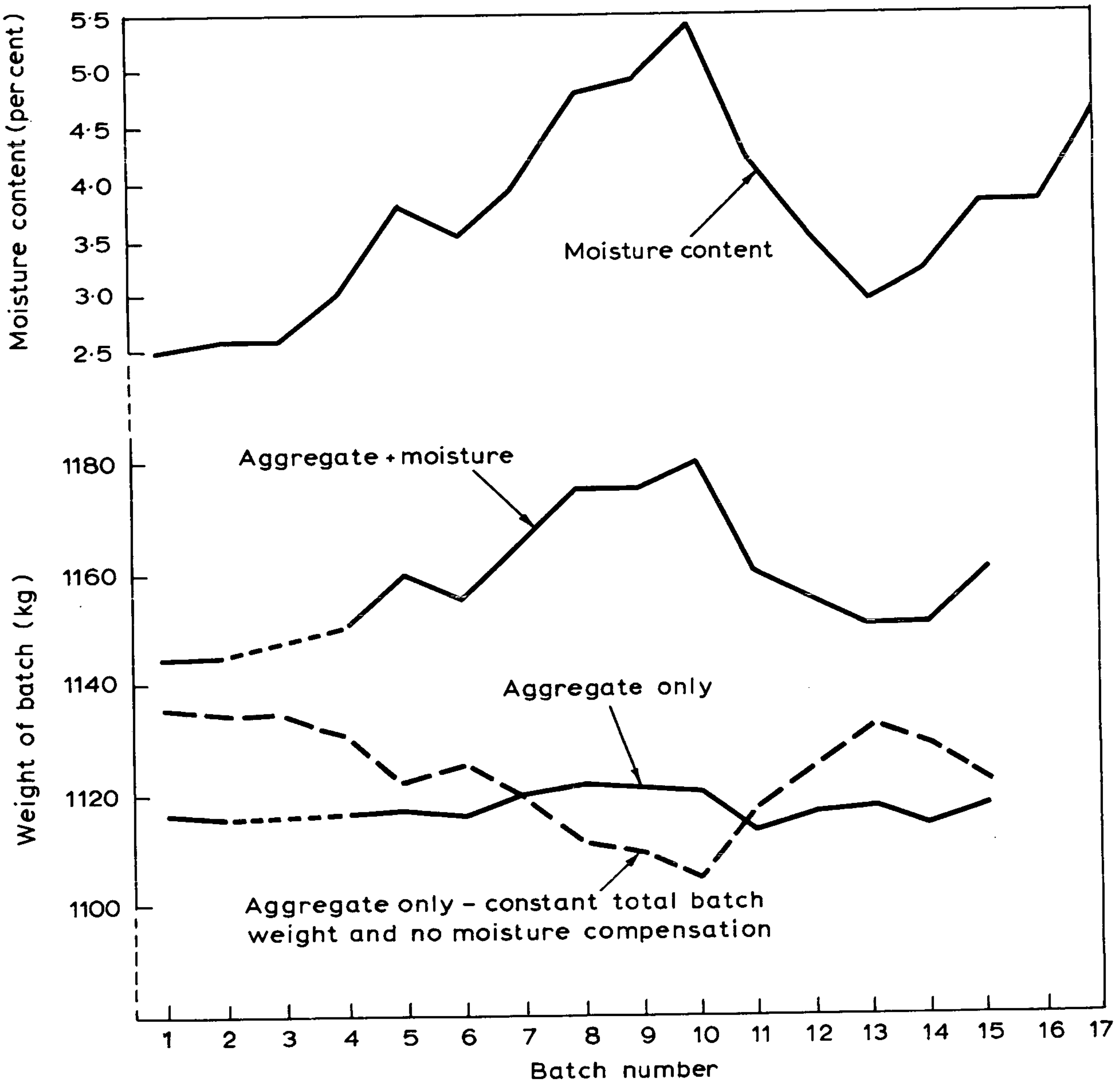


Fig.2. INDICATED VARIATION OF MOISTURE CONTENT AND BATCH SIZE IN THE AGGREGATE WEIGH HOPPER OVER A PERIOD OF PRODUCTION AT THE SL PLANT AT THUN, SWITZERLAND

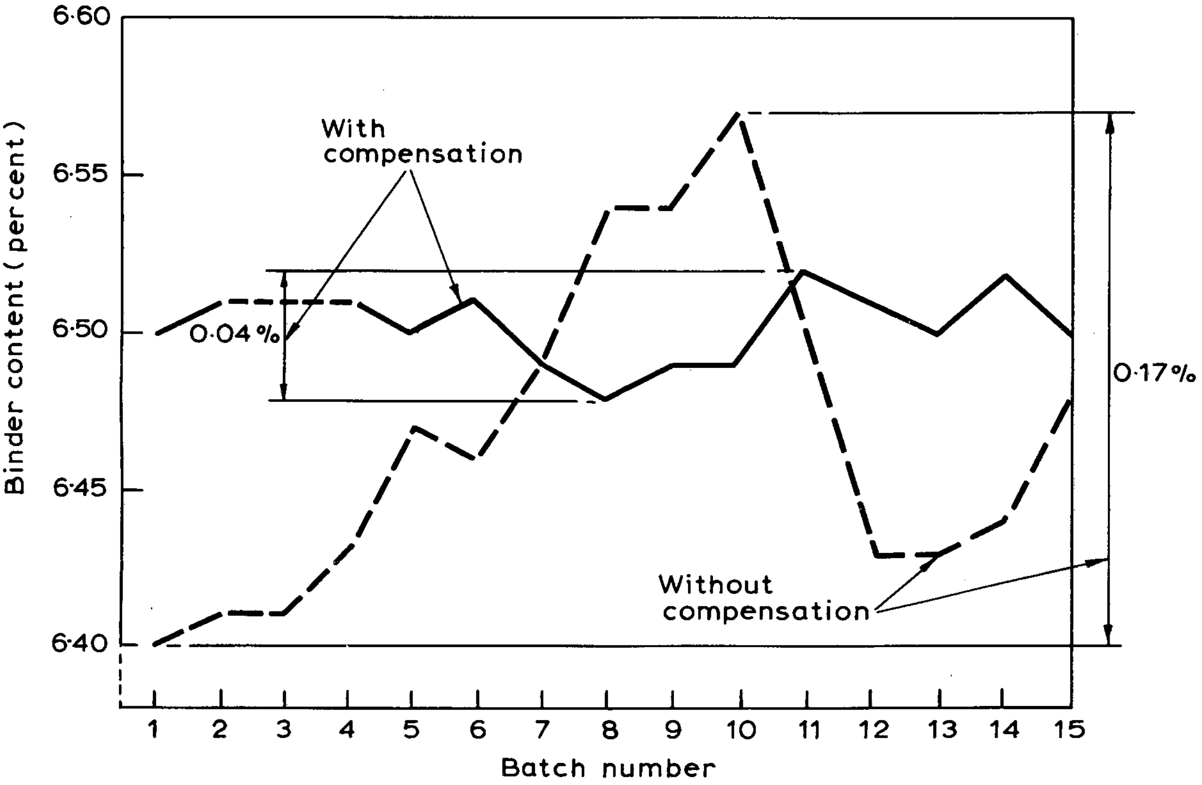


Fig. 3. VARIATION OF BINDER CONTENT OVER A PERIOD OF PRODUCTION ON THE S L PLANT AT THUN, SWITZERLAND, CALCULATED FROM READINGS ON CABIN INSTRUMENTS

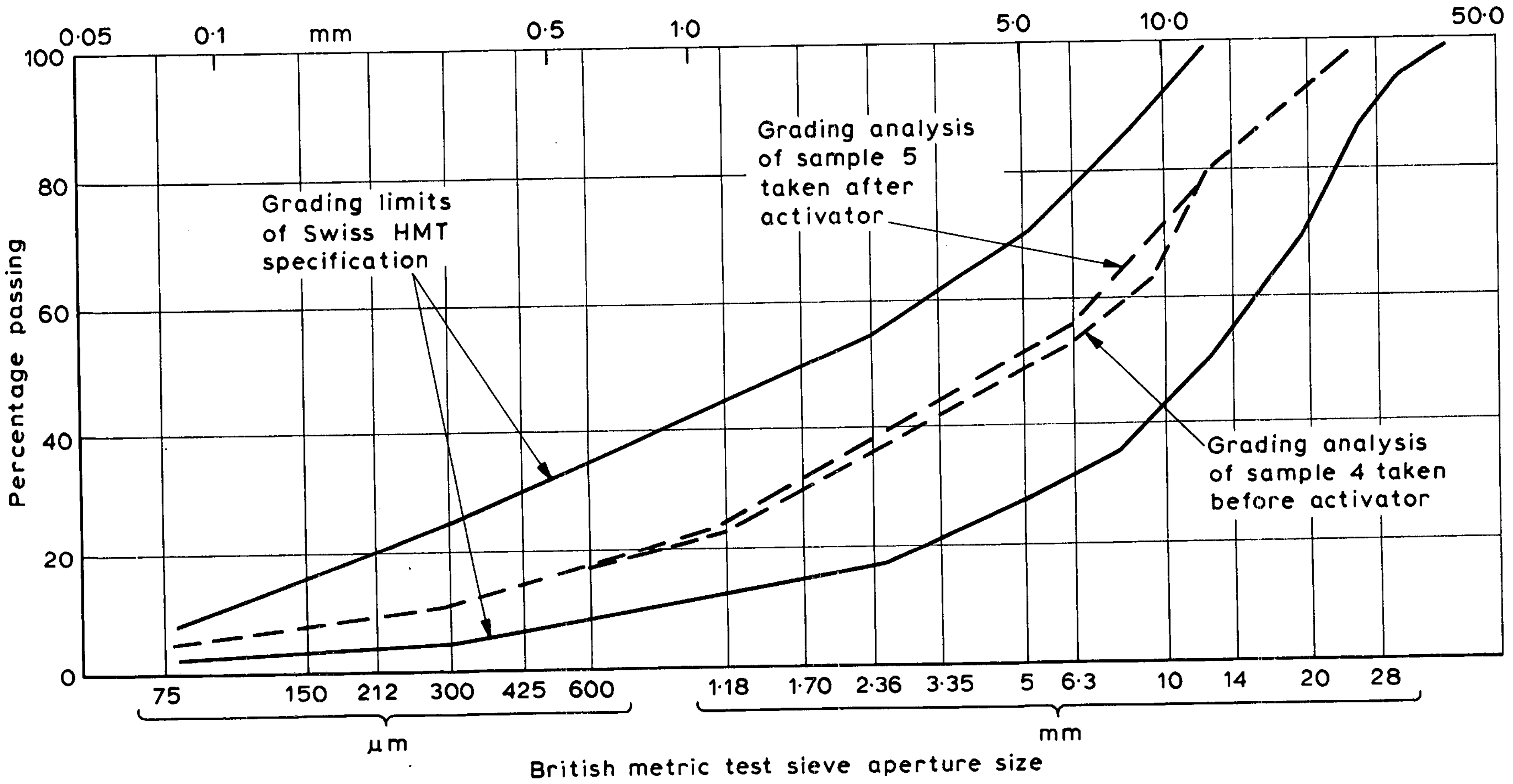


Fig. 4. AGGREGATE GRADINGS OF SAMPLES OF SWISS BASECOURSE MATERIAL TAKEN AT DIFFERENT STAGES IN THE SL PROCESS

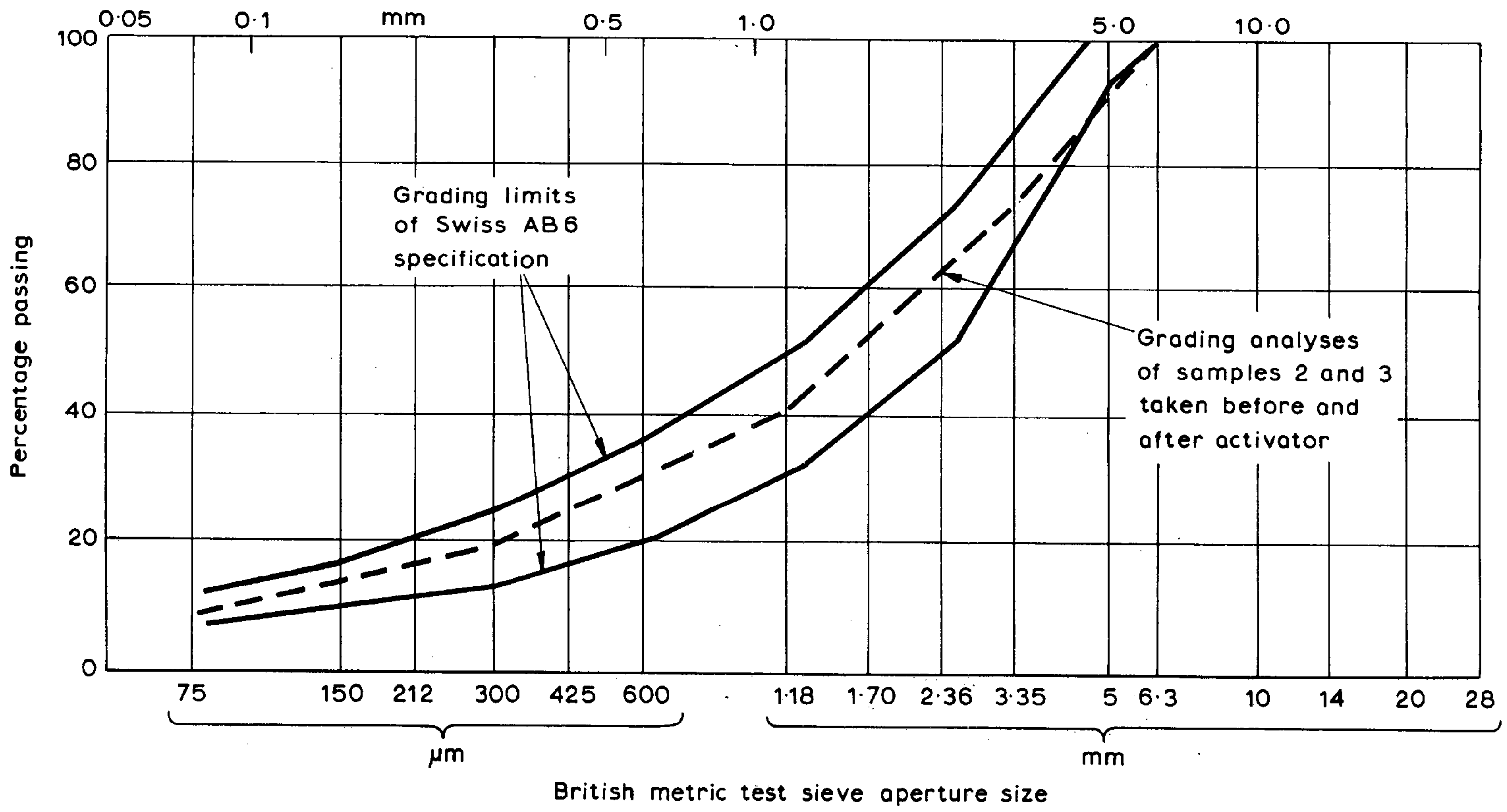


Fig. 5 AGGREGATE GRADINGS OF SAMPLES OF SWISS WEARING COURSE MATERIAL TAKEN AT DIFFERENT STAGES IN THE SL PROCESS

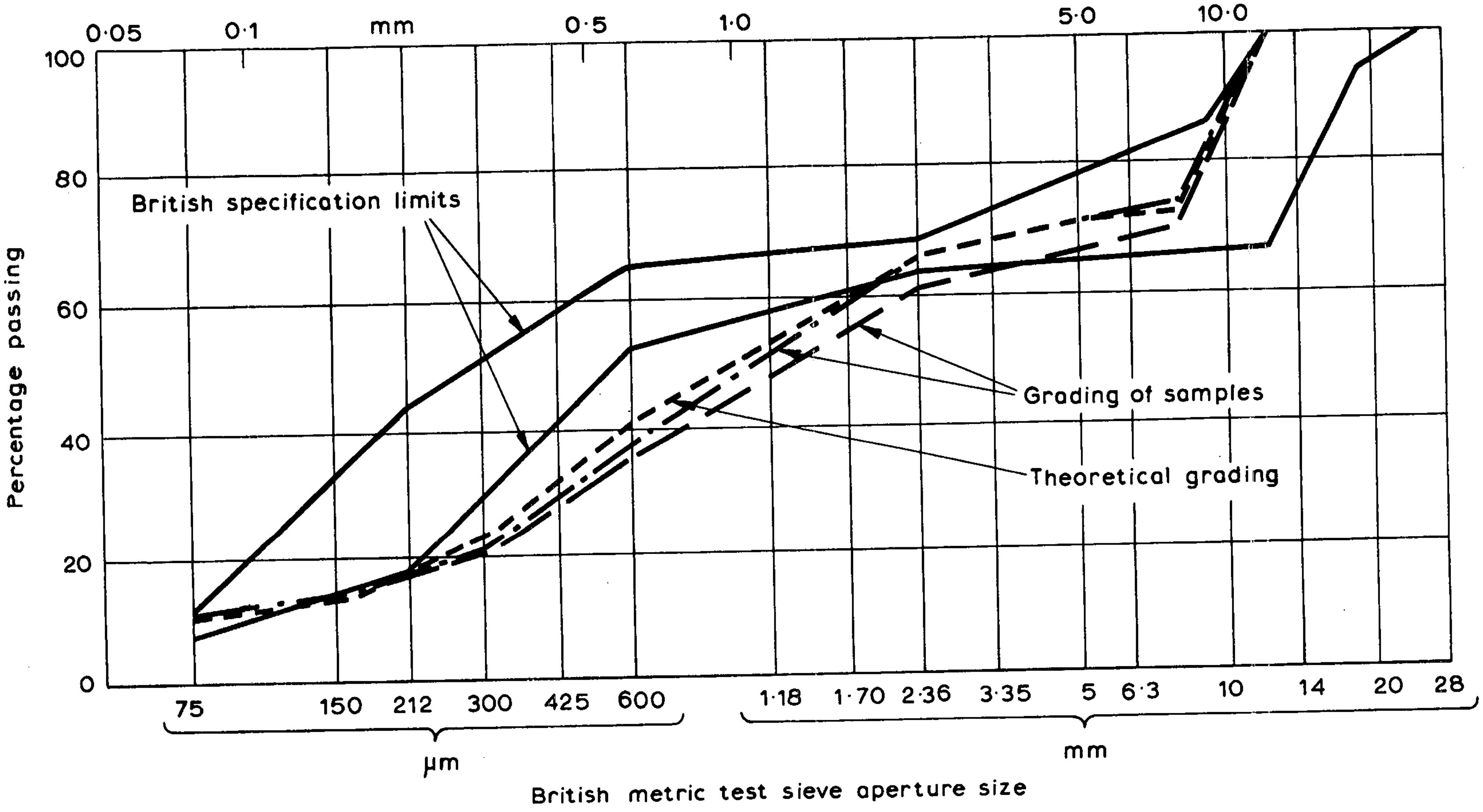


Fig. 6. GRADINGS OF WEARING COURSE ROLLED ASPHALT MANUFACTURED ON SL PLANT AT THUN, SWITZERLAND. DATA OBTAINED FROM FRUTIGER SOHNE A-G

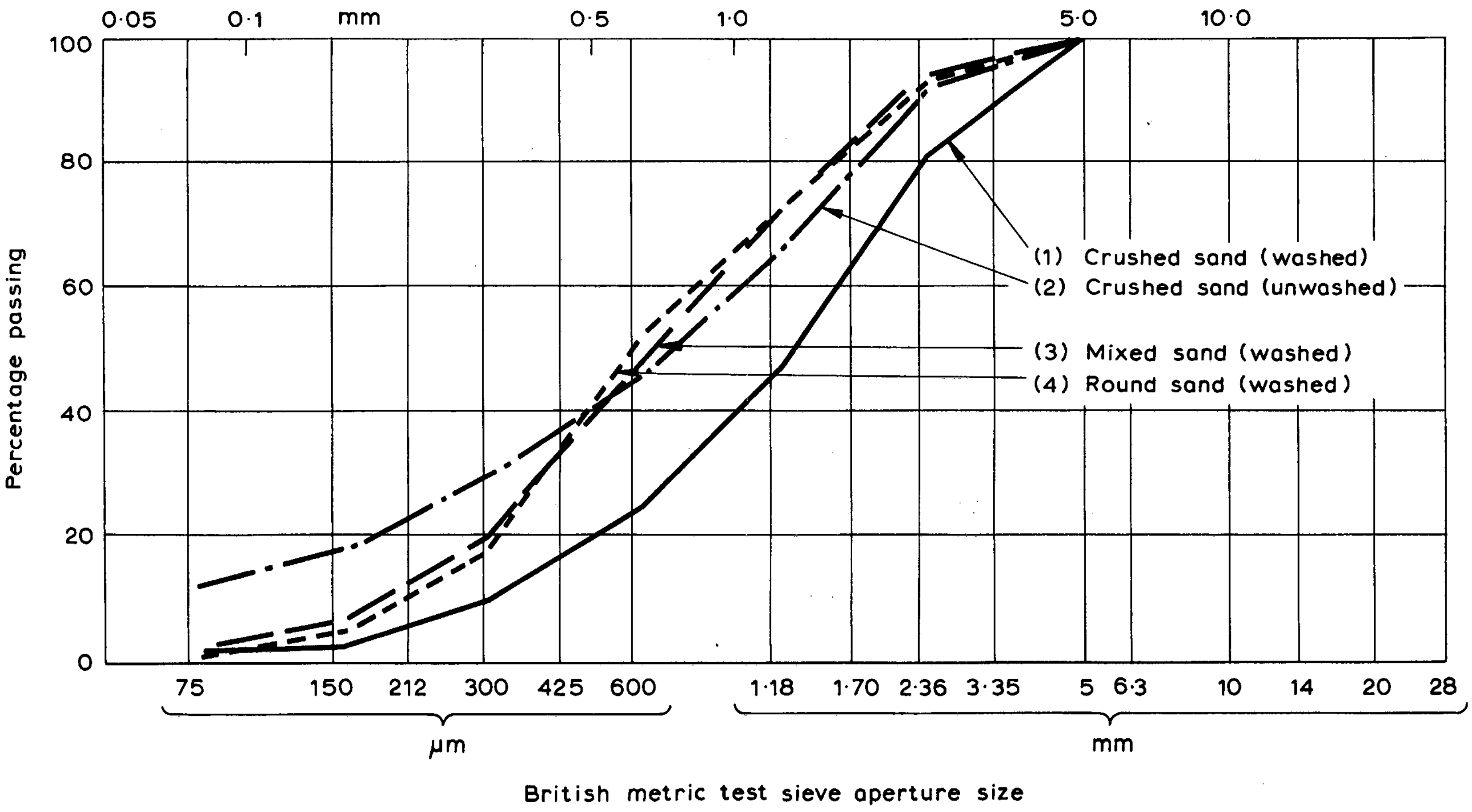


Fig. 7. GRADINGS OF FOUR SANDS USED ON SL PLANT AT THUN, SWITZERLAND

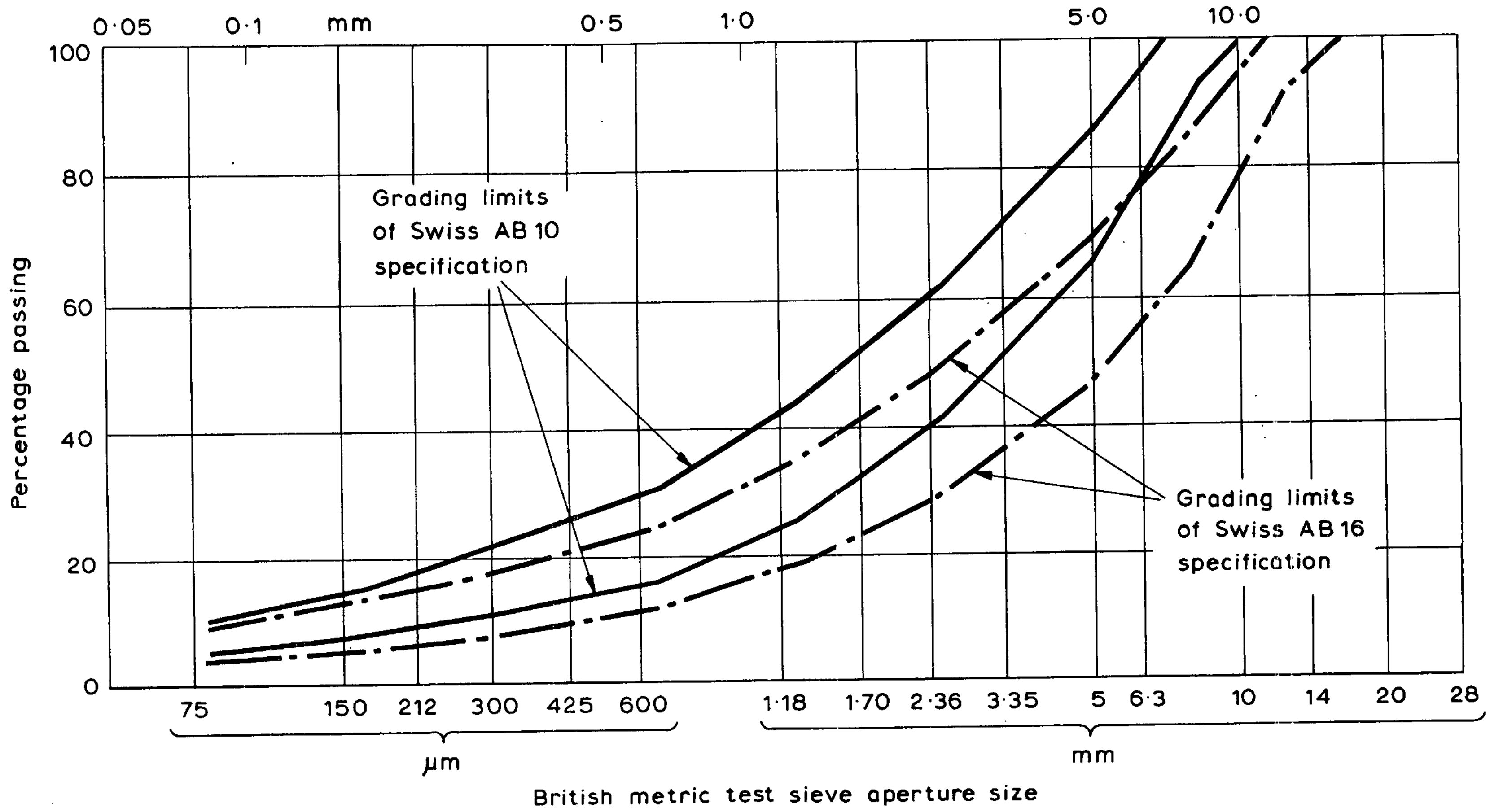


Fig. 8. AGGREGATE GRADING OF SWISS AB 10 AND AB 16 SPECIFICATIONS

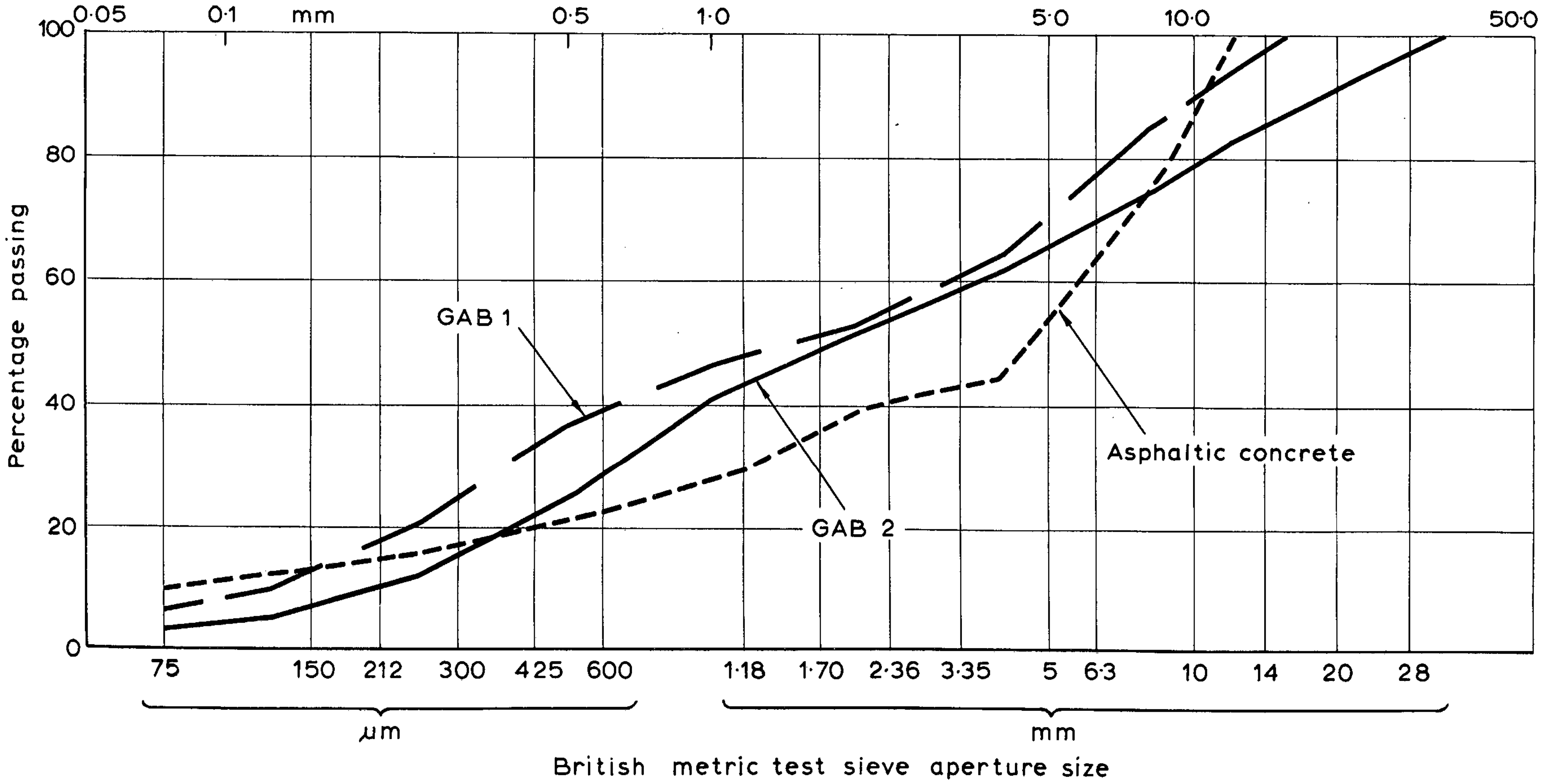


Fig. 9. AGGREGATE GRADINGS OF MATERIALS PRODUCED AT AALBORG, DENMARK

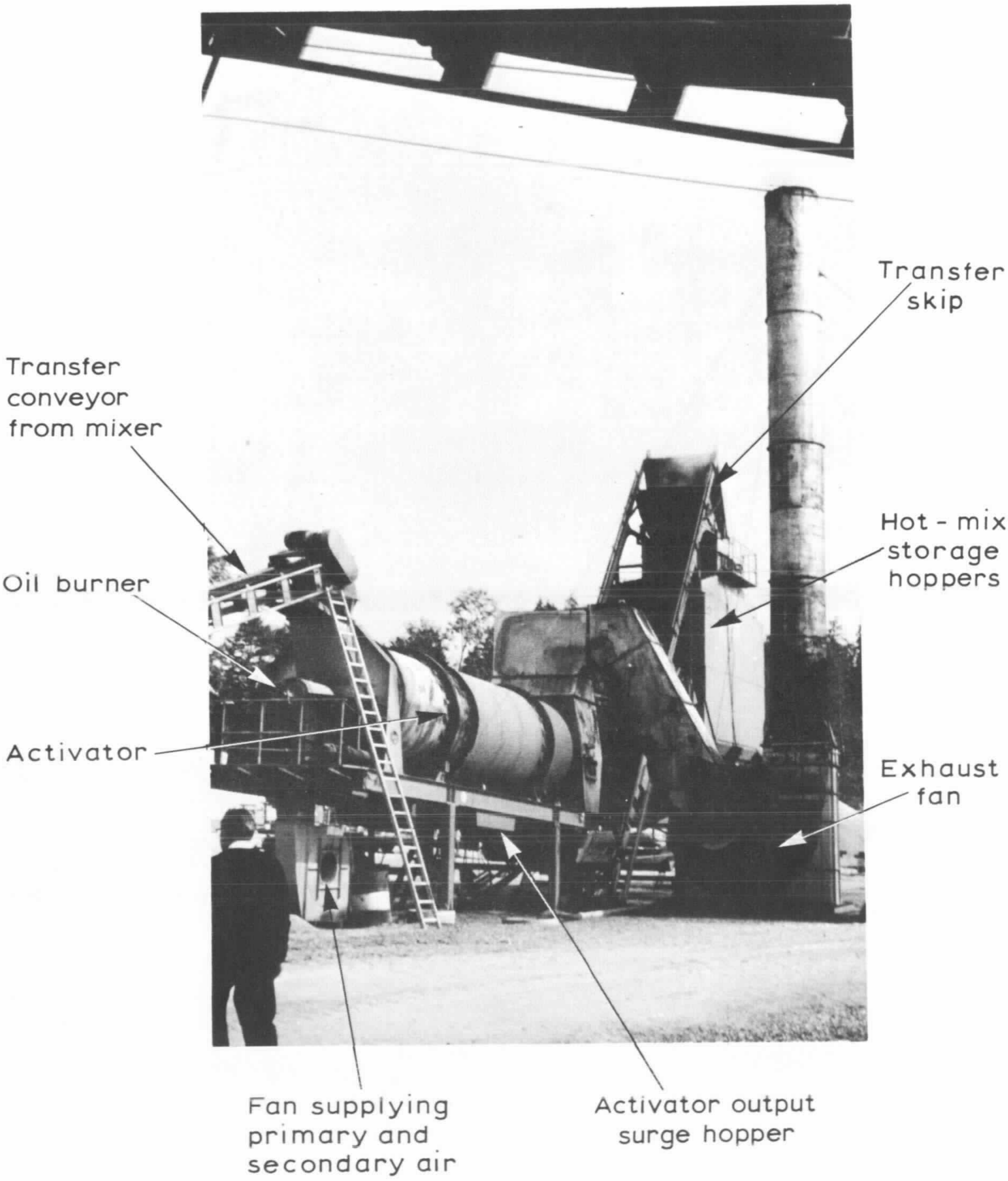


Plate 1 ACTIVATOR OF WIBAU SL PLANT AT THUN, SWITZERLAND

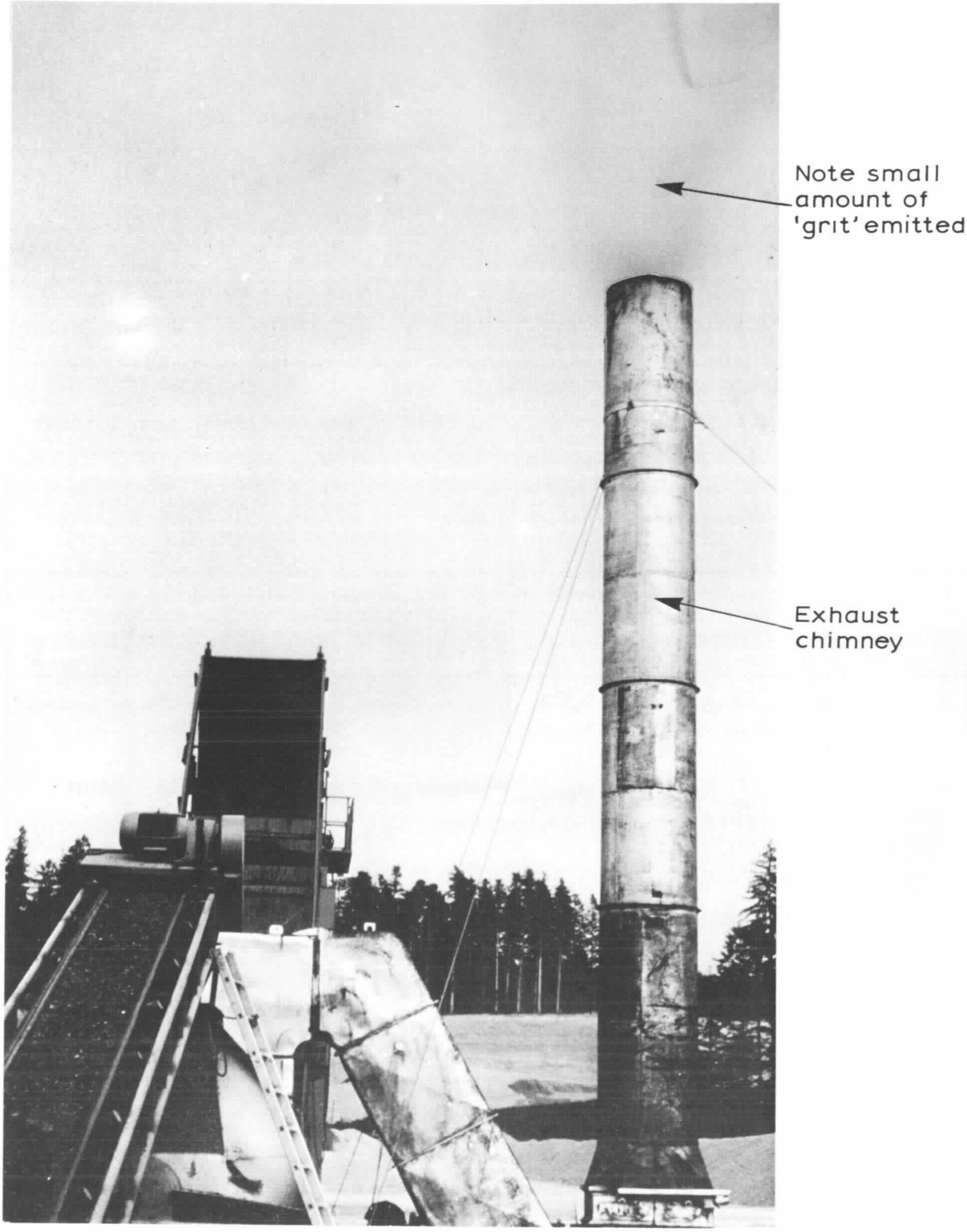


Plate 2 EXHAUST DISCHARGE OF WIBAU SL PLANT AT THUN, SWITZERLAND

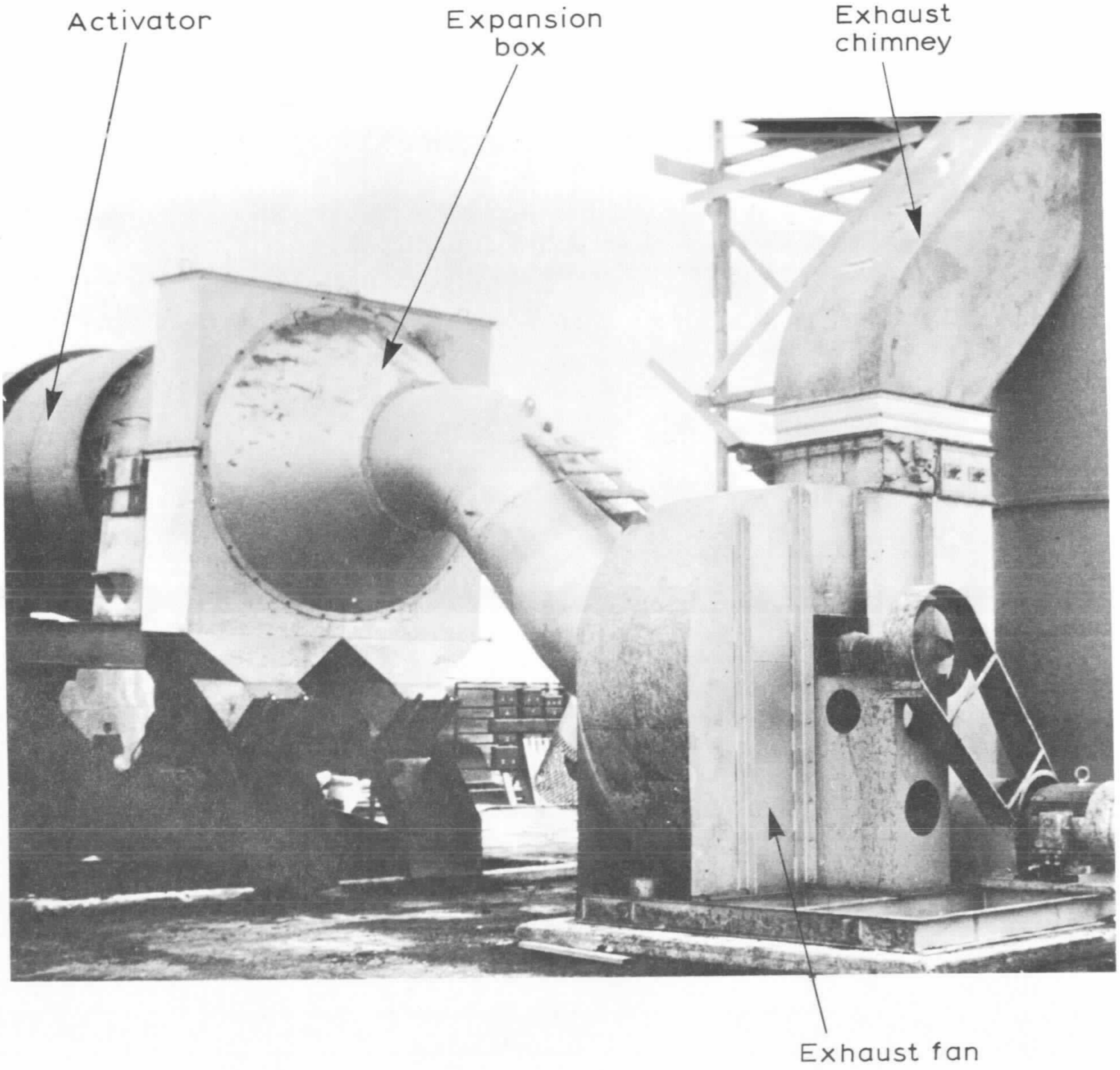


Plate 3 ACTIVATOR EXPANSION BOX AND EXHAUST FAN OF WIBAU SL PLANT AT KINDERTOFT, DENMARK

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ABSTRACT

The Wibau dustless asphalt plant: the performance of European installations: B W FERNE and G D GOODSALL: Department of the Environment, TRRL Report LR 533: Crowthorne, 1973 (Transport and Road Research Laboratory). In the Wibau dustless (SL) asphalt plant the binder is added to the aggregate before it is dried and heated in contrast to a conventional plant in which the sequence of events is reversed. This new process virtually eliminates the discharge of dust into the atmosphere without the need to provide expensive dust collecting equipment and has other possible economic advantages deriving from its ability to carry out production in two stages.

A group representing the Department of the Environment's Transport and Road Research Laboratory and Engineering Intelligence Division, and the Asphalt and Coated Macadam Association have visited five plants in Western Europe in order to assess their ability to produce satisfactory bituminous materials. It was found that a wide range of dense materials containing penetration grade bitumen binders was being produced satisfactorily on the Wibau SL plant at output temperatures above 120°C. This suggests that the process could be employed to manufacture many of the dense bituminous mixtures used in Great Britain. Although the limited evidence available suggested that materials produced by the SL process should have an adequate road performance, for full acceptance further evidence of the performance under traffic is required. The use of the process for a wider range of materials and its use in the two-stage form requires further investigation.

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