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EVALUATION OF KOSOVO QUARRIES, HOT-MIX ASPHALT AND ROAD CONSTRUCTION

KOSOVO CLUSTER AND BUSINESS SUPPORT PROJECT

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EVALUATION OF KOSOVO QUARRIES, HOT-MIX ASPHALT AND ROAD CONSTRUCTION

THIS REPORT ADDRESSES AN ASSESSMENT AND THE STATE OF CONDITIONS OF ROADWAYS, AGGREGATE QUARRIES, HOT-MIX ASPHALT PLANTS AND ROAD CONSTRUCTION INDUSTRIES THROUGHOUT KOSOVO. THE REPORT INCLUDES FIELD REPORTS, DOCUMENTATION AND STATUS OF ACTUAL PLANTS AND PROJECTS THROUGHOUT THE REGION.

Kosovo Cluster and Business Support project "Evaluation of Kosovo Quarries, Asphalt and Road Construction Industries"
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PURPOSE OF ASSIGNMENT

The purpose of this assignment is to evaluate current business operations of the entire Asphalt industry in Kosovo. The goal is to upgrade asphalt production industry to the level of European Asphalt plants. After reviewing existing plants, and understanding the demands on the industry in Kosovo, the Hot Mix Asphalt [HMA] Processing Consultant will prepare an outline for a "Working Manual for Processing of Hot Mix Asphalt" for quality production of asphalt based on EN or AASHTO standards. The intent is that the manual shall include all necessary procedures and policies in order to upgrade the asphalt plants in Kosovo so that they become successful operators with possibilities for future expansion.

BACKGROUND

The private sector Kosovo asphalt production industry is very young as in past there were SOE (State owned enterprises) only. The first private asphalt plant was built in 2000-2001 and became a successful company involved also in road construction. Other companies in road construction industry followed and constructed asphalt plants, which they viewed as very profitable and with a long-term future. However, as there are no proper regulations in Kosovo, too many companies are operating these new asphalt plants without professional staff. Investors in road construction are having problems with quality of asphalt, which often does not last more than two-three years. The industry currently employs 50-100 workers depending on season but the potential is to increase this number. All asphalt production in Kosovo is locally produced; the raw material such as aggregates (limestone and andesite) is obtained from several quarries, but bitumen is imported from neighborhood countries usually with no quality control or testing. In Kosovo there is no proper plan for recycling of asphalt. Proper procedures for QC/QA of raw materials and final product are required in order to upgrade staff skills and plant operation. The European Union's plans for a Regional road network does not foresee any "E" road passing through Kosovo, though linkages to these roads will be required within Kosovo. Moreover, the industry is well positioned to tender for construction on sections of the "E" roads.

Market Position:

The market is shared between approximately 10-15 asphalt plants each with different production capacity. The market for the moment is very small and too many companies are chasing the limited work available. Few operate at full production capacity; some operate at as little as 25%. Nevertheless, new companies still appear to want to enter the field. Our aim is to increase production and quality at the existing plants. By raising the standard of performance at these plants, Kosovo's economy will get more value from its existing investments and deter other investments from being squandered in an already overcrowded field.

Production:

Main raw materials used are: aggregates from Kosovo, Bitumen from Macedonia, Greece and Albania.

Key inputs required for a rapid expansion of operations are available. These include skilled manpower and abundant availability of raw material, all at reasonable cost. There is a possibility that the "Andesite" stone will be available for the 2006 construction season.

The main issues are to identify and implement the most efficient production and quality control for asphalt industry. The needs are: to reduce wastage; increase quality according to European standards; decrease operations cost; quality control of raw material; prepare mixture recipes; streamline the production line; and organize plant management.

EXECUTIVE SUMMARY

Interviews, plant tours, QA/QC and construction practice inspections were performed with USAID, members of RCAK and the Pristina University. The inspections were to assess current status of equipment, practices, raw materials, methods, design, testing, product installation and a general understanding and knowledge for the proper design, installation, testing and maintenance of roads throughout Kosovo. It is clear that the required technical foundations and understanding of end-result, statistically-based specifications for full implementation of EU standards are not understood, in place or practiced.

Typical operation conditions due to the lack of understanding and compliance with EU and modern end-result specifications were; no laboratory equipment or technical staff at most locations, a lack of technical training of personnel to develop or implement design and control of job mix formulas, proper testing, control techniques, mix design and QA/QC, raw material QA/QC, and plant production and paving-compaction operations. At some locations, there was also a general lack of accepted safety equipment and practices such as hard hats, gloves and other essential equipment and practices to provide a proper level of safety for operations personnel. Generally, production personnel have experience in running their plants or equipment to perform the task at hand, but lack scientific and technological training regarding a complete understanding of the product and the effects of material and production variations and variables that affect the product quality.

The University of Pristina laboratory was inspected to assess their facilities and capabilities. The laboratory has most of the basic laboratory equipment required for training and testing of HMA materials, although most equipment is in need of repair or replacement, and some technical methods are antiquated. Moreover, the University does not seem to have a well-outfitted library of EU standards which are also unknown to the RCAK members and other HMA producers and suppliers.

Important issues to assist the Kosovo HMA industry along with the road construction group RCAK and their supporting cast of feed stock and supply industries and Government agencies are:

1) to work with bitumen, aggregate and filler sources and any other source of raw material supply to improve the quality and/or certification of their materials prior to delivery to the plants or projects**.**

2) to understand and implement typical end-result specifications for use in QA/QC and EU type standards within industry and government.

3) to train all employees at the quarries, HMA plants and paving-compaction operations in the fundamentals of materials, QA/QC, mix design, product testing, production, paving, compaction and in-place testing of all aggregates and HMA products.

4) to plan for the eventuality of Kosovo adopting the complete EU standards with a goal of being fully prepared before the implementation of the standards takes effect.

5) to work with Kosovo's Municipal and State Government agencies for road construction to assist with the understanding of best management practice systems to implement ideals required by competitive bidding, lump-sum contracts, end-result specifications and EU standards relating to project design and US standards for procurement, inspection and payment procedures.

6) to work with RCAK and ICMM to assist with the proper permitting of all locations, including not only the 400 legitimate operators who have applied, but also the

investigation and prosecution of the 300 illegitimate operations who avoid permits that severely undermine the entire system.

7) to assist RCAK with the implementation, training and start-up operation of an independent laboratory for aggregates and HMA including adoption and learning of EU standards.

Finally, it is recommended that KCBS and USAID assist with the implementation of all phases of the integration process for full EU standards compliance, along with proper safety standards, and to make a commitment to providing support for training, understanding and follow-up. A reasonable timeline for understanding and trial compliance with EU standards is likely to be on the order of three years.

FIELD ACTIVITIES TO ACHIEVE PURPOSES

There were many field trips and inspections of quarries, sand and gravel operations, HMA facilities, various Agencies, Associations, and the Pristina University, including general infrastructure inspections throughout the region. All detailed reports of the travels, inspections and findings including specific examples can be found in Annex 1, addressing all field trips.

TASK FINDINGS AND RECOMMENDATIONS

The Scope of Work shall be as follows:

- Conduct an assessment of existing Asphalt plants (max 10)
- Develop procedures for plant and production management of all operations from material receipt to final product delivery.
- Establish procedures for maintaining high standards of quality, reliability and safety. Evaluate and develop improved techniques for the control of quality, reliability and safety.
- Produce recipes for asphalt mixes designed to meet specified requirements and allow for easy construction, and prepare the manual on how the materials must be mixed, tested, transported and placed to assure a quality product. Include design, performance and production of mixtures using reclaimed asphalt pavements (RAP).
- Develop a program for recycling of asphalt or usage of wasted material.
- Identify potential capital equipment improvements or investments regarding plant operation.

BITUMEN

Bitumen is also known as “asphalt cement”, “AC” or “binder”. Kosovo has no petroleum source or refining plant or capacity that can produce bitumen for HMA paving. The primary sources of supply for bitumen that are used for production of HMA road paving products in Kosovo are located in Albania, Greece, Macedonia, Bulgaria and Serbia.

Discussions with HMA producers in Kosovo provided information about various issues relating to the availability, cost, quality and variability of the bitumen from various sources. There were reports of bitumen deliveries in which tanker truck loads have been contaminated with as much as thirty percent filler. There are also reports that there can be an inconsistency in the bitumen grade (measured by the penetration method) that may be due to “shopping around” purchasing by the HMA producer, or inconsistencies in the bitumen that is actually delivered from the refinery. For example, one HMA producer advised that they use bitumen with a penetration of 50-65 for all their mixes. Another HMA producer advised that they use bitumen with a penetration of 85-100 for their base mixes and bitumen with a penetration of 50-65 for their wearing course mixes. Moreover, one HMA producer stated that he receives a written quality analysis from the refinery only once every fifty tanker truck loads. Yet another HMA producer stated he buys his bitumen through an Albanian broker-dealer who provides all the necessary refinery certification with each tanker truck load.

Normal practice dictates that there should be some refiner certification with each load, particularly in a volatile and competitive price market that inherently encourages shopping

and product variability. There are also reports of wide variations in the price of bitumen from various refineries sold to the HMA producer which, without some bitumen price escalation clause in the HMA contracts, can dramatically affect the producers purchasing decision. This price variation encourages the use of bitumen from more than one refining source, even on a day-to-day basis. The recent dramatic rise in crude oil prices has probably exacerbated these market forces. For example, a Kosovo HMA producer might design his job-mix formula using one source of bitumen and commence a project with that particular grade and source. Then, in the middle of the project, he may switch to another binder from another source due to pricing or supply source forces beyond his control. Moreover, in this example, both refinery sources of bitumen may be producing and selling the same penetration grade, but the inherent differences from one refiner and their crude oil feed stock, to another refiner and their feed stock, could have a dramatic effect on the bitumen properties - and therefore final HMA performance.

AGGREGATES

There has also been an investigation and assessment of the condition of fine and coarse aggregates in Kosovo for use in HMA, and in general road construction activities. Investigation of aggregate used for the manufacture of HMA has provided information about the availability and lack of quality of a range of various materials.

Almost all coarse and fine aggregates made in Kosovo are produced in regional limestone quarries. There are also SOE quarries in Serbia that produce aggregates for the market. In the spring of 2006 the first andesite quarry in Kosovo will come on-line. Typically, andesite is harder and of higher density than limestone, and is used primarily in HMA wearing course mixes. In the Kosovo road building community there may be a general view that “limestone” is “limestone”. It is not yet known what the variety of mining, crushing and screening methods that are in-place in Kosovo, but it is well known that even similar strains of mineral aggregates such as limestone can vary widely in quality, density, shape of fracture, and gradation, due in part, to the limestone itself, and also to quarrying, blasting, crushing and screening methods and equipment. It has also been reported and observed that some crushed stone material from individual quarry sources can vary widely in gradation - even from one truck load to the next. It has been reported that the availability of crushed materials can suddenly end in the middle of a road construction project or during HMA production, which then forces contractors or HMA producers to look elsewhere for supplemental materials to complete the work. This may be due, in-part to quarry production inefficiencies, equipment maintenance, crushing and screening capacity, electric power availability, product demand, or other sales commitments. Moreover, the current ICMM situation tends to suppress inventory. The HMA plants that were visited all seem to have very little aggregate stockpiles on-hand. This may be good for the plant owner’s cash-flow, money management and inventory control, however, a just-in-time (JIT) inventory control does not work well for HMA production, even with the best QA/QC program and management in-place. Apparently, there are also aggregate sources known as “river gravel” and “river sand”. This source of material can be generally good, particularly for ready-mix concrete, as long as the material is processed, crushed, screened, and controlled by modern equipment and QC/QA methods. In Kosovo, this material is apparently available from numerous, small sand & gravel operations. Inquiries to date with the HMA plants and contractors seem to suggest that they normally object the use of the sand and gravel materials as unusable in HMA. It is also understood that the Ministry of Environment and Special Planning of the government apparently intends to restrict the mining of river sand and gravel in and effort to conserve the natural resource of existing rivers and streams. Further investigation of other HMA facilities and sources of aggregate may provide additional information to this matter.

One recently adopted system to standardizing the permitting of mining and processing of mineral materials has been the establishment of The Independent Commission for Mines

and Minerals (ICMM). The ICMM has been in operation for about one year. During this time, ICMM has received approximately 450 permit applications, of which 50 have been fully investigated and acted on with final permits issued and in place. There are many stone quarries and sand & gravel operations throughout Kosovo that have already made application, and a few have actually obtained the ICMM permit. The ICMM permitting activity requires, among other things, a complete background investigation, not only of the applicant, but for a complete and clear land title search (investigated by ICMM). It is our understanding that ICMM charges a 200 euro application fee, to be paid along with the applicant's submittal. Once the permit has issued, some of the permittees must pay a proposed running royalty equal to 1 euro per cubic meter of in-situ materials that are blasted or excavated for further processing.

It is unclear what the permittee receives of value or consideration for paying a running royalty. Since there is potential liability on clear land title, which seems to be a high priority, perhaps the ICMM can provide assistance for liability insurance or for obtaining coverage to the permittee. It is understood that no insurance underwriters are willing to write liability policies until after Kosovo statehood is in place. It is further understood that proof of liability insurance is part of the ICMM permit process which creates a problematic situation for the permittee since he cannot currently obtain the required insurance coverage. It also seems inequitable for ICMM to charge, one the one hand, a 2% across-the-scale royalty on sales for the 90% majority of minerals from high value nickel to low value coal, yet on the other hand charging a 1 euro per in-situ blasted material royalty on the 10% minority of low value aggregates and sand & gravel. Another inequity observed for a permittee of ICMM is for aggregates used in construction is the variation in product value based on the final finish goods being royalty-rated on a volume basis, rather than weight basis. For example, with the volume method, a light density limestone quarry operator would have an advantage over a heavier density andesite quarry operator. This is due to the difference in volume-to-weight of the finished goods. There is also some inequity in charging a running royalty based on the in-situ blasted raw material. It is much more fair, reasonable and equitable, from a competitive free-market perspective, to assess a running royalty based on the final product being sold by weight across a scale. By assessing a royalty on the final product as a percent of selling price across the scale, there is no inequity due to waste, overburden or production losses and also for the problem of pre-payment for processed inventory. Moreover, by requiring a running royalty on in-situ blasted feed stock, the permittee would have an incentive to minimize and over-manage their inventory control so as not to pay a royalty well before the sale of final product. This practice could also exacerbate the problem already found at HMA facilities and road construction projects whereby they report running out of aggregate sources in the middle of a project or production run. This current, ICMM proposed, in-situ method of fee assessment may also severely impact permittee cash flow based on inventory turn-over which affects all business enterprises.

It was reported by ICMM that there are also approximately 300 mining, quarrying and other similar operations that have not applied for permits and are operating illegally throughout the Kosovo region. These un-permitted and illegal operations, if left unchecked, will seriously undermine all the equitable and legal operators. An investigation of ICMM should be considered to learn why these illegal operations continue.

FILLER

The investigation and assessment of mineral fillers for use in the manufacture of HMA in Kosovo has provided some insight into the fillers themselves, the filler availability and the filler quality. Since the vast majority of coarse and fine aggregates produced throughout Kosovo, for use in road construction and HMA are made from limestone, a few limestone quarries have become small sources of fillers. It is believed that in order to provide limestone filler, some quarry operators have baghouses for fugitive emission control from primary and

secondary crushers, or screening systems. It is unknown how many quarry operators employ such dry-capture control systems. Such systems provide not only a source of revenue to the aggregate quarry operator by selling the filler, but the systems provide good fugitive particulate emissions control. Only two limestone quarry and/or crushing-screening operations that were observed had any baghouse controls. Almost all quarries seem to have nothing for emission control or the more common water spray. During the assessment inspections, one limestone crushing operation was observed to have a baghouse for dust (filler) collection, but the baghouse was installed primarily for reducing the fines in manufactured sand for the production of Ready-mix concrete. This operator also had an HMA plant that could use the collected fines from the crusher baghouse from the cleaned fine aggregate. It is also unknown how many HMA plants in Kosovo control their dryer emissions with baghouses. However, most plants that were visited did have baghouse emission control. A baghouse provides a source of fines that are not provided by HMA plants that either have no controls or have wet scrubbers for emissions control. It is well known that capturing, handling, blending and injecting of fillers to the HMA, whether the filler is provided by the HMA plant dryer baghouse (as part of the process), or provided in bulk from quarry operations, or from dedicated mineral filler producers, requires very careful operational skill and good QA/QC. Good filler management at the HMA plant provides for a proper mix, and care must be made to minimize the variability of filler quantity in the HMA product. Failure to do so can have a dramatic effect on the quality of the resulting HMA road construction materials.

Another long-term potential source of significant quantities of fillers is fly ash (not to be confused with bottom ash) produced from applying an appropriate air pollution control (APC) system on coal-fired electric generating stations such as the large KEK plant in Pristina. It is believed that the generating station near Pristina emits uncontrolled coal combustion gases along with particulate matter (fly ash). These emissions could easily be controlled with well-known technology. A proper particulate control on the KEK plant would yield significant quantities of fly ash that could be used not only as fillers for use in the production of HMA throughout Kosovo, but also used as fly ash to be mixed along with cement in the production of ready-mix concrete (RMC), and other concrete-type products. The uses and effects of fly ash in both HMA and RMC are well known and are common practice. Moreover, the potential for KEK to sell the fly ash for domestic use and possible export provides a source of revenue to help offset the capital cost of the APC. Typically, fly ash sells for about one-half of the price of cement powder. Another major benefit provided by the APC at KEK would be an improvement to the ambient air quality by providing control of particulate emissions from the generating station. It is believed that KCBS and the University of Pristina, along with appropriate technical support, may be a candidate organization to implement the surveying, testing and development of fly ash, and to track its quality and use in construction materials such as HMA and RMC.

RECLAIMED ASPHALT PAVEMENT (RAP)

The ability to mill or rip-and-crush old existing HMA pavements is well known throughout the modern HMA industry. Milling machines like the “Roto-Mill” are the most common machines for this purpose and is the most practical method for removal of a precise layer of existing HMA. A few HMA producers in Kosovo already have milling machines that are used for this purpose. Moreover, the use of old, milled (or ripped and crushed) HMA in a modern HMA production plant allows the reuse of an existing resource, and can reduce some demand on new, virgin aggregate and bitumen materials. However, the investigation of the existing HMA road materials in Kosovo has provided one potential problem for the possibility of a RAP recycling program. It has been learned that some unknown quantities of existing roads throughout Kosovo may have been made with tar rather than contemporary bitumen. The toxic effect of tars, particularly those tars made when producing coal tar gas, is well known.

Contemporary environmental cleanup of coal tar and other tar-like materials is ongoing throughout the US and EU. In the US, the existing tar-impacted products are either removed and disposed in a proper, lined landfill operation, or incinerated in thermal treatment facilities. Therefore, any RAP program developed for use in the HMA road construction program in Kosovo will require a detailed and scientific testing, mapping and delineation of the existing roads that are the candidates for rehabilitation and recycling.

MIX DESIGN AND QA/QC

The investigation of the HMA industry in Kosovo has provided an understanding of the wide variation in degrees of proficiency, and sometimes a lack of knowledge in the areas of:

1) manufacture of and proper QA/QC for the feedstock aggregates to be used in road construction and HMA road paving materials.

2) evaluation, determination and proper QA/QC of those feed stocks prior to consideration for a mix design or formula for use.

3) analysis (by destructive and non-destructive tests) to determine the viability of a candidate feedstock material.

4) development of a proper mix design, and subsequent test information to allow for the proper determination of the effective blend and correct bitumen content.

5) effects and implementation of the plant and material feed stocks (aggregates, bitumen, filler) and to provide a proper QA/QC best management practice along with trained personnel that are required to produce a high-quality, statistically based, QA/QC implemented, end result specification - and subsequently high quality and properly controlled HMA product.

6) proper transport, installation, laydown, compaction and field QA/QC for HMA pavements for high-quality road construction projects, along with the transportation, installation, compaction and QA/QC of other required road construction materials.

7) proper definition of random, in-situ locations for the un-biased sampling and proper testing of the road construction materials and HMA road paving products to effectively analyze and implement a proper, statistically based, un-biased, end result specification to be used for payment.

PRODUCTION METHODS AND PAVING OPERATIONS

The investigation and assessment of production methods and paving operations of HMA road building projects in Kosovo has been difficult to develop due to the seasonality of the HMA production. However, this assessment provided an excellent first investigation to assess the industry during the pre-season, winter period. This provided the accessibility of not only the plants, but the owners and their personnel who would otherwise be too busy to discuss the overall plan for improvements to the Kosovo quarries, HMA products and other road construction materials. A general assessment was made based on inspection of the equipment used for production and paving operations. Some HMA plant operators advised of needing to replace the bags in their plant dryer baghouses due to 10 years of use which has rendered the baghouse ineffective. This problem probably had a dramatic effect on the plants dryer and subsequently reduced the production capacity. It was also reported that common paving practice in Kosovo includes paving during rain events. This practice is unacceptable.

DRAINAGE, MOISTURE DAMAGE AND PROPER ROAD DESIGN

The investigation and assessment of the road materials that are in-place throughout Kosovo, including recently installed roads and existing infrastructure found in city streets, two-lane city connector roadways and village streets has provided insight into basic infrastructure problems and causes for some premature failures. Generally there seems to be a lack of understanding (or the overlooking) of the problems and outright premature failure caused to HMA and/or other road construction materials by the action of freeze-thaw or simple pumping of standing water from constant vehicular traffic. The water source can be from melting snow, or rain, or any form of underground streams, runoff or natural springs. Throughout all of Kosovo there are many examples of the lack of proper storm water drainage and reduction of the water from the road surface or subsurface. However, there is one village (Klina) that has a main street that was recently reconstructed with proper storm-water control and water drainage - and the results, compared to other locations, is dramatic. There are also a few recently re-constructed HMA roadways in the area of Peja that have been widened and repaved with HMA during which attention to storm-water management has been put into place and installed appropriately.

ECONOMIC RESULTS

DIRECT

The poor road conditions throughout most of Kosovo are a result of many different problems that can be corrected. It is difficult to point to one all encompassing direct issue that is responsible for every condition. A few roadway problems are related to poor, uncorrected, sub-base conditions, many other problems are related to the HMA mixture itself and the lack of proper materials, installation, and ineffective QA/QC, other problems are indicative of a lack of proper storm-water control, some problems relate to over-weight vehicles, or an under-designed structure, and still others relate to lack of maintenance. However, when one considers all the issues, the expenditure of capital to continually maintain the roads in the current poor conditions seems cyclical. Thus, each euro spent just for continued maintenance of a poorly constructed roadway system depletes the funds that could be available for other road construction. The annual value of this cyclical use of capital is difficult to quantify, however, it is easy to imagine that it is quite considerable.

INDIRECT

The poor road conditions throughout most of Kosovo also impact the economic well-being of the roadway user, and cause expenditures of capital that could be used elsewhere. For example, it is virtually impossible to drive along at even the posted speed limit on many portions of the two lane and other rural roads that connect villages or cities. The slowing, outright stopping and disruption of the vehicles and traffic patterns can account for significant lost time and revenue. An example of such negative economic impact to the roadway users follow.

If there are 300,000 vehicles in all of Kosovo, and each vehicle were used half the time and each vehicle lost ½ hour each day due to the poor road conditions, then the estimated loss in productivity is: 300,000 vehicles x ½ x ½ hr = 75,000 hours of lost time each day.

Moreover, the slowing, stopping, disruption and dodging caused by poor road conditions can account for an inefficient use of fuel in all the vehicles. For example, if an average of 20 km is driven each day by ½ of the vehicles, and the loss in fuel economy due to the poor conditions is assumed to be just 0.02 liter per km, then the wasted fuel is: 300,000 vehicles x ½ x 20 km x 0.02 liters/km = 60,000 liters of fuel wasted per day.

The poor road conditions are also responsible for many vehicle accidents that could be avoided by improving the conditions. There is a significant impact to vehicles such as undercarriage damage, suspension, and rim-tire damage. Moreover, the total value of accidents, both in loss of money and life and limb, plus the cost in lost time, is not readily available. However it is anticipated to be quite considerable.

Thus, if most roads in Kosovo were just in reasonable and passable condition, and just 50% of these indirect losses were eliminated, the economic effect would be significant.

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE ACTIVITY

BITUMEN

Prior to any significant HMA production, and in accordance with requirements of EU standards, whether with virgin materials or attempts to begin HMA recycling, we should establish contact and meet with technical and sales representatives from every source of bitumen supply that is available for Kosovo. The task should include gathering technical data from all existing and prospective sources of bitumen that are throughout the entire region, including all refineries. The goal of the task will be to learn more about individual refining differences and to establish a standard for communication, exchange of technical data, bitumen production test data, and QA/QC records. A further goal will be to study and monitor their progress. The information will be compiled and should be made available to all Kosovo HMA producers.

AGGREGATES

In accordance with requirements of EU standards for aggregates to be used in HMA and other road construction activities, we should establish contact with every source of aggregate supply that is available in and for use in Kosovo. The task should include providing training and copies of basic gradation tests and control for meeting EU standards. This task may include gathering gradation and other QA/QC data to study and monitor their progress. The information will be compiled and made available to all Kosovo HMA producers.

ICMM

Further assistance, communication and cooperation with ICMM should be encouraged to make certain there is no advantage or disadvantage provided to any ICMM permittee based on the product they mine, produce and sell, regardless of the mineral or the industry they serve. Moreover, continued efforts from all parties (USAID-KCBS-RCAK) to negotiate a fee based on a percentage of the selling price at the point-of-sale should be encouraged and supported. However, it may take some extended time (1-2 years) to develop such a royalty system. It seems that the primary effort of ICMM is to stop the illegal operations or the potential for illegal activities that have driven the actual development of the ICMM and their regulations as they exist.

Further dialog and cooperation should be provided directly to ICMM to better understand the permitting process and the long term goals and in particular for assistance to ICMM to stop the illegal, un-permitted operators who undermine the entire system. This task should include a study or survey of the progress on behalf of the properly permitted operators. In order to defend and protect against corruption within ICMM, they have developed an open website to allow anyone free access to the permit and investigation process.

The issue of locating and stopping the 300-odd illegal mining operations is by far the single largest overriding issue facing the ICMM and has most of their attention.

FILLERS

We should study, gather and share knowledge and information, including a technical data base on all sources of fillers for use in HMA production throughout the region. We should consider forming a joint technical group (USAID, KCBS, RCAK, Ministry of Construction, KEK and Pristina University) to support and develop the potential for use of KEK fly ash, and to track its development for use in construction materials such as HMA and RMC.

RECLAIMED ASPHALT PAVEMENTS (RAP)

Prior to any recycling, whether by milling, or ripping and crushing, each candidate road for rehabilitation will need to be reviewed, surveyed, inspected and tested. Those existing HMA roads or sections of roads that are found to be made with toxic tars will need to be either encased with additional layers of new HMA, or removed and properly recycled or disposed of. Those existing HMA roads that are in need of rehabilitation that are found to be made with petroleum bitumen will become candidates for milling, and subsequent hot-mix recycling at Kosovo HMA plants that have been properly equipped to handle such HMA recycling operations. We should provide technical assistance and equipment support to HMA producers to allow hot-mix recycling at their plants. Perhaps the University of Pristina, along with appropriate technical support, could become the organization to implement the surveying and testing of roads for the tar or petroleum bitumen determination throughout the region.

Subsequent to the HMA “plant production training” at Teltomat in May 2006, another similar training session for “HMA plant modifications and operations for RAP” with World Learning Center should be considered and implemented. We can support such hands-on equipment and production training with further communications and negotiations with the HMA plant equipment manufacturers in the EU to develop another factory-type session.

MIX DESIGN AND QA/QC

Technical support and training for the purchase, installation and implementation of individual QA/QC laboratories for each HMA plant should be discussed with RCAK and each HMA producer. In order to have the entire Kosovo road construction industry prepared and ready for EU standards, they should be provided with support and proper information regarding all phases of proper mix design and QA/QC methods for using end-result specifications. At the moment, there seems to be a lack of understanding of even the effects of variable feedstock and QA/QC to design and produce proper mixes, manage paving operations, and perform in-place compaction-compliance testing. We should consider assistance to provide, monitor, develop and reinforce continuing education for the HMA industry including individual plant-to-plant basis. The education should include, at a minimum, proper training in HMA design, testing and random sampling for EU standards, along with an understanding of un-biased sampling and testing of the road construction materials and HMA road paving products to effectively analyze and implement a proper, statistically based, un-biased, end result specification to be used for payment.

We have discussed an “Asphalt Technologist Training and Certification Program” with RCAK and the University of Prishtina. A 3 or 4 full-day training program should be encouraged and developed by USAID – KCBS and implemented by RCAK - on a fee basis. The suggested fee structure for the program might be on the order of 5 euros for students, 25 euros for people from any RCAK member in good standing, and 50 euros for professionals or others. Oversight and management of the classes for the class content would be provided by KCBS and the advertisement marketing and fee collections would be managed by RCAK. The classes and training program would be held at the University of Prishtina laboratory and

class rooms, with the Professorial staff providing the KCBS assisted, hands-on lab and class instruction. At the end of the program a written exam would be given to all attendees and an official certificate from the University would be issued to those who pass the course exam.

PRODUCTION METHODS AND PAVING OPERATIONS

Observation of existing paving equipment, along with inspection of existing road construction projects provided an excellent source for supporting the conclusions in this report. There seems to be a wide variation in knowledge (or lack thereof) of the effects of paving operations and compaction equipment, including their importance in making the final product complete, proper and long-lasting. We should consider assistance to develop, train, monitor, and reinforce the continuing education of RCAK and the HMA industry in this area, including the first scheduled training session tentatively set for May 2006 at Teltomat.

Subsequent to the HMA "plant production training" at Teltomat in May 2006, another similar training session for "paving and compaction" with World Learning Center should be considered and implemented. We can support such hands-on training with further communications and negotiations with the equipment manufacturers of paving and compaction equipment in the EU to develop another factory-type session.

DRAINAGE, MOISTURE DAMAGE AND RIGHT OF WAY DESIGN

We should assist with a review and study the need to implement a proper understanding of storm water management, along with design criteria, with particular emphasis on the potential for damage to the existing and future infrastructure. There also needs to be a better understanding and implementation, throughout all cities, municipalities and villages within Kosovo of the importance of proper storm-water management. These standards should be included in their designs and specifications for all road construction and reconstruction.

GOVERNMENT SPECIFICATIONS, PROCUREMENT AND PAYMENT

We should encourage and assist all central, regional and local Government agencies involved with roadway design, construction and maintenance to embrace, develop and implement full and complete end-result type specifications, including the EU-style standards for each applicable material, practice or design requirement. Moreover, the application and use of contemporary United States style procurement and payment standards, along with our initiatives should also be embraced, implemented and used. This task should include study and monitoring of their progress.

RCAK

We should encourage and assist all association activities that are directed toward increasing membership and their awareness for developing a technical data base, including literature, a library and sharing of technical know-how. The association should be supported to develop and implement 1) a fully instrumented, independent laboratory for study of HMA, fillers and aggregates, and 2) a continuing education program and teaching effort for all members, including the understanding and implementation of EU standards along with all the proper QA/QC for feedstock, production methods, equipment, materials and all road construction materials and activities.

We should work with RCAK and the recently proposed "concrete association" to work together or perhaps even fully merge with one another into one larger association. The existing cost of operating the RCAK office, the management, staffing and other overhead

could be shared by both associations. Consideration should be made for some type of dual membership and should be part of the overall membership plan since many quarries and contractors are involved in both HMA and concrete production enterprises. The association should also be encouraged to develop an “associate” membership level for equipment suppliers, professionals and others. These associate members are usually non-voting status but can provide much needed technical support.

PROFESSIONAL ASSOCIATIONS AND CERTIFICATIONS

Currently there are no requirements for professional certification in Kosovo. For example, there are graduate engineers from various regional Universities, but there are no sanctioned examinations and certifications with accompanying “sealed” work for Professional Engineers. This is also true for other professions such as architects and even technicians who have many diverse skills. We should encourage and assist the business associations, Universities, Government and others to establish Professional examinations and associations and to investigate, endorse, examine, provide and obtain professional certifications.

ANNEX I: FIELD TRIPS

We visited the two newest hot-mix plants in Kosova. They are near Ferizaj, about 30 km south of Pristina. We traveled a two-lane road, part of which was recently recycled by an Italian contractor with a Marini Travel Plant. The travel plant “in-situ” concept has not been realized worldwide since most pavements that are due to be repaired or recycled are in need of significant material rehabilitation and rejuvenation. It is difficult to impart significant rehabilitation by milling up, heating, rejuvenating, re-laying and re-compacting HMA in a single, large pass operation. The recent snow had melted, so a visual inspection was made while driving. Overall, the road condition would be rated as fair to poor. Most stretches of the roads that went through low lying areas were built between roadside berms. The berms severely impacted the road materials by allowing standing water, which, along with constant traffic, is one primary destructive force on road materials. The stretches of road that were elevated above the surrounding area with some natural grade effect to provide water run-off, and those sections with swales (ditches) along the sides of the road to provide good water drainage, seemed to be in better condition. The pavements did show significant prior, and recent, failure in the tire-track lanes from truck traffic. It is unknown what the enforced or un-enforced maximum gross vehicle weight is, but it is suspected there is some overweight traffic traveling throughout Kosovo. Numerous patches have been installed along those truck rutted sections – but only in the wheel path. The longitudinal joints were quite visually obvious and probably due, in part, to poor workmanship, or a lack of knowledge for making a cold joint during road paving or patching. There were significant transverse cracks which may be due to improper selection of bitumen grade for the local climate, or reflective from the layers below.

It is also unclear what restrictions and enforcement actions are on truck gross weight. We should review the EU standard and ask the Government to implement controls on the gross weight of trucks. Continued application of excess weight from trucks on the roadways and existing infrastructure will continue to inflict damage.

Pristina-to-Ferizaj Road – Longitudinal Patches

We visited the Papenburg-Adriani (PA) plant. We met with Muhamet Dervishi and Dieter Mertensotto, two principals in the venture between a German company and a Kosovar company. The plant is a new style batch HMA plant made by Teltomat, a German HMA plant manufacturer with factory works near Berlin. The Teltomat company produces about 50-80 plants of various sizes per year. The works company is owned by the parent company Gunter Papenburg AG. See the photograph of the PA plant which is a medium-sized 3-ton batch. The plant is a modern asphalt batch plant including equipment such as a dryer-baghouse direct fired drying system, along with contemporary computer controls (with recordation printer), motor controls, laboratory, and other support systems that are very capable (assuming the use of proper mix design and feed materials) of making EU quality HMA. In our meeting we managed to exchange information to have a clear understanding of USAID goals, along with the plant production, feedstock and QA/QC issues. One main item of discussion and understanding was an agreement whereby the RCAK members may have available to them a plant production technical training session at the Teltomat works factory.

Papenburg-Adriani HMA Plant – Ferizaj, Kosovo

We also visited the Eskavatori Company plant. We met primarily with Haziz Rysha, Managing Director of the company. The Eskavatori Company is a privately owned Kosovar enterprise. The plant is a newer style batch plant that was manufactured in Italy and relocated to Kosovo by the Eskavatori Company. The Eskavatori plant is a medium sized 2-ton batch plant, and is a typical, contemporary HMA batch plant including equipment such as a dryer-baghouse drying system, along with modern computer controls (currently without a recordation printer), motor controls, laboratory, and other support systems. This plant, as with PA, will be very capable (assuming the use of proper mix design and feed materials) of making EU and other quality HMA mixes. We had a good discussion and exchanged enough information to allow me to understand more of the problems and challenges that exist.

Eskavatori HMA Plant - Ferizaj, Kosovo

Road Rebuilt by Eskavatori near Peja, Kosovo

Road Rebuilt by Eskavatori near Peja, Kosovo – New Storm Water Control

We visited the region directly to the west of Pristina – and almost to the Albanian border to a village called Prisren. During the drive, we observed many of the road construction material facilities along the way. It also afforded me the time to observe the roadways in this region. We took a circuitous route which afforded sightings of many variations and types of equipment and installations. We saw a few SOE hot-mix plants that are in very poor condition. It is unlikely that those plants could make high quality EU mixes without significant investment in new equipment. We also saw a couple newer, contemporary hot-mix batch plants that appeared to be every bit as good as the Papenburg-Adriani and Eskavatori HMA facilities that are to the south of Pristina. We also saw approximately ten quarries in varying condition, from defunct and not workable, to fully operational. Most quarries seem to use a jaw-style primary crusher followed by some conical or impact tertiary systems, along with varying types of single to multiple screening units for aggregate sizing. We also saw remnants of a number of sand & gravel operations and a few were located along river beds. Apparently the mining of river gravel and sand is being prohibited by environmental and conservation requirements, so we will be able to discount those products from the matrix of candidate feedstock products.

Also, in this region west of Pristina, we noticed two hot mix batch plants that could be considered in the same “better” category as the two seen last week. That accounts for four newer HMA batch plant in the “better” category. Overall, we saw probably six or eight other HMA batch plants that would be considered medium or poor.

During the travels and tours, we've been able to observe the condition of the roads, bridges and streets. The condition is generally from medium to poor, or worse. We have not yet traveled on any existing (those built more than a couple years ago) roadway that I would call excellent or superior. Every stretch of road has some problem from stress, cracking, rutting or shoving. Most locations or stretches of roadways suffer from some damage due to lack of quality or control of mixes, heavy stress from truck weight, or storm water. We traveled through stretches that were acceptable asphalt pavements at one location, but they are barely passable due to potholes and damage caused by poor quality or water. The drainage of surface water needs to be addressed to solve problems in many areas. There does not seem to be any storm drain control built into the majority of the infrastructure - which will be a difficult problem to solve without major reconstruction efforts.

Failing Road near Prisren, Kosovo - Problem - Standing Water

Bridge Problems - Near Prisren, Kosovo

We also went to the southeast area of Kosova to Ferizaj. We visited the Bejta Company and met the owner, Bejtullah Kciku and Adem Kciku. We stopped at their new Andesite quarry that has a new, 300 ton per hour crushing and screening system. They installed this new crusher last year, and are still waiting for the ICMM permit to allow blasting operations to begin. Bejta Company seems frustrated by ICMM and their permit process. Bejta was told by the previous ICMM administrator (A German fellow) that Bejta was required to purchase their dynamite only from a particular German supplier, and the required purchase terms were going to be written into their permit. That German fellow is now gone from ICMM, but Bejta is still waiting for permission to begin blasting. They recently engaged a German lab to test their andesite aggregate to compare theirs to other andesite material mined in Austria.

Bejta Company – Andesite Quarry

We also visited the Bejta Company limestone quarry that also produces about 300 tons per hour of limestone aggregate. Their limestone is easier (slightly softer) to crush and screen when compared to Andesite. Thus, Bejta probably produces slightly more tons per hour at peak operation. We spoke about the issues they and the RCAK association has with ICMM, including the inequities of the in-situ blasting royalty arrangement. I also asked to see the Bejta testing lab – they have none for either quarry. They do not even have a set of sieves for gradation testing and control. I asked why they had no laboratory and they told me the University professor stops by once a month or so to take a few samples. I tried to convince them that a lab, with just sieves and shaker, would be in their best interest. Without gradation testing being on-site, their chances of meeting the EU standards are slim and with risk.

Bejta Company – Limestone Quarry

We also spoke with Konrad Wundke of the ICMM office. I inquired about the liability insurance issue for the land titles, along with other risk issues, and he said insurance is not provided as consideration for the ICMM royalty. He advised that the permittee would need to provide the any insurance. However, because Kosova is not a nation yet, the insurance underwriters won't issue anyone a policy. It's sort of a catch-22 situation. I also tried to convey to Konrad the inequities of the current royalty rate for the aggregate producers, particularly based on the in-situ blasting method, and he agreed to meet me to discuss.

We also traveled to the western part of Kosovo to Istog and Peja. The purpose of the trip was to see two HMA companies, Granit and Asphalti. Along the way from Pristina we passed through the village of Klina, where the main street was rebuilt sometime in the last three or so years. The quality of the pavement from curb-to-curb looked good. The design and construction of this main village street is an important example of what can be done in Kosovo. The current condition of the main street in Klina is due, in part to the attention to design and construction that provided proper curbside inlet and underground storm drainage. This project is good when compared to most villages that don't appear to have working storm water control. In most cases, the water from melting snow or rain just sits in the right-of-way and continuously freezes-thaws and degrades the HMA pavements. Any reconstruction of other similar village or city streets in Kosovo should consider using Klina as a model.

Klina Street – Built With Storm Drain System

Klina Street with No Storm Drain System

We went to Granit and met with Mr. Ismet Loshaj, owner, and Mr. Jashar Blakaj, technical advisor. The Granit plant was a more vertically integrated than most of the others we've seen. They have a limestone crusher for producing aggregate for both their HMA plant and their Ready-mix concrete plant. Due to their requirement for clean, manufactured sand for making concrete, the Granit limestone crusher has a baghouse for capturing the fines from all their crushing and screening. This is the first system like this that we've seen in Kosova. Granit uses the limestone fines as filler in their HMA batch plant. The plant has two filler silos, which is a good example of "best management practice". There is one silo for the crusher dust filler that is made on-site and one silo for their purchased filler. Granit advised that they occasionally purchase limestone filler that is made somewhere in Kosova. The Granit HMA plant was a recent vintage, batch-type plant, with a mixer of two tons per batch. Granit purchased the plant used in EU and imported it to Istog. The HMA plant also has a used, but reconditioned, baghouse for their aggregate drying system. They, like the others, burn fuel oil in the plant burner. They advised that the fuel oil in Kosova is all the same price, whether used for automobiles, industrial fuel or off-road construction equipment. Granit advised that their HMA plant bag house needs a new set of bags. The current bags are 10 years old and they limit production capacity. Not surprisingly, Granit has ordered new bags that will be installed before the 2006 season. The plant also has two hot mix storage silos that hold about 150 tons of finished HMA products. They have certificates from the Albanian refiner for each truck load and provided a copy of one. I asked to see the Granit laboratory for QA/QC of their aggregates, RMC and HMA and I was advised they do not have a lab. Like some of the other companies we've visited, they seem to believe that all the mix design and QA/QC can be provided by the University or a central lab like IBMS. I advised that they will need to develop their own plant lab to meet EU specs. They understood and agreed.

Granit Company HMA Plant, Istog, Kosovo

At Asphalti we met first with Mr. Nazmi Kadriaj, owner. We met at the Asphalti plant, a fairly recent vintage Marini batch-type plant, with a mixer of two tons per batch. Asphalti purchased the Marini plant from an Italian contractor here in Kosova and moved it to his site. His plant is typical with a cold feed system, dryer, batch tower, and HMA storage silos. He reported he produced 40,000 tons in 2005. I asked about his fuel for his dryer and he advised that he burns heavy oil rather than fuel oil. Apparently the heavy oil costs about one-half of the cost of fuel oil. In order to support the use of heavy oil for combustion (requires heating to 80C for proper atomization for combustion), Asphalti has an extensive tank farm for bitumen and heavy fuel. This is the first heavy oil system for aggregate drying that I've seen.

Asphalti Company HMA Plant, Peja, Kosovo

We also learned from Asphalti and Granit that there is a dedicated limestone filler manufacturing plant in Kosova. The plant is located in the west near Peja in Decan, Junik. The company is a partnership of a Swiss company, "Part von Wyel" and a Kosovar company of Mr. Avni Tofaj. They report they are preparing to expand the plant as requirements and sales of limestone filler demand. Asphalti also reported to us that he thought another filler making company was in Ferizaj but we did not have time to investigate.

We also visited the northern part of Kosovo near the Serbian border. We went to a village about 40 km north of Metrovica and met Company AS. The Company AS HMA plant is an assemblage of parts that this contractor put together from various pieces purchased from all over northern Kosova. The aggregates that were in his yard were supplied by a Serbian andesite quarry, and are a blend of dirt and stones. The owner stated they screened the aggregate before they used it. He purchases his bitumen from northern Serbia or Albania and the travel distance to either bitumen source is about 250 km. The bitumen is about 250 euro per ton, delivered. The large coarse aggregate is about 12 euros per ton delivered and the smaller coarse aggregate is about 15 euros per ton, delivered. Their aggregate prices seem higher here than in other parts of Kosovo. They plan to set up a stone crushing operation and there were two small jaw crushers in his yard, both without motors. It is unlikely Company AS will be able to meet the EU standards with this current equipment arrangement. They will need considerable equipment upgrades and processing training and support. The owner showed us the village road they recently re-built last fall with this plant's first production run. You can see from the photos that the job does not look too bad considering what they have to work with. They also showed us the 20 km road they are re-building under a contract to the Serbian Government. The roadway design does not seem to be up to the EU standards.

Company AS, HMA Plant, Northern Kosovo

Company AS, Village Street Paving Project, Northern Kosovo

Company AS, Road Rebuild and Widen Project, Northern Kosovo

We had a meeting with a large group of plant owners from the RCAK Association to discuss the training program for the managers. They agreed we should have the training in May 2006 and in Berlin at Teltomat Company. We discussed the training agenda and they seemed enthusiastic about the prospect of having their production people learn more about plant operations. We asked them to provide us with comments about their most pressing needs for the immediate future and they stated 1) mix design, 2) mix QA/QC, 3) paver and laydown operations and 4) material compaction and testing.

We also inspected streets and roads in the vicinity of Pristina. The Pristina streets and road conditions are very poor due to hot-mix quality problems and inadequate storm water drainage issues. The Pristina street problems are exacerbated by the constant traffic flow. However, problems caused by the lack of hot-mix quality and from poor, or nonexistent, storm water control are seen in all of Kosovo.

Street without storm drains or ineffective drains, Pristina, Kosovo

Street without storm drains or ineffective drains, Pristina, Kosovo

There is a lack of proper trench repair throughout the Pristina. A utility company or contractor will cut an existing street for underground utility and make little or no effort to patch the cut. This poor practice allows storm water to quickly undermine nearby pavements.

Utility Trench with No Repair, Pristina, Kosovo

Utility Trench with Minimal Repair, Pristina, Kosovo

We visited Mr. Florim Grajcevci with the Kosovo Ministry of Transportation. We discussed a number of topics including the future adoption of the EU standards and the plans for a 120 km EU four lane highway through Kosovo, from Serbia to Albania. We reviewed the needs for assisting the Department, the RCAK and other contractors to prepare and implement the necessary EU standards.

We drove to Klina area and met with Mr. Binak Kalludra, Director and Owner of Benita Company. Benita is a private enterprise that has been in contracting and construction for almost 30 years. Currently, they own a sand and gravel plant in Klina that produces coarse and fine aggregates for making ready mix concrete in their concrete pant for buildings and related construction activities. They also operate a filler making plant that produces limestone filler for sale to HMA facilities throughout the western portion of Kosovo. The Benita Company also owns and operates a limestone quarry that makes various sizes of coarse and fine aggregates for sale to HMA facilities and for other construction activities. The limestone quarry also includes a filler making system that operates as part of the primary-secondary crusher APC.

Benita – Dedicated Limestone Filler Making Plant

Benita – Limestone Filler Making Plant Part of Crusher

Benita – Limestone Crusher System for Making Aggregates

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HOT-MIX ASPHALT TECHNOLOGY & CONSTRUCTION

Lecturer: Paul Bracegirdle

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Opinions expressed in this publication do not necessarily represent the views of United States Agency for International Development or the United States Government

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- **Asphalt Technology**
- Asphalt Pavements for Vehicular Traffic
- Structural Design Concept
- Asphalt Pavement Materials
- Types of Asphalt Pavement Construction
- Rehabilitation
- Hot Mix Recycling
- Pavement Maintenance
- Asphalt Technologist

Petroleum Asphalt (Bitumen)

- Desired Properties or Characteristics of Asphalt (Bitumen)
- Specifications and Tests for Asphalt Cement (Bitumen)

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- Specific Gravity
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- Asphalt Mix Design Procedure
- Preliminary Calculations
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- Summary of Equations
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- Drum Mixing
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- Reclaimed Materials
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- Blending
- Mix Design Calculations
- Optimum Bitumen Content

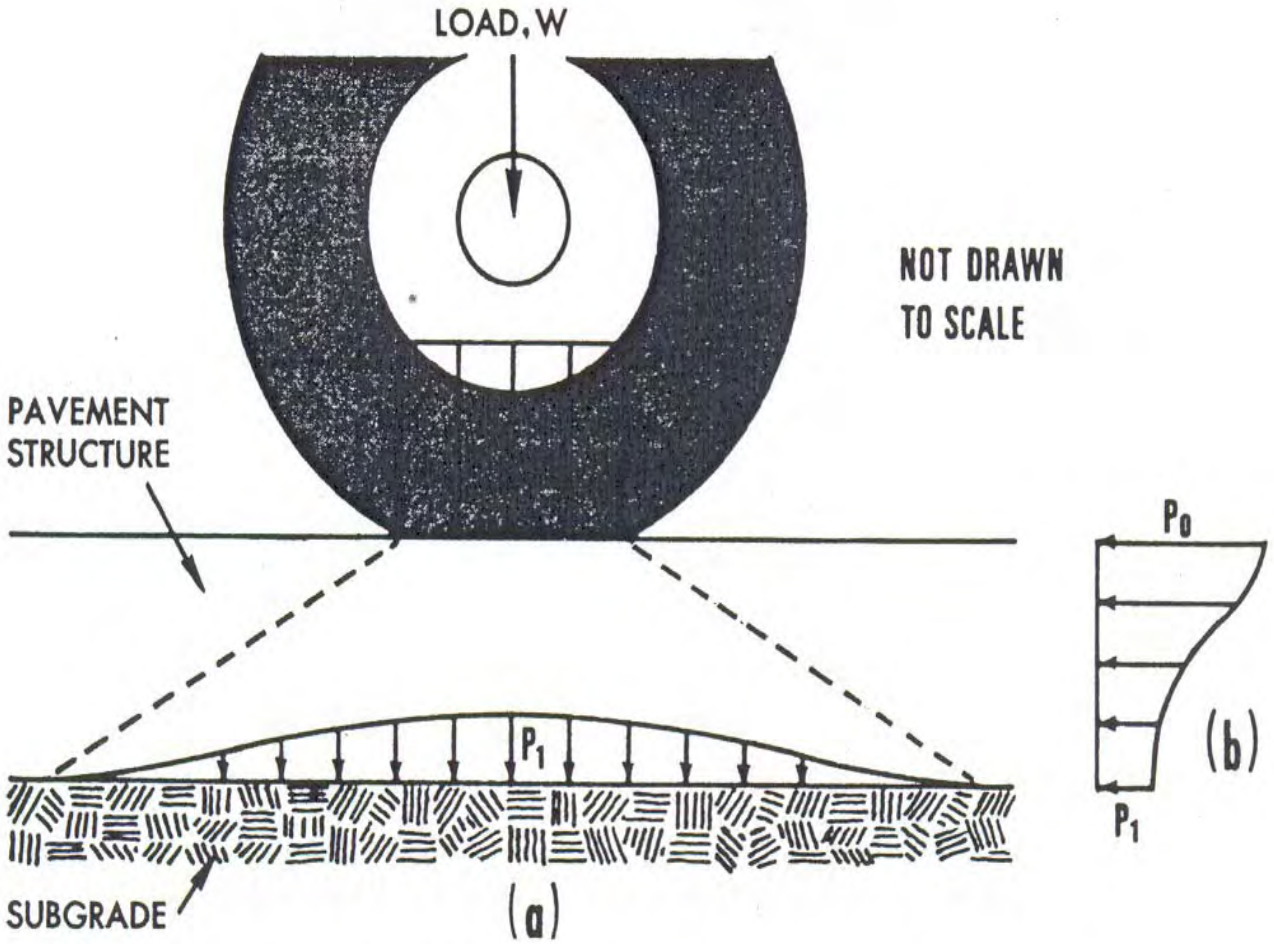
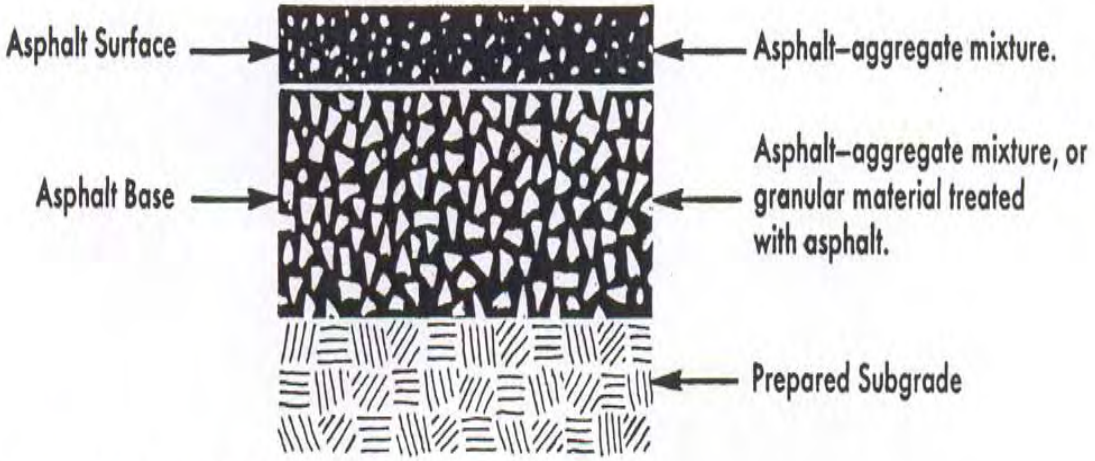
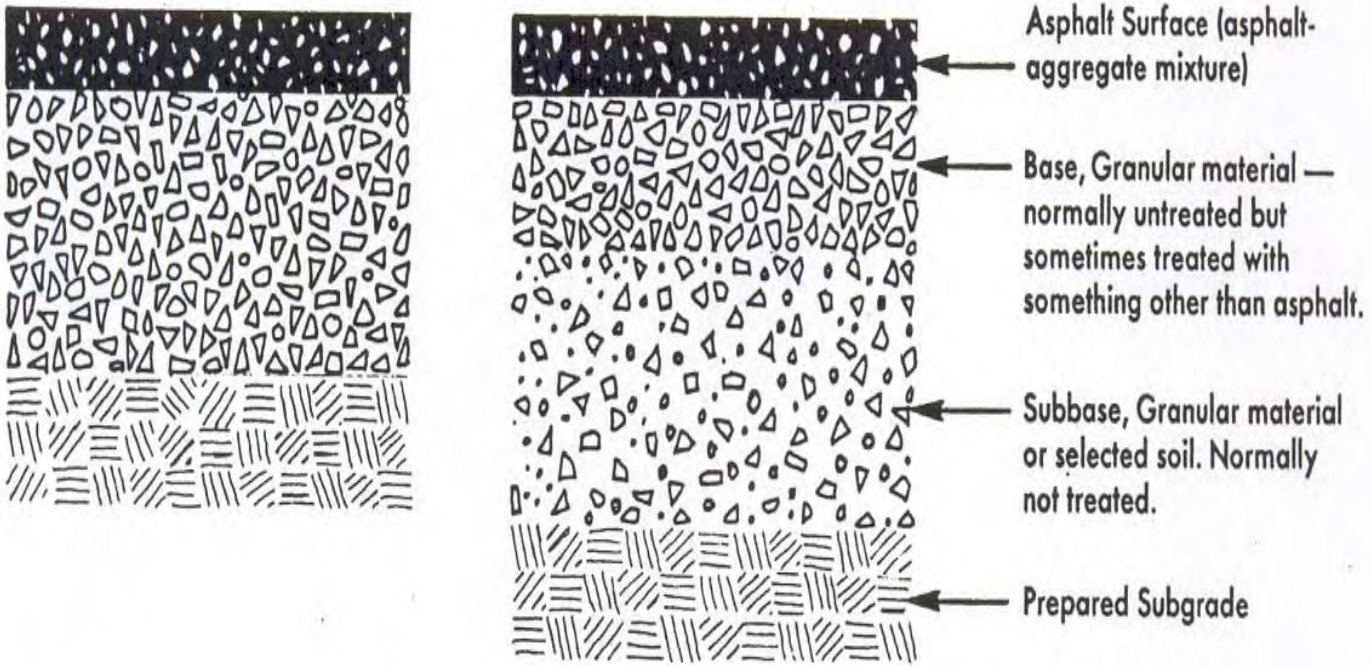


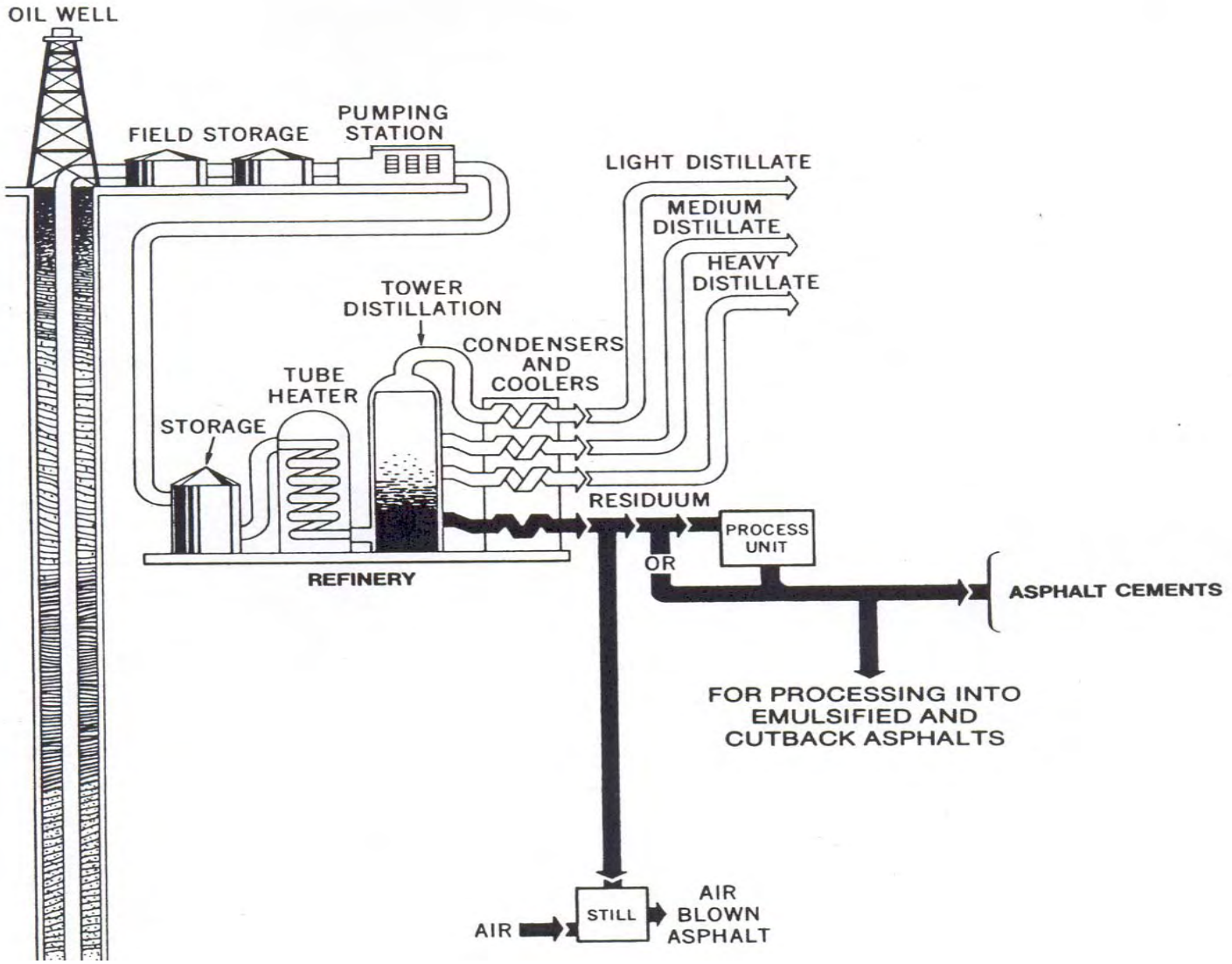
Figure 1. Spread of wheel-load through pavement structure



FULL DEPTH ASPHALT PAVEMENT



ASPHALT PAVEMENT WITH UNTREATED BASE (AND SUBBASE)


OIL WELL
FIELD STORAGE
PUMPING STATION
LIGHT DISTILLATE
MEDIUM DISTILLATE
HEAVY DISTILLATE
TOWER DISTILLATION
CONDENSERS AND COOLERS
TUBE HEATER
STORAGE
RESIDUUM
PROCESS UNIT
OR
REFINERY
ASPHALT CEMENTS
FOR PROCESSING INTO EMULSIFIED AND CUTBACK ASPHALTS
AIR
STILL
AIR BLOWN ASPHALT

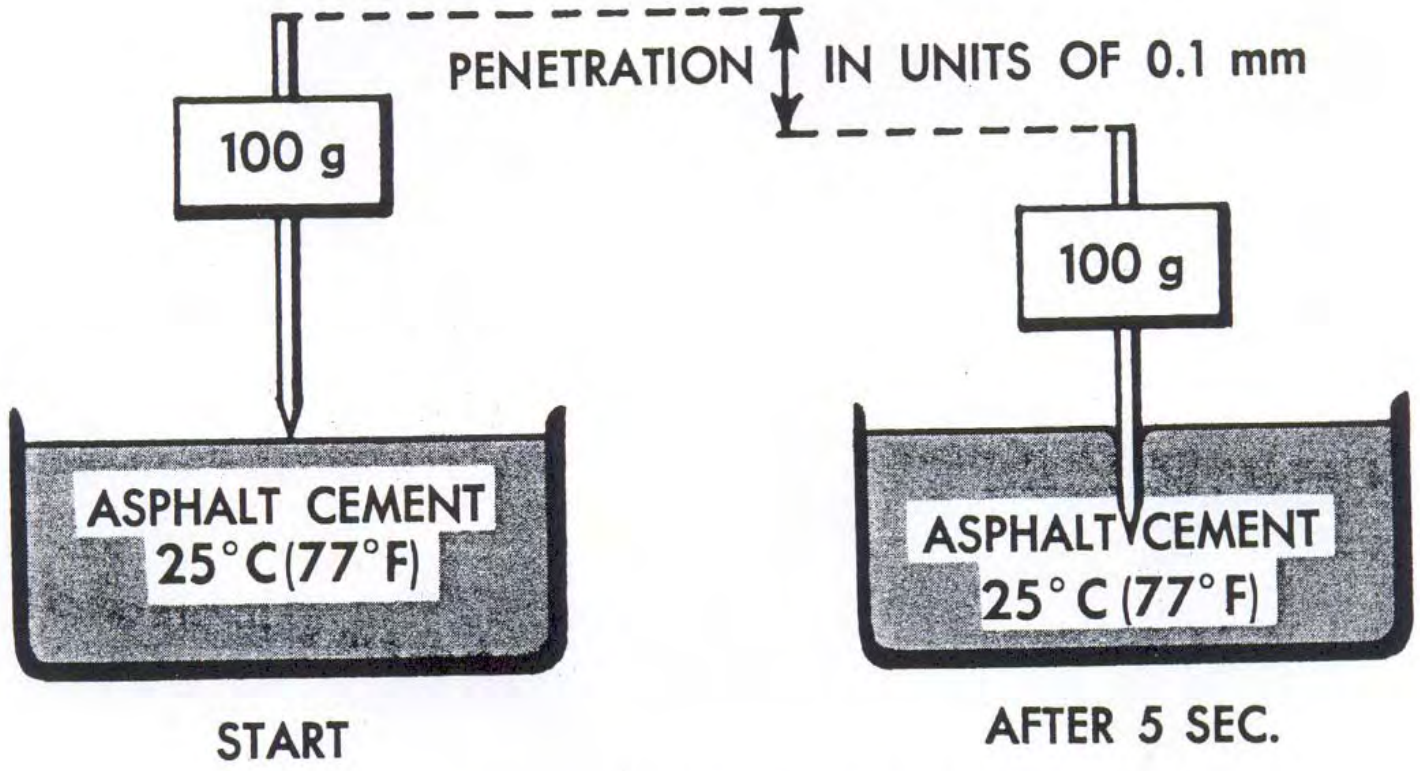


Figure 7. Penetration test

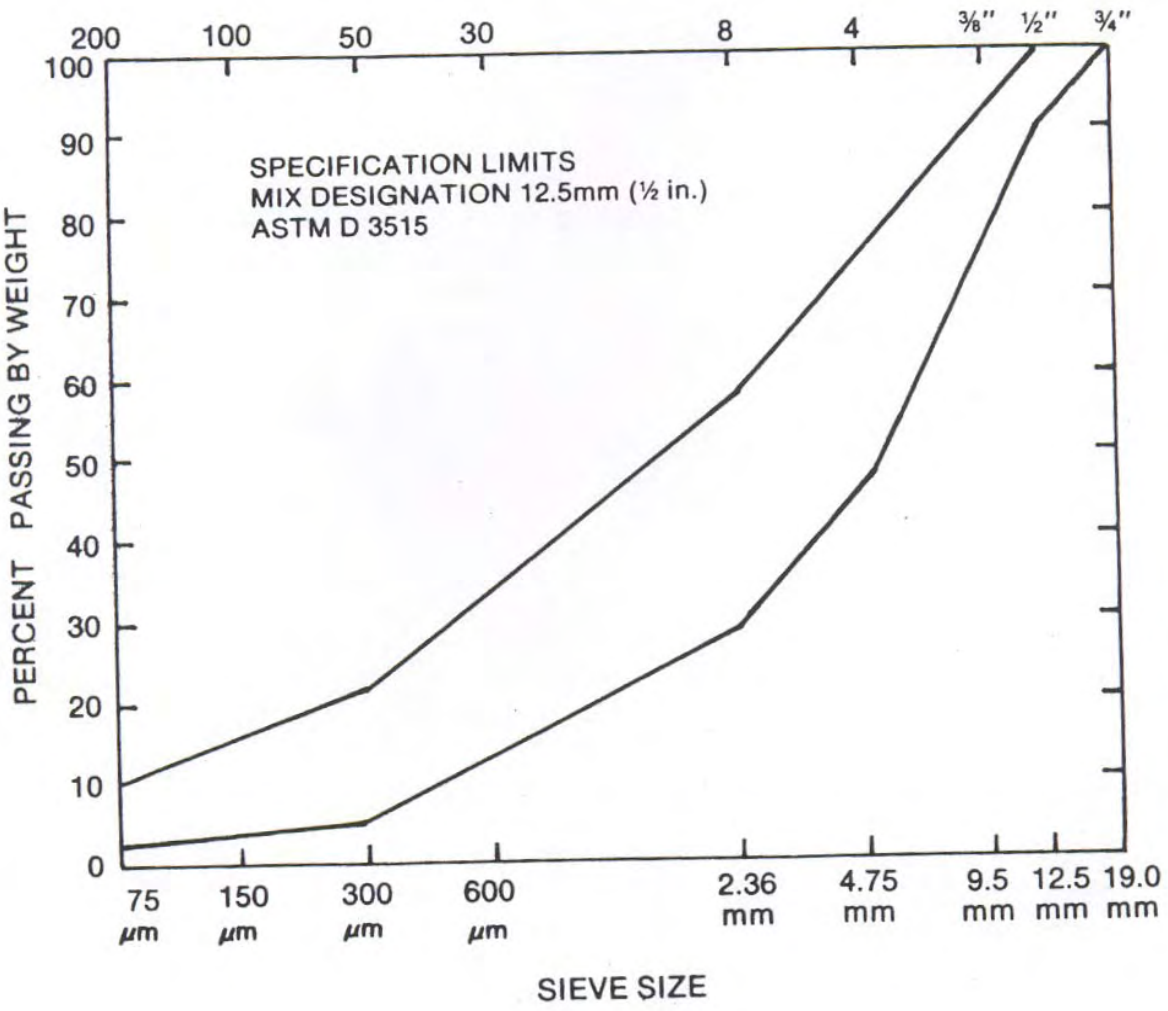


Figure 1. Gradation curve of an aggregate blend for an asphalt concrete surface course

TABLE 1

NOMINAL DIMENSIONS OF U.S. STANDARD SIEVES

Sieve designation		Sieve opening	
Standard	Alternative	mm	In.
38.1 mm	1½-in.	38.1	1.50
25.0 mm	1-in.	25.0	1.00
19.0 mm	¾-in	19.0	0.750
12.5 mm	½-in.	12.5	0.500
9.5 mm	⅜-in.	9.5	0.375
4.75 mm	No. 4	4.75	0.187
2.36 mm	No. 8	2.36	0.0937
1.18 mm	No. 16	1.18	0.0469
600 μm	No. 30	0.600	0.0234
300 μm	No. 50	0.300	0.0117
150 μm	No. 150	0.0150	0.0059
75 μm	No. 200	0.075	0.0029

PERCENT PASSING

Sieve	19.0 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm	600 μm	300 μm	150 μm	75 μm
	¾"	½"	⅜"	No. 4	8	30	50	100	200
Spec.	100	80-100	70-90	50-70	35-50	18-29	13-23	8-16	4-10
Aggr. A	100	90	59	16	3.2	1.1	0	0	0
Aggr. B	100	100	100	96	82	51	36	21	9.2

(a) Grading Specification and sieve analyses of aggregates

$$\text{(No. 8), } b = \frac{P - A}{B - A} = \frac{42.5 - 3.2}{82 - 3.2} = 0.50,\ a = 1 - 0.50 = 0.50$$

Sieve	19.0 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm	600 μm	300 μm	150 μm	75 μm
	¾"	½"	⅜"	No. 4	8	30	50	100	200
.50 × A	50	45.5	29.5	8.0	1.6	0.6			
.50 × B	50	50.0	50.0	48.0	41.0	25.0	18.0	10.5	4.6
Total	100	95.5	79.5	56.0	42.6	25.6	18.0	10.5	4.6
Spec.	100	80-100	70-90	50-70	35-50	18-29	13-23	8-16	4-10

Minus No. 200 low, increase b to 0.55, a to 0.45

(b) First trial combination

Sieve	19.0 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm	600 μm	300 μm	150 μm	75 μm
	¾"	½"	⅜"	No. 4	8	30	50	100	200
.45 × A	45	40.5	26.6	7.2	1.4	0.5			
.55 × B	55	55.0	55.0	52.8	45.1	28.0	19.8	11.5	5.1
Total	100	95.5	81.6	60.0	46.5	28.5	19.8	11.5	5.1
Spec.	100	80-100	70-90	50-70	35-50	18-29	13-23	8-16	4-10

Minus No. 30 high, let b = 0.52, a = 0.48

(c) Second trial combination

Figure 1. Trial-and-error calculations for combining two aggregates

LESSON 1

PROPERTIES OF ASPHALT MIXES

INTRODUCTION

Hot-Mix Defined

Hot-mix asphalt paving consists of a combination of aggregate uniformly mixed and coated with asphalt cement. To dry the aggregates and to obtain sufficient fluidity of asphalt cement for proper mixing and workability, both the aggregate and asphalt must be heated prior to mixing — hence the term hot-mix.

Aggregates and asphalt are combined in a mixing plant in which all of the constituent materials are heated, proportioned, and mixed to produce the desired paving mixture. After plant mixing is complete, the hot mix is transported to the paving site and spread in a loosely compacted layer to a uniform, even surface with a paving machine. While the paving mixture is still hot, the material is further compacted by heavy motor-driven rollers to produce a smooth, well-consolidated course.

Classification of Hot Mixes

Hot-mix asphalt paving mixtures may be produced from a wide range of aggregate combinations, each having its own particular characteristics suited to specific design and construction uses. Aside from the amount and grade of asphalt used, the principal characteristics of the mix are determined, in the main, by the relative amounts of

(a) coarse aggregate, retained on 2.36 mm (No. 8 sieve).

(b) fine aggregate, passing 2.36 mm (No. 8 sieve).

(c) mineral dust, passing 75 μm (No. 200 sieve).

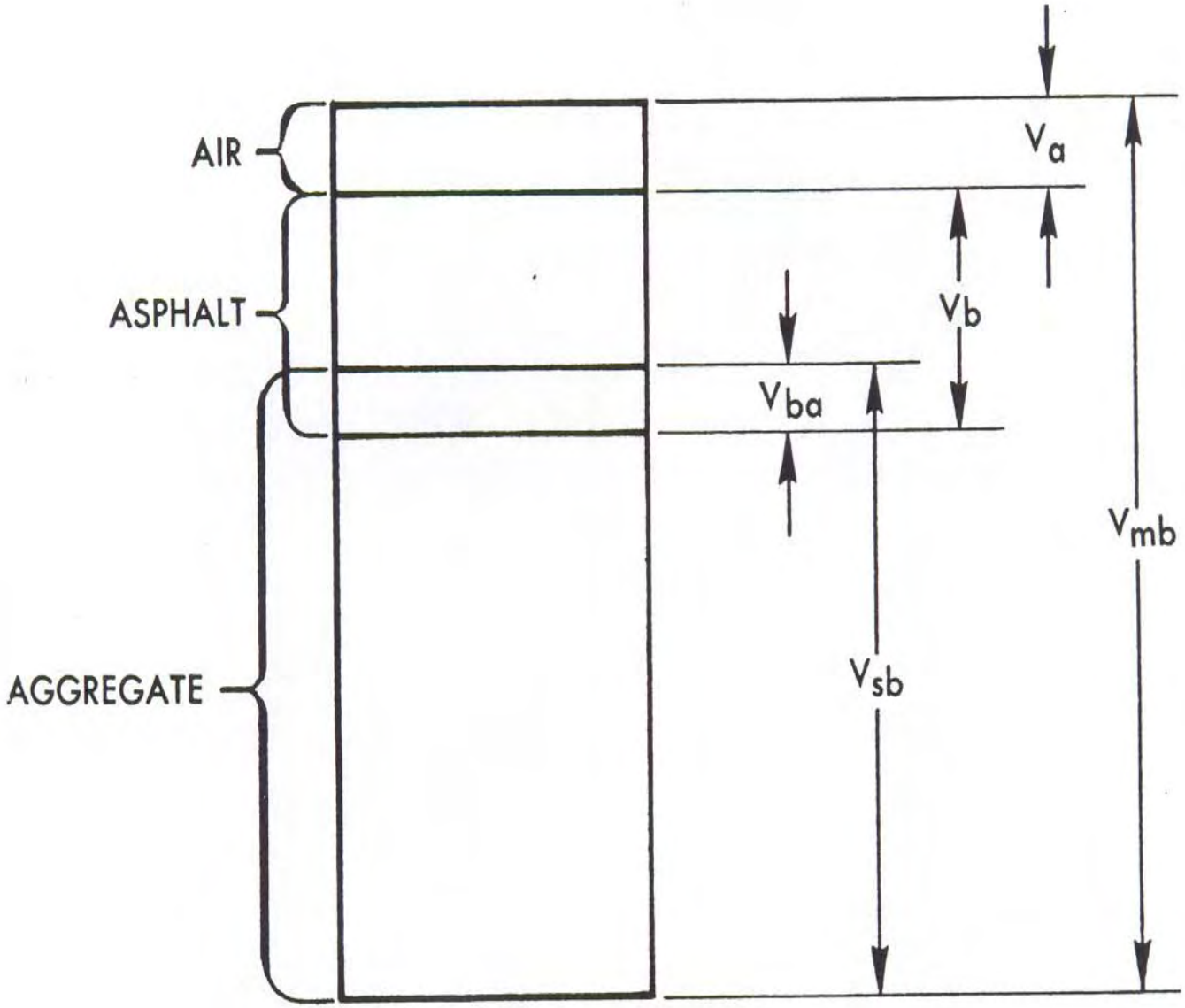
Asphalt concrete is a type of hot mix that meets strict requirements, and should be accurately defined. It is a high-quality, carefully controlled hot mixture of asphalt cement and well-graded, high-quality aggregate thoroughly compacted into a uniform dense mass typified by dense-graded paving mixes.

CONSIDERATIONS IN ASPHALT MIX DESIGN

Desired Properties

To properly design an asphalt paving mixture for a specific application, consideration must be given to the following desirable mix properties:

1. Stability,
2. Durability,
3. Flexibility,
4. Fatigue resistance,
5. Skid resistance,
6. Impermeability, and
7. Workability.


AIR
ASPHALT
AGGREGATE
V_a
V_b
V_{ba}
V_{sb}
V_{mb}

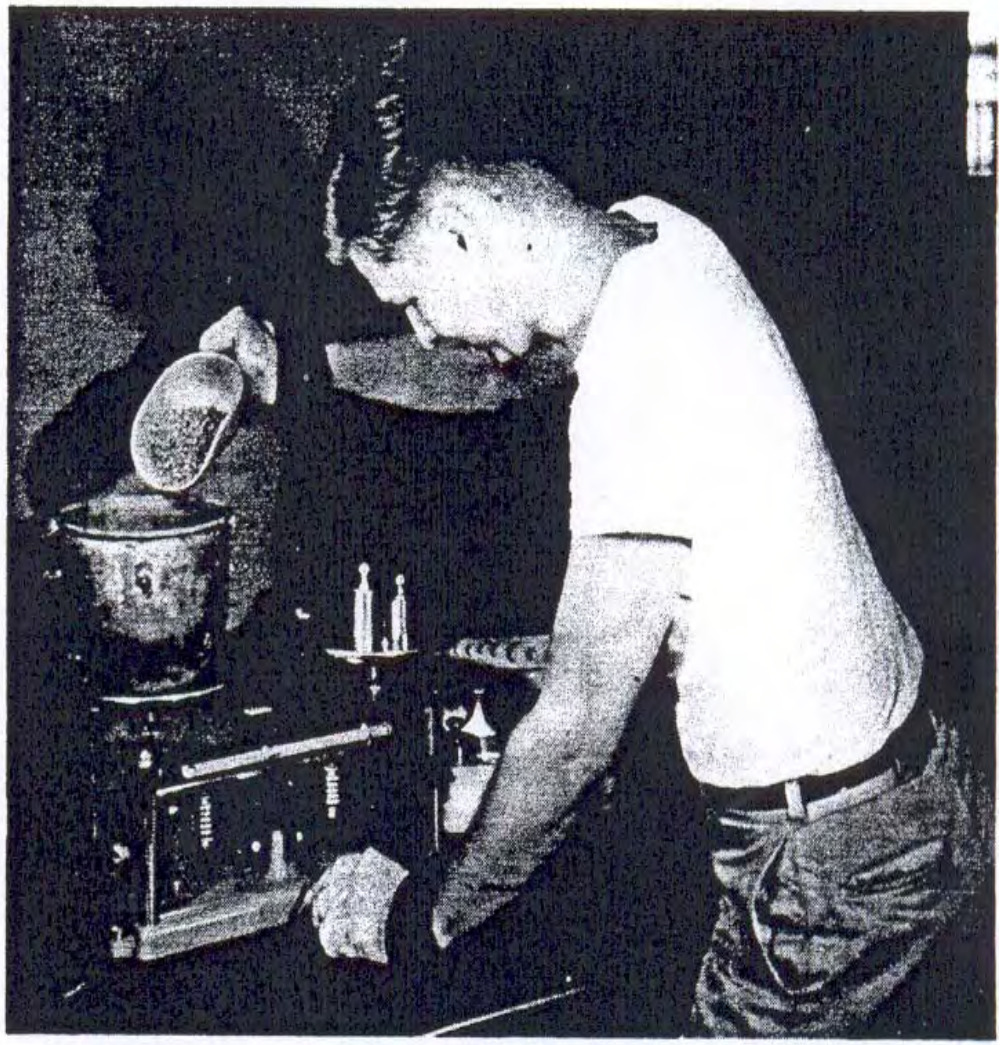


Figure 1. Weighing aggregates for batch mixes

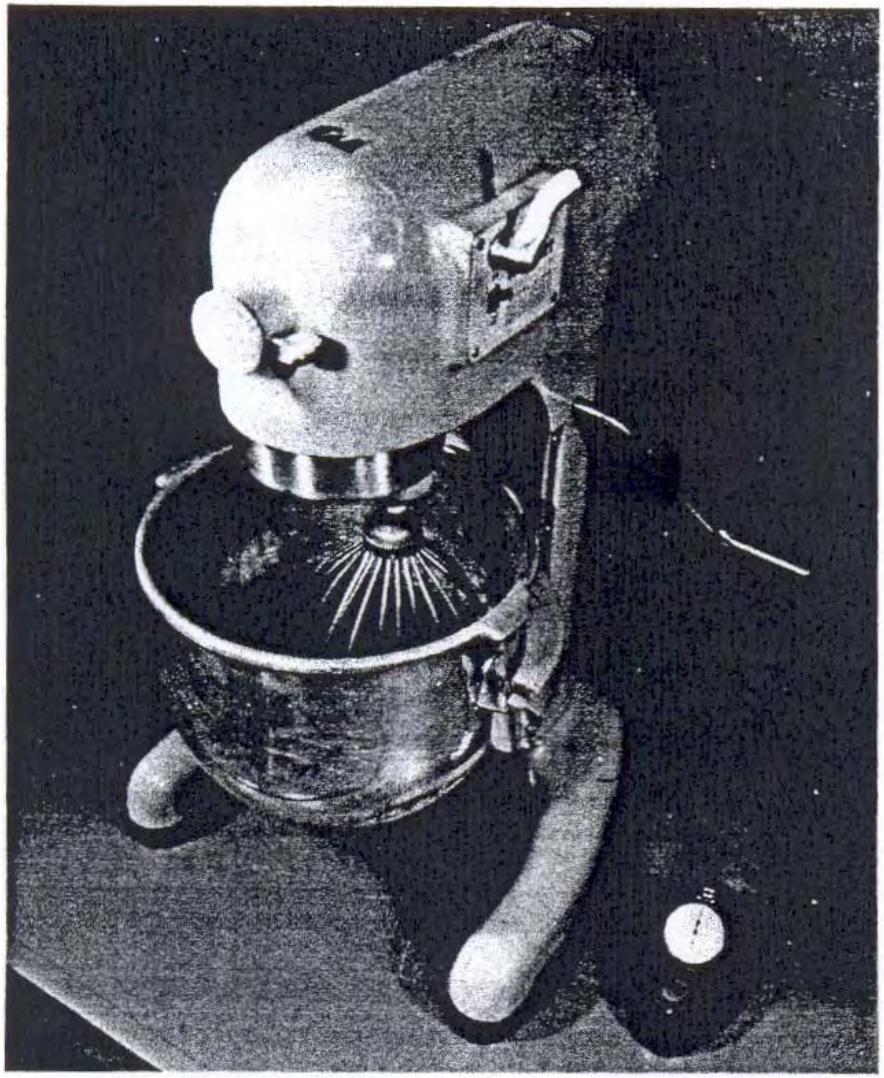


Figure 4. Mechanical mixer or batch mixing of asphalt and aggregate

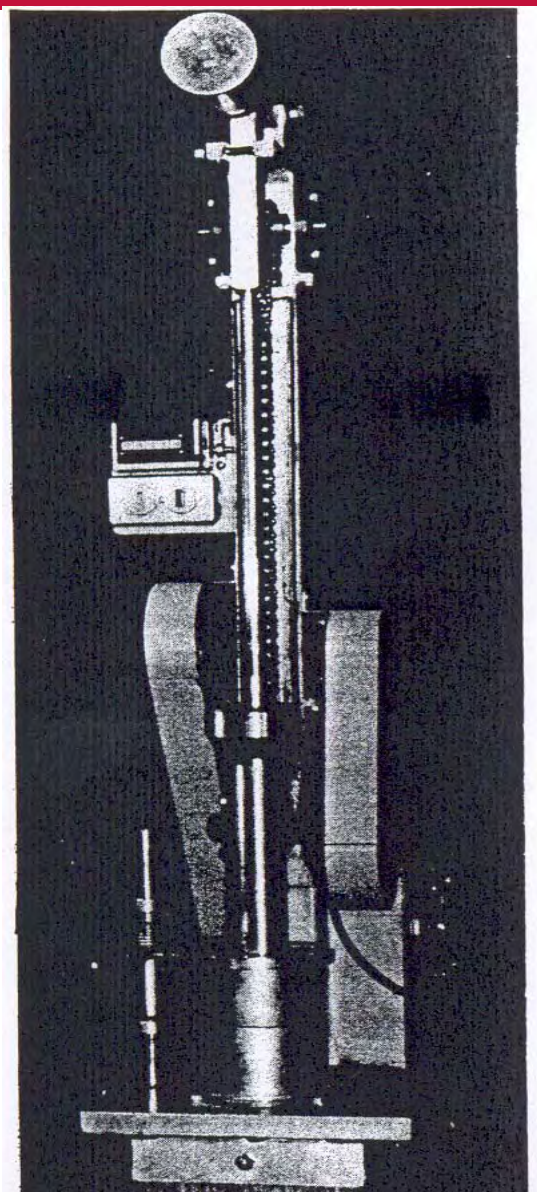


Figure 5. Mechanical hammer used in preparing Marshall test specimens

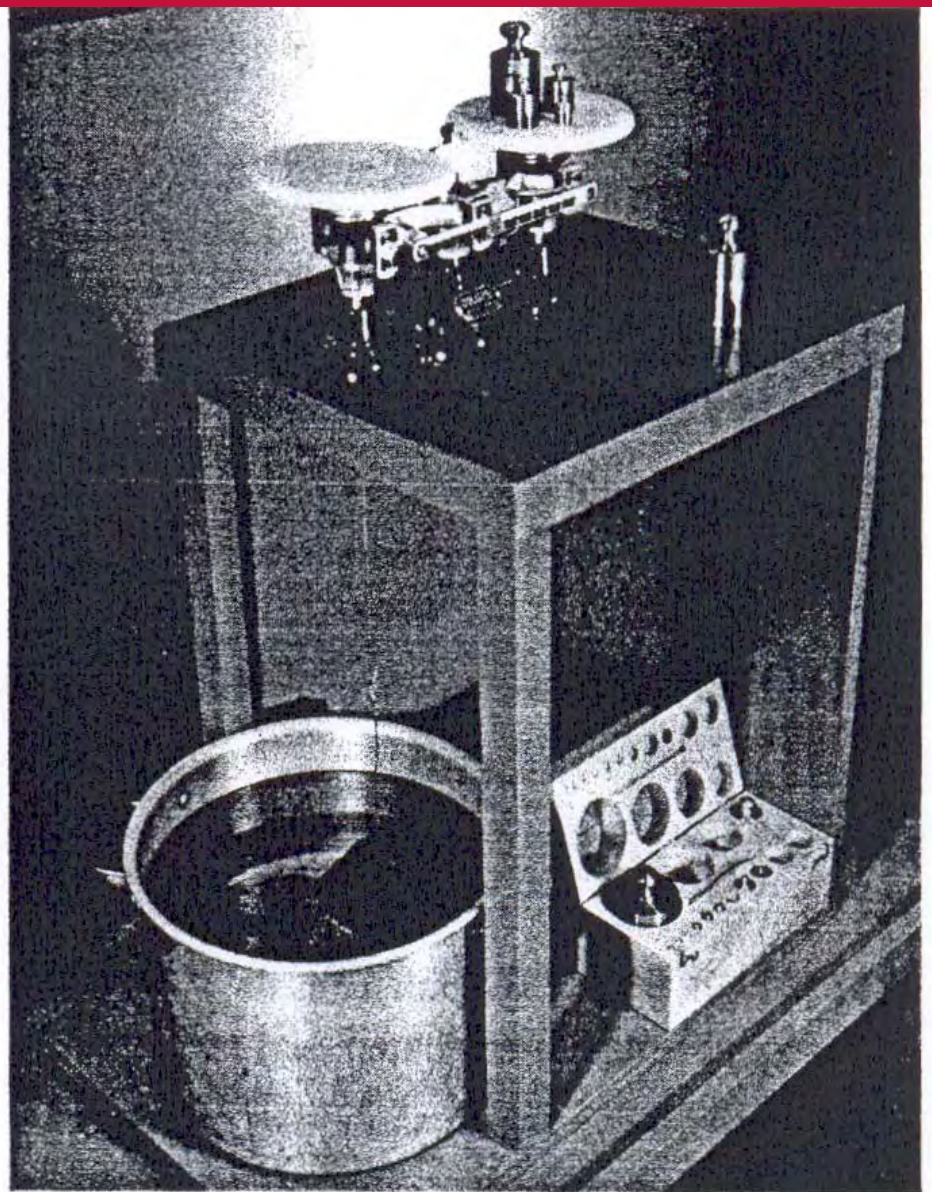
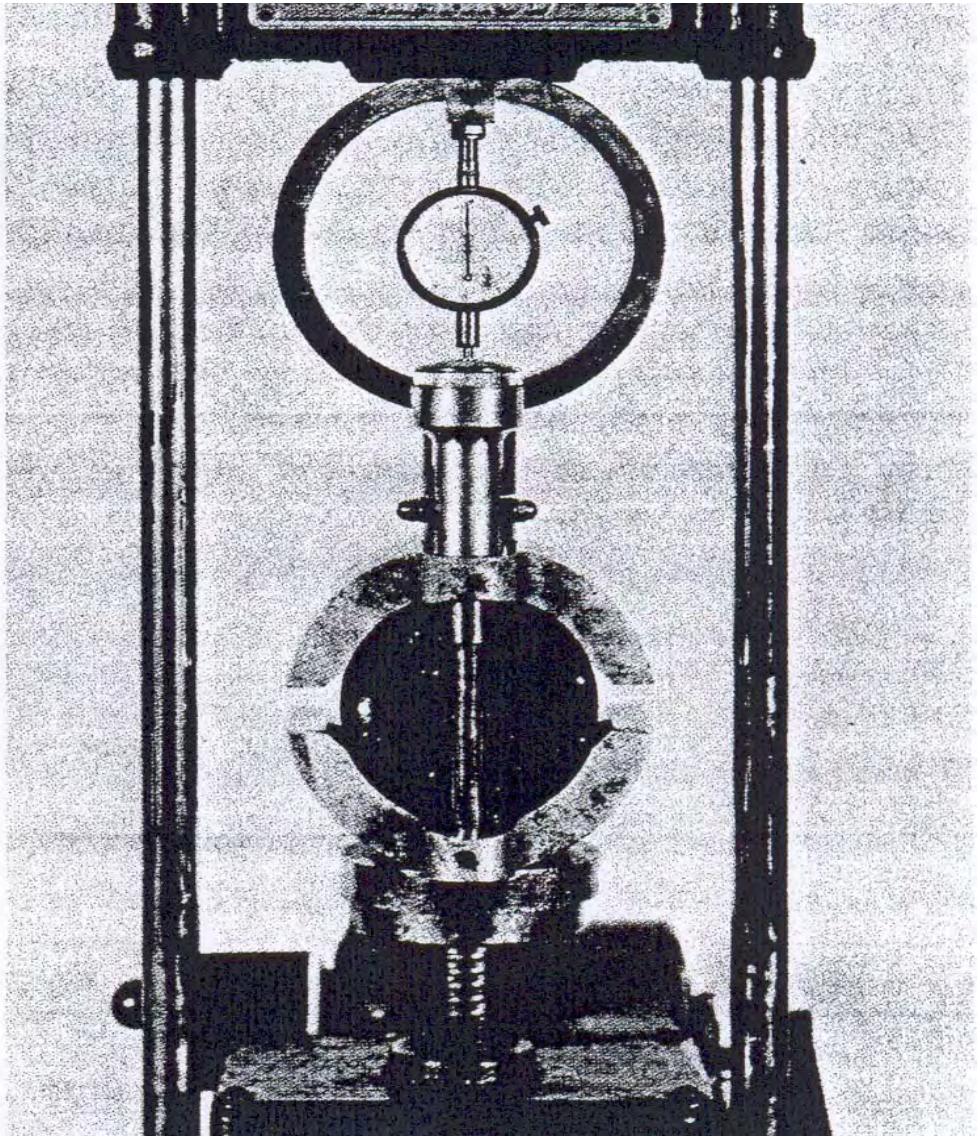
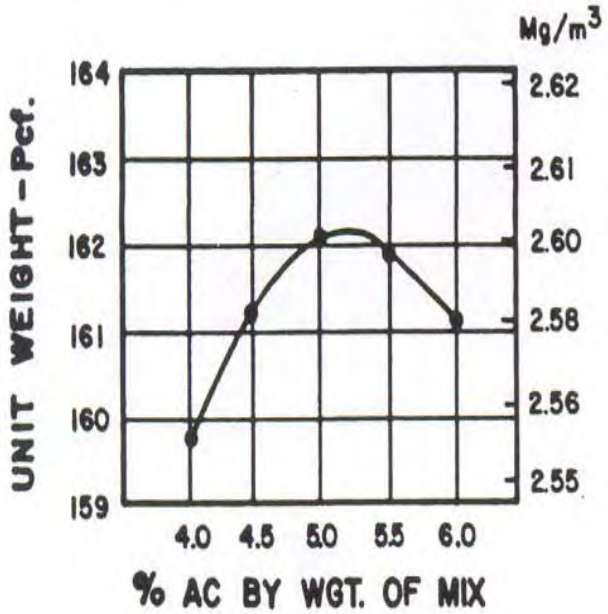


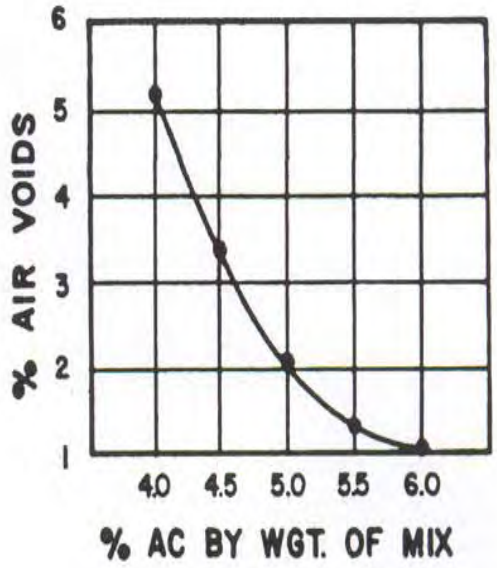
Figure 7. Weighing compacted hot-mix specimen in water

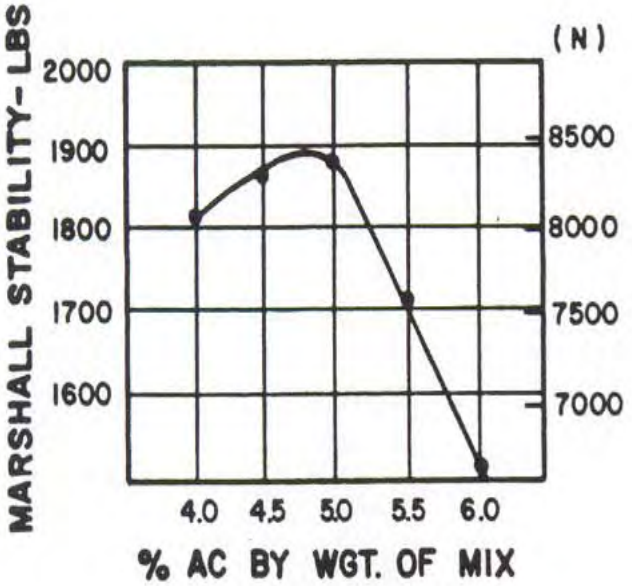
(Photograph by G. A. Oldham, Dept. of Highways, New Brunswick, Canada)

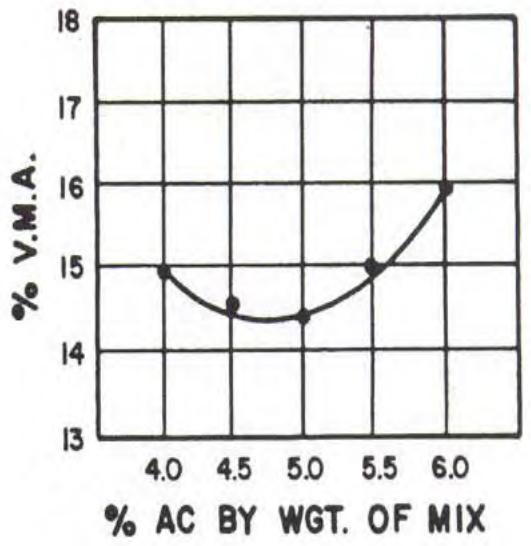
Figure 8. Marshall stability and flow test

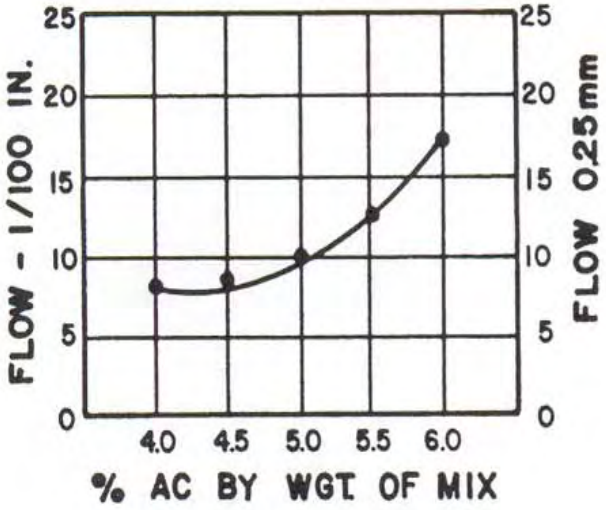



Mg/m3
UNIT WEIGHT - Pcf.
164
163
162
161
160
159
2.62
2.61
2.60
2.58
2.56
2.55
4.0 4.5 5.0 5.5 6.0
% AC BY WGT. OF MIX


% AIR VOIDS
6
5
4
3
2
1
4.0 4.5 5.0 5.5 6.0
% AC BY WGT. OF MIX


MARSHALL STABILITY- LBS
2000
1900
1800
1700
1600
(N)
8500
8000
7500
7000
4.0
4.5
5.0
5.5
6.0
% AC BY WGT. OF MIX


% V.M.A.
18
17
16
15
14
13
4.0
4.5
5.0
5.5
6.0
% AC BY WGT. OF MIX


FLOW - 1/100 IN.
FLOW 0.25mm
25
20
15
10
5
0
4.0
4.5
5.0
5.5
6.0
% AC BY WGT OF MIX

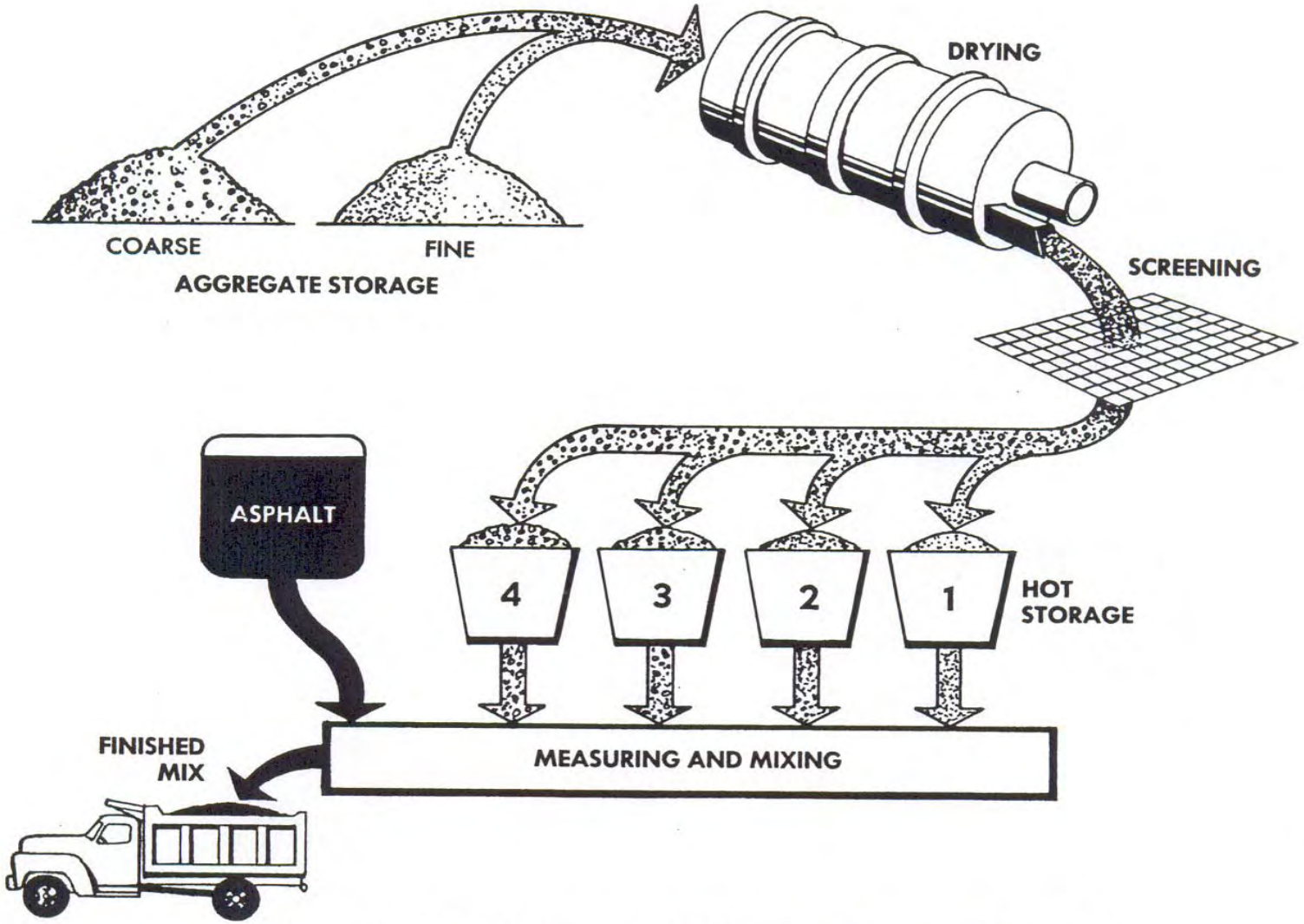


Figure 1. Typical diagram of batch or continuous asphalt plant

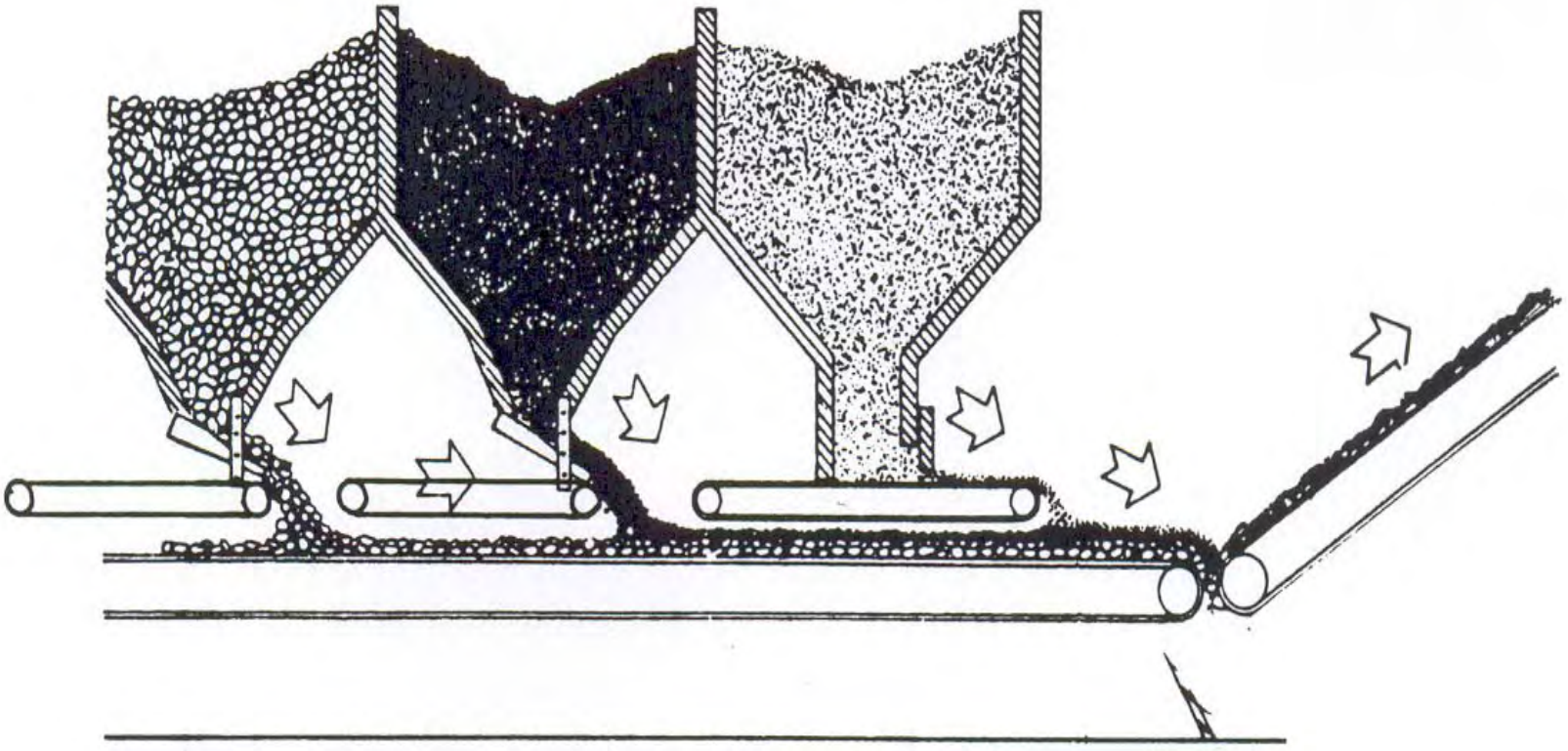


Figure 7. Three-bin cold feeder and belt

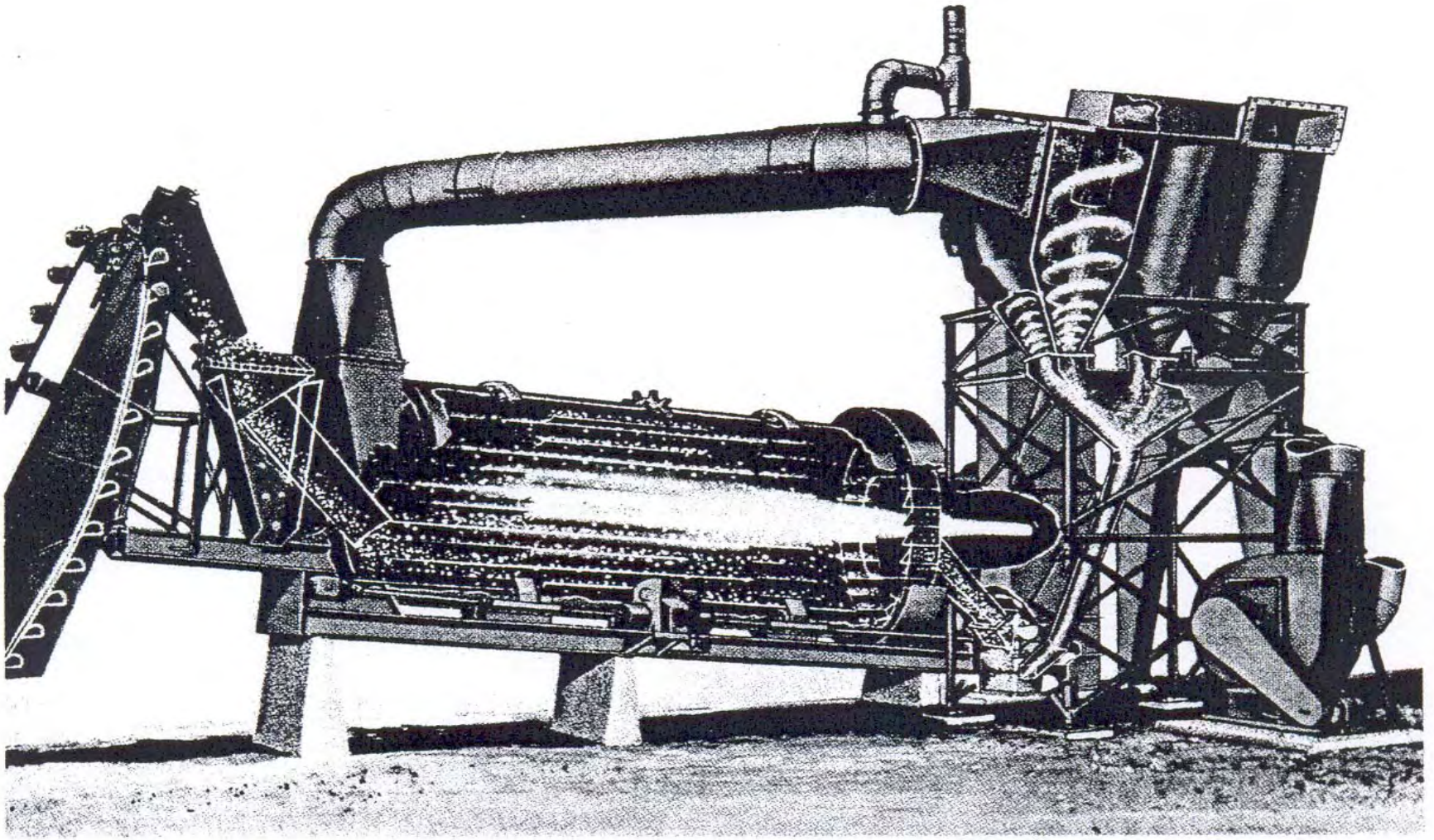


Figure 11. Dryer and dust collector in a central mixing plant
(Courtesy Barber-Greene Co.)

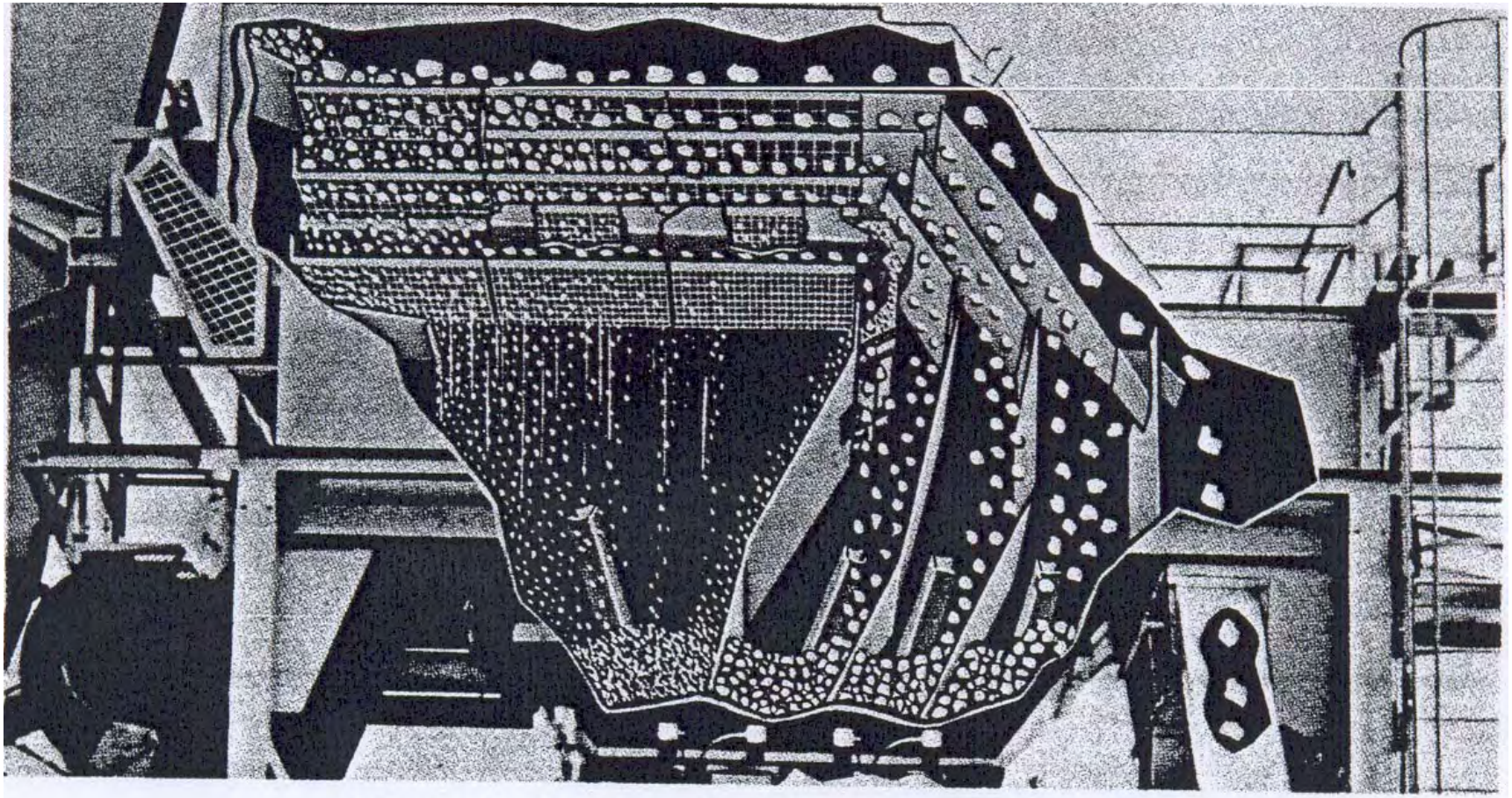


Figure 15. Cutaway view showing details of flow of material through screens and bins
(Courtesy Iowa Manufacturing Company)

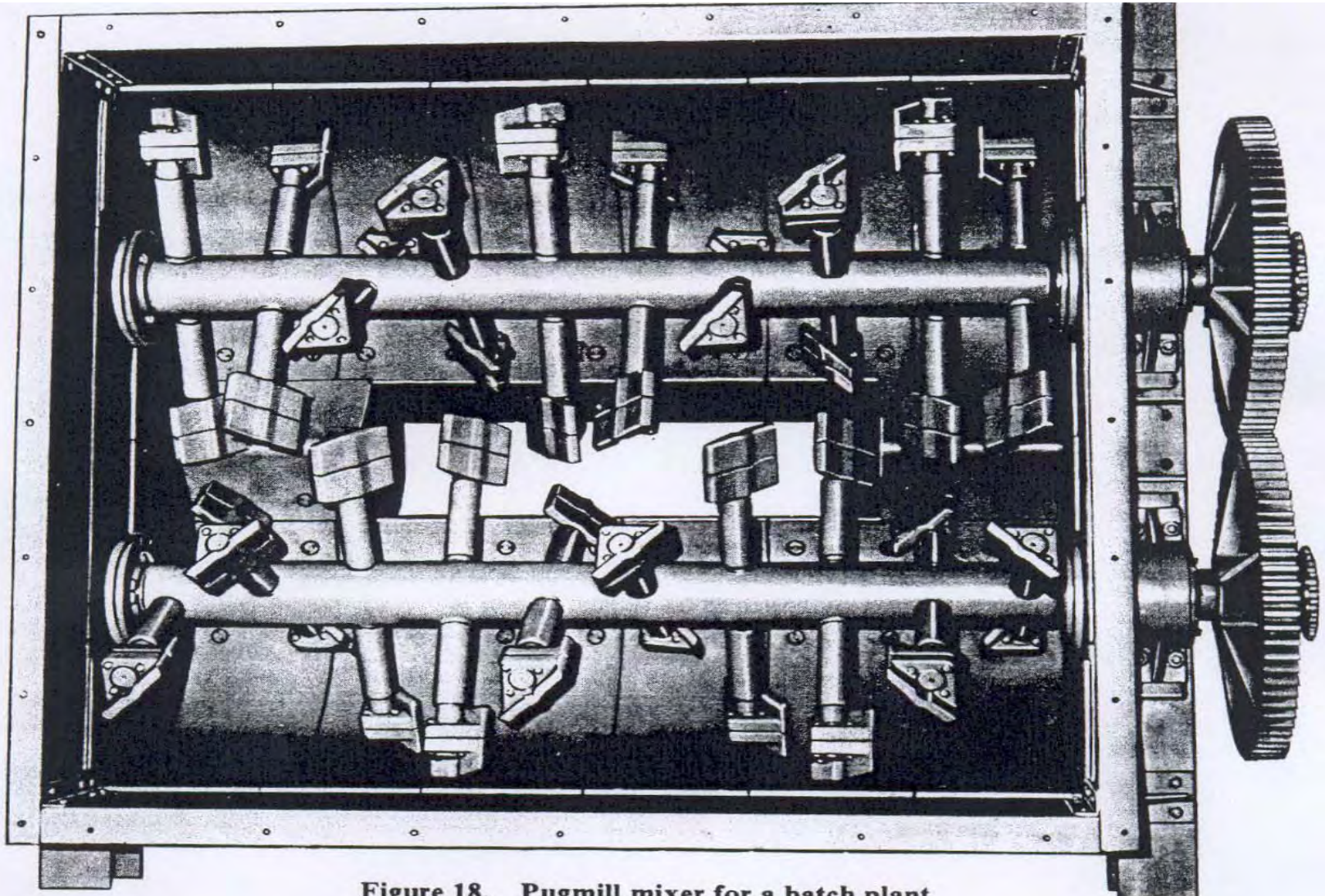


Figure 18. Pugmill mixer for a batch plant
(Courtesy Iowa Manufacturing Company)

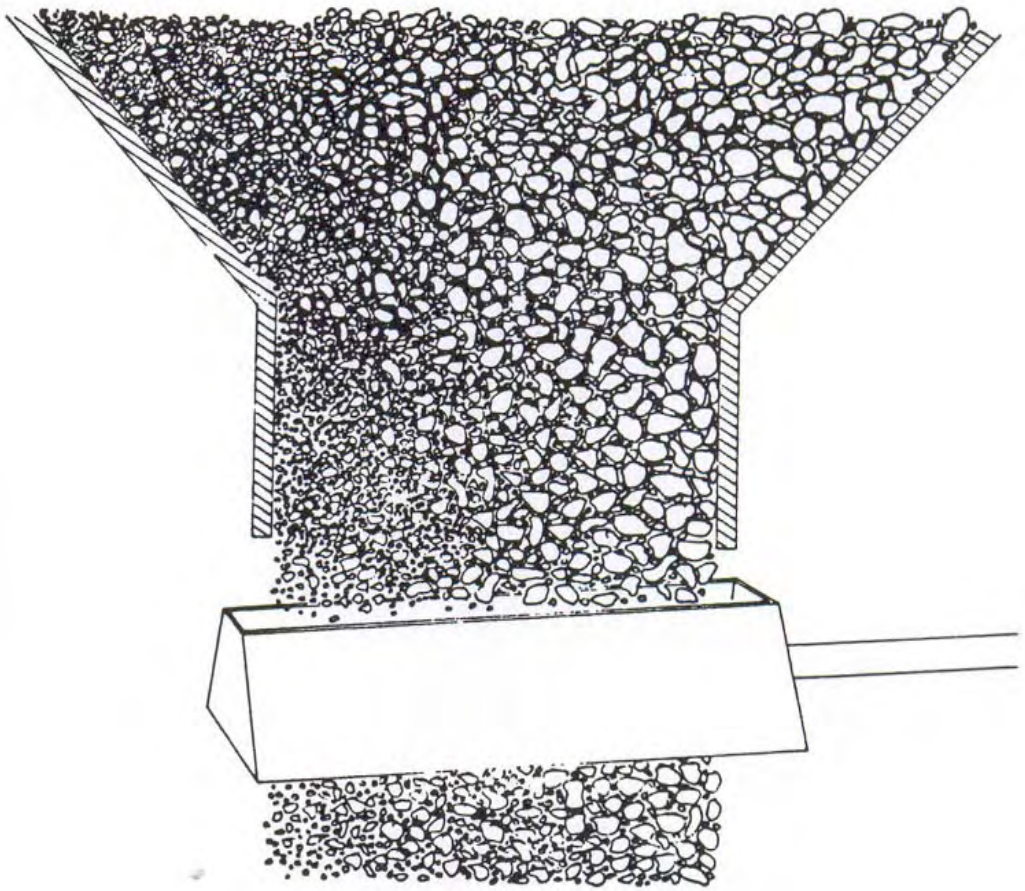


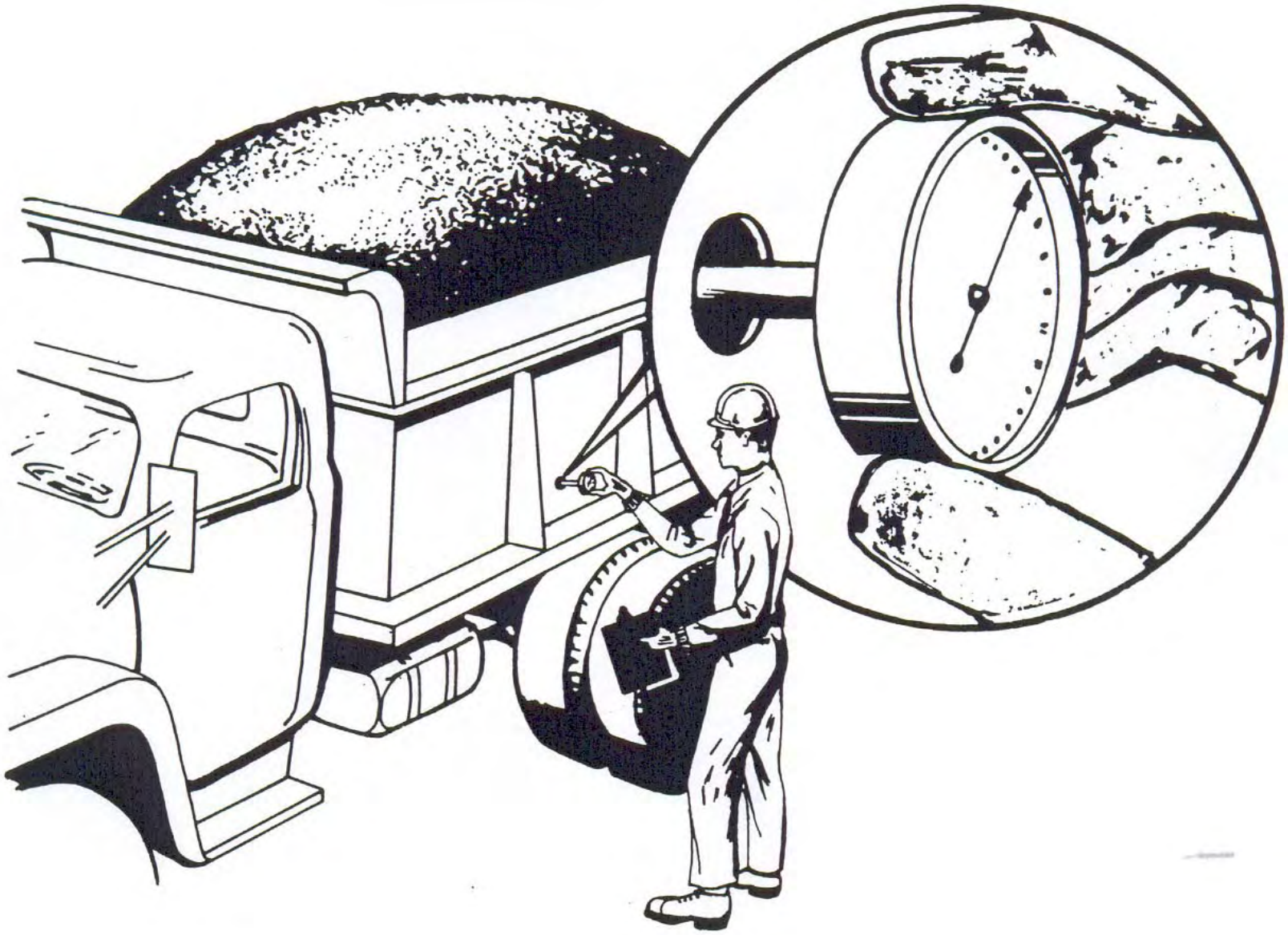
Figure 8. Correct use of sampling device

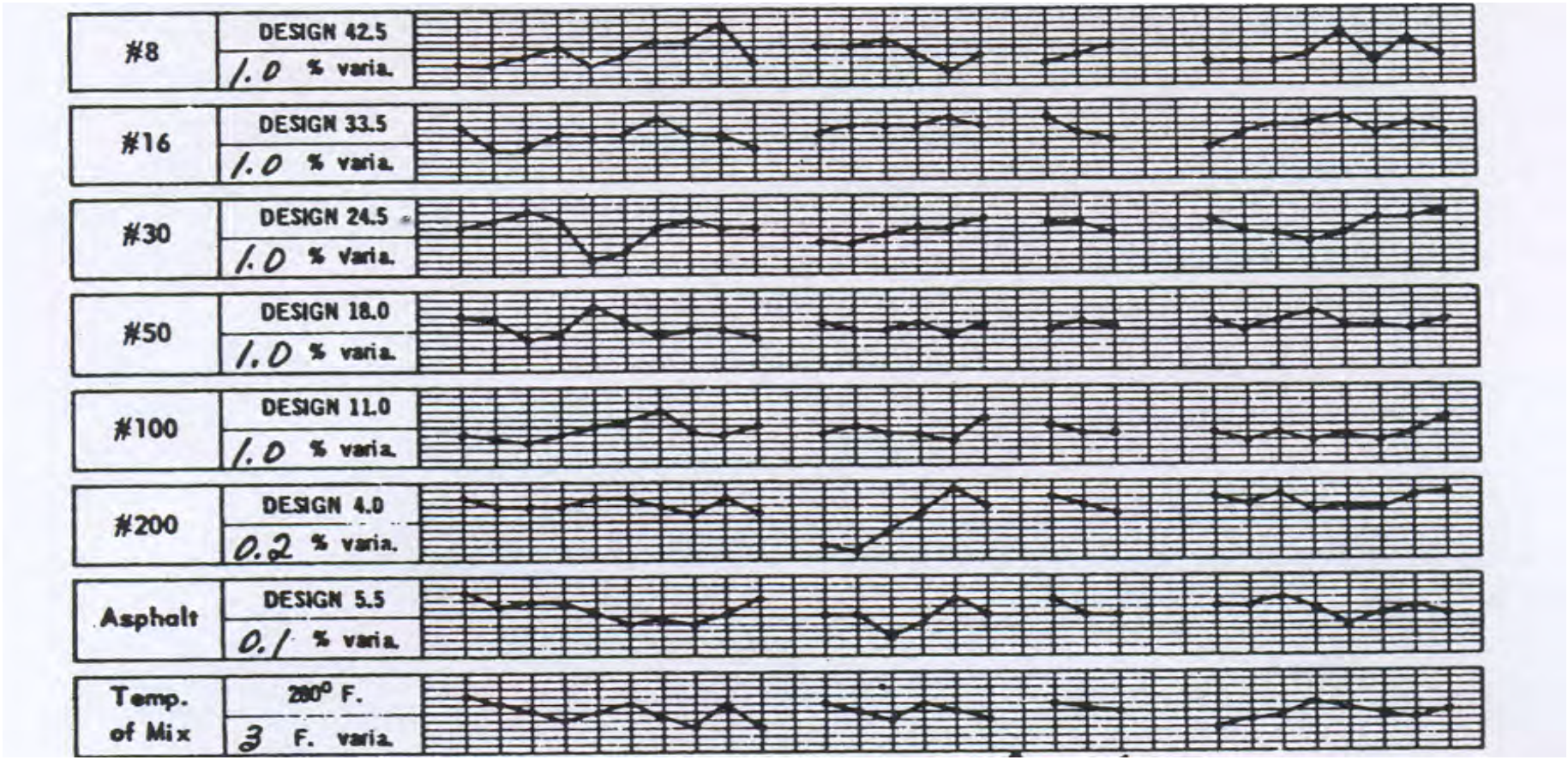
TEMPERATURES

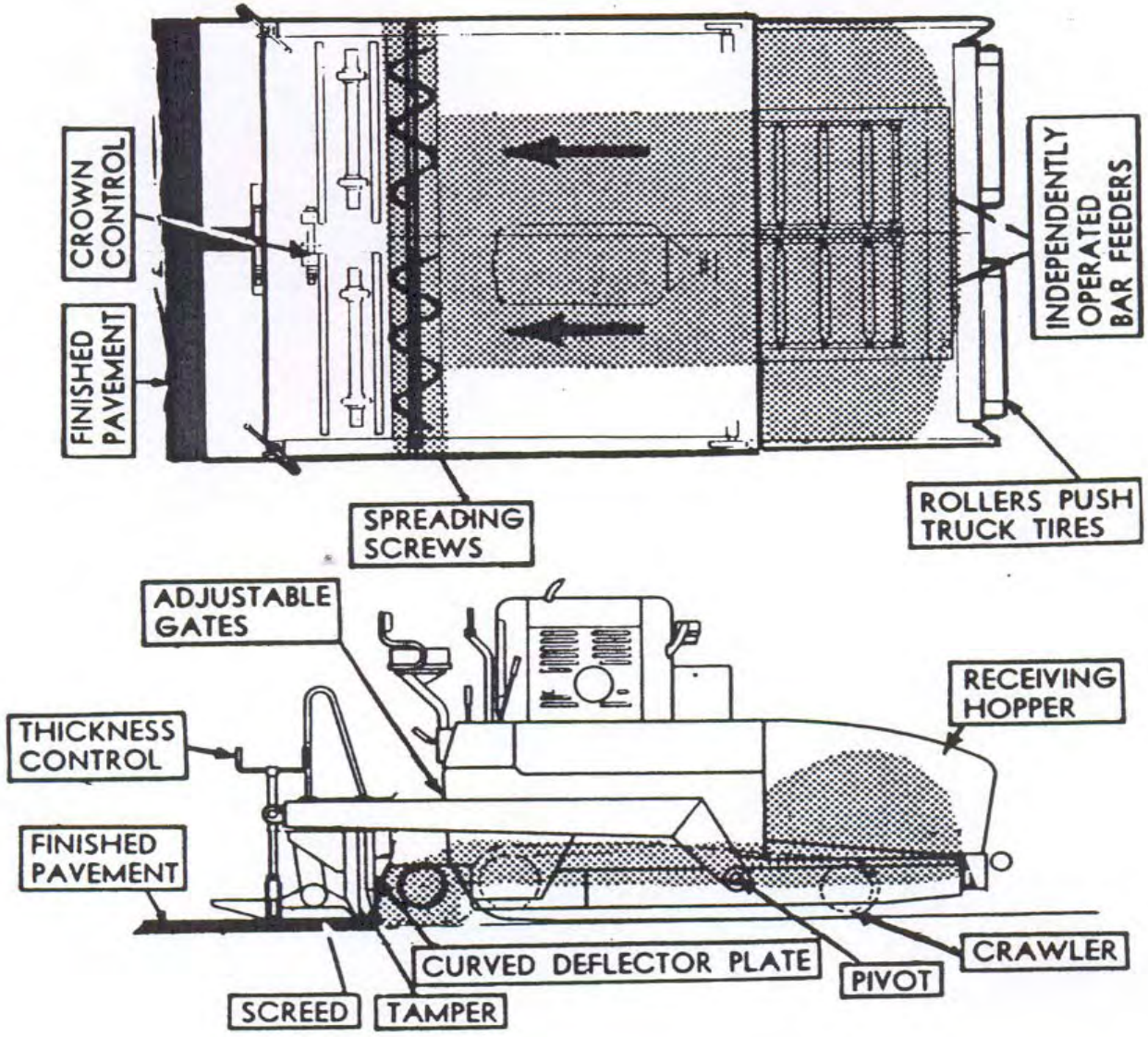
Determining Mixing Temperature

The mixing temperature for asphalt concrete is determined by the requirements for achieving dry aggregate, for good particle coating, and for laying and compacting. The aggregate must be sufficiently dry so that there is no foaming or slumping of the finished mixture or other evidence of moisture that may adversely affect its placement or service behavior. This means, then, that the temperature of the heated and dried aggregate controls the temperature of the asphalt-aggregate mixture in the pugmill. The temperature of the asphalt rapidly adjusts to that of the aggregate when the two are mixed.

The lowest possible temperature at which these objectives can be attained should be used to reduce asphalt hardening and energy requirements. Therefore, temperatures for mixtures immediately after discharge from the pugmill may be as low as can be demonstrated to get good coating and compaction, but not more than 163^0 C (325^0 F).




#8
DESIGN 42.5
1.0 % varia.
#16
DESIGN 33.5
1.0 % varia.
#30
DESIGN 24.5
1.0 % varia.
#50
DESIGN 18.0
1.0 % varia.
#100
DESIGN 11.0
1.0 % varia.
#200
DESIGN 4.0
0.2 % varia.
Asphalt
DESIGN 5.5
0.1 % varia.
Temp. of Mix
280° F.
3 F. varia.


CROWN CONTROL
FINISHED PAVEMENT
SPREADING SCREWS
INDEPENDENTLY OPERATED BAR FEEDERS
ROLLERS PUSH TRUCK TIRES
ADJUSTABLE GATES
RECEIVING HOPPER
THICKNESS CONTROL
FINISHED PAVEMENT
CURVED DEFLECTOR PLATE
PIVOT
CRAWLER
SCREED
TAMPER

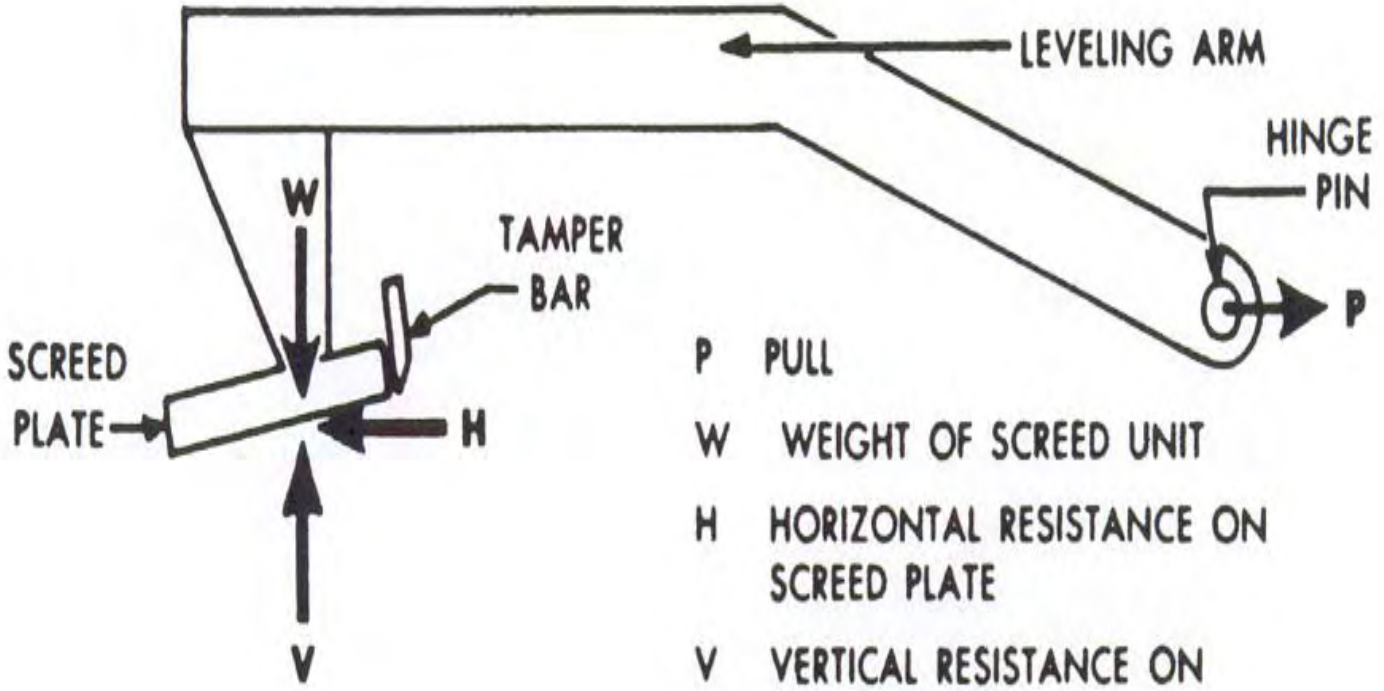


Figure 2. Forces acting on the screed during paving operation

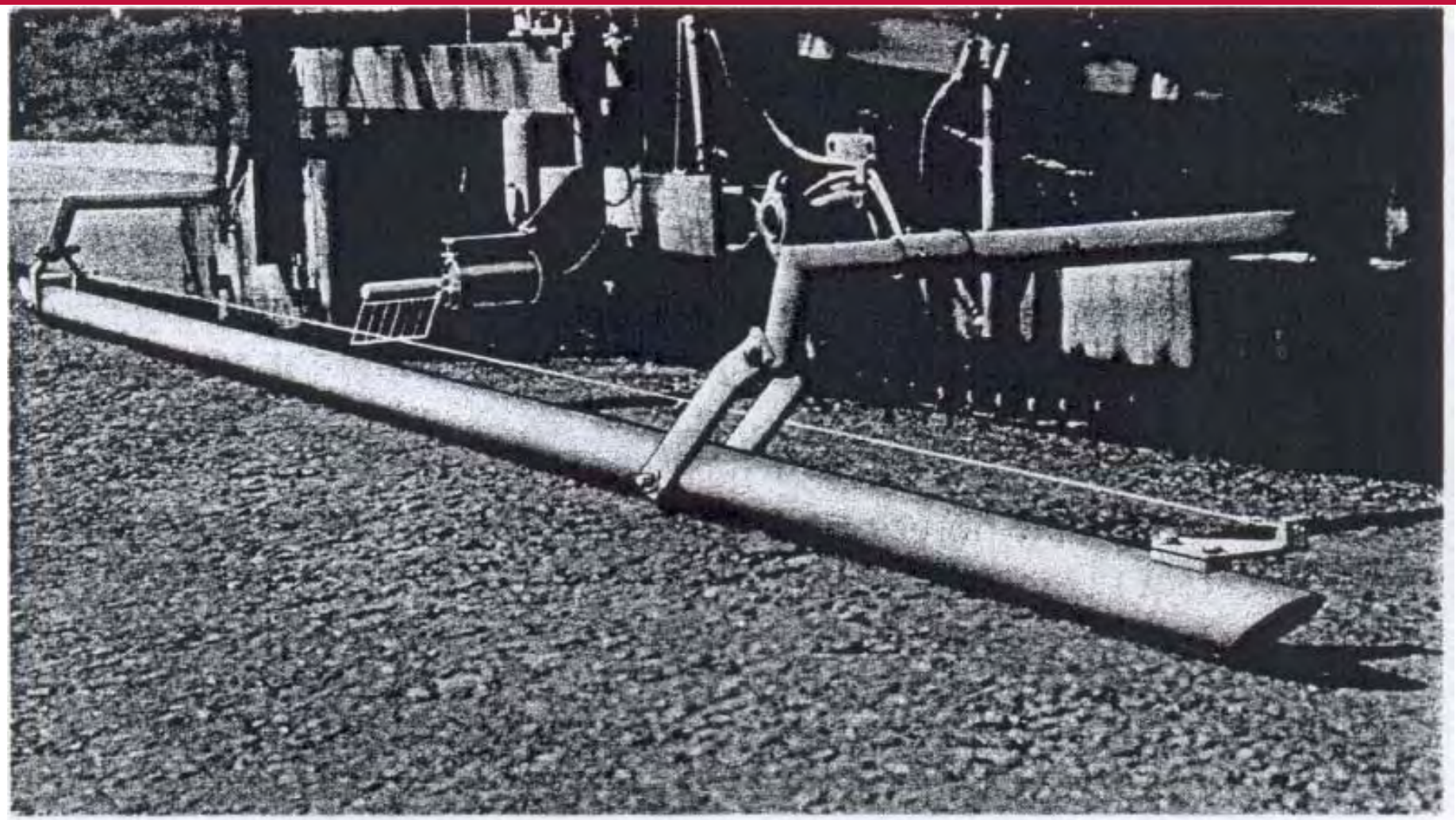


Figure 6. Long ski grade follower

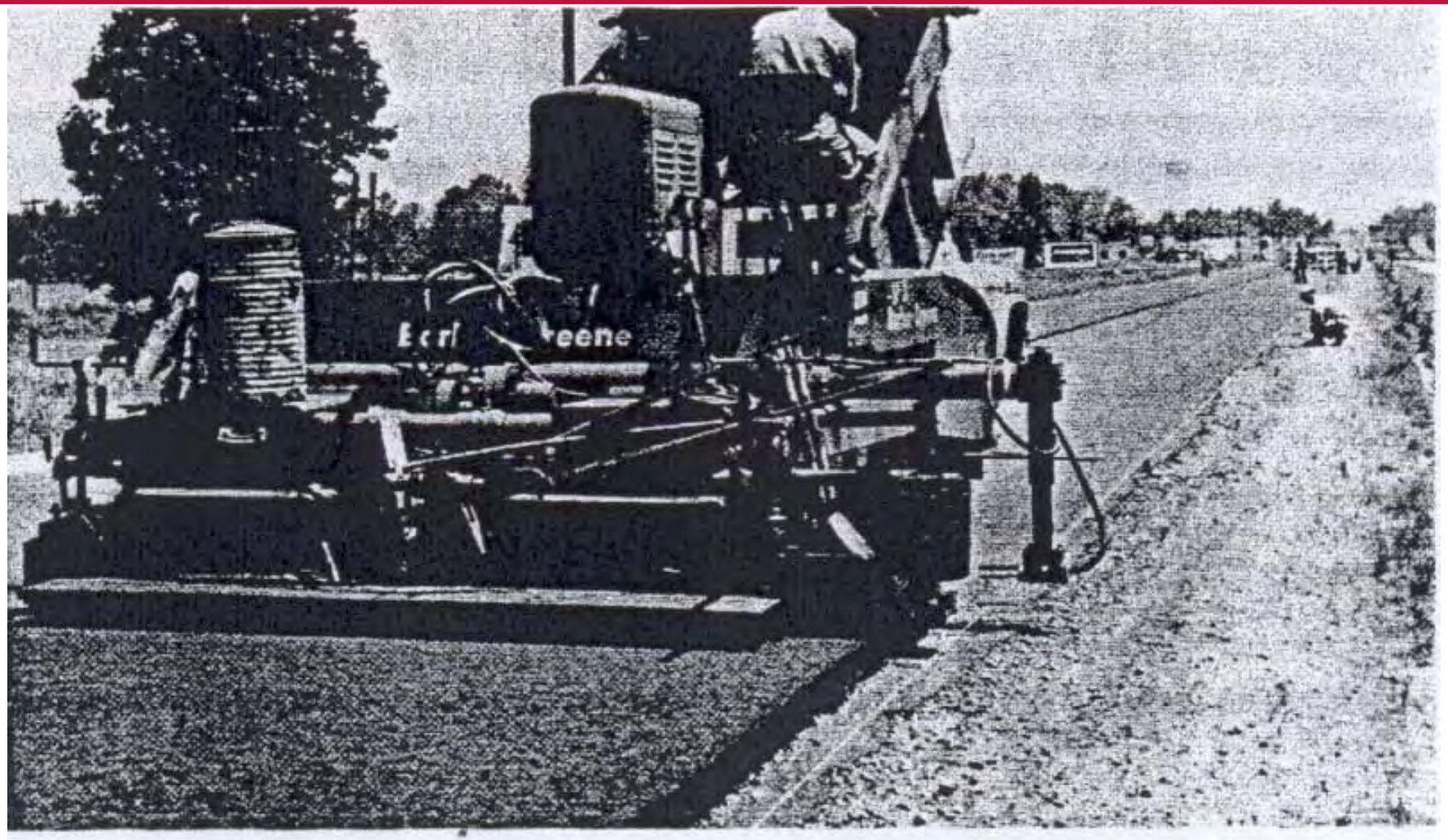


Figure 7. Grade follower. Stringline is also used as a guideline for paver operator

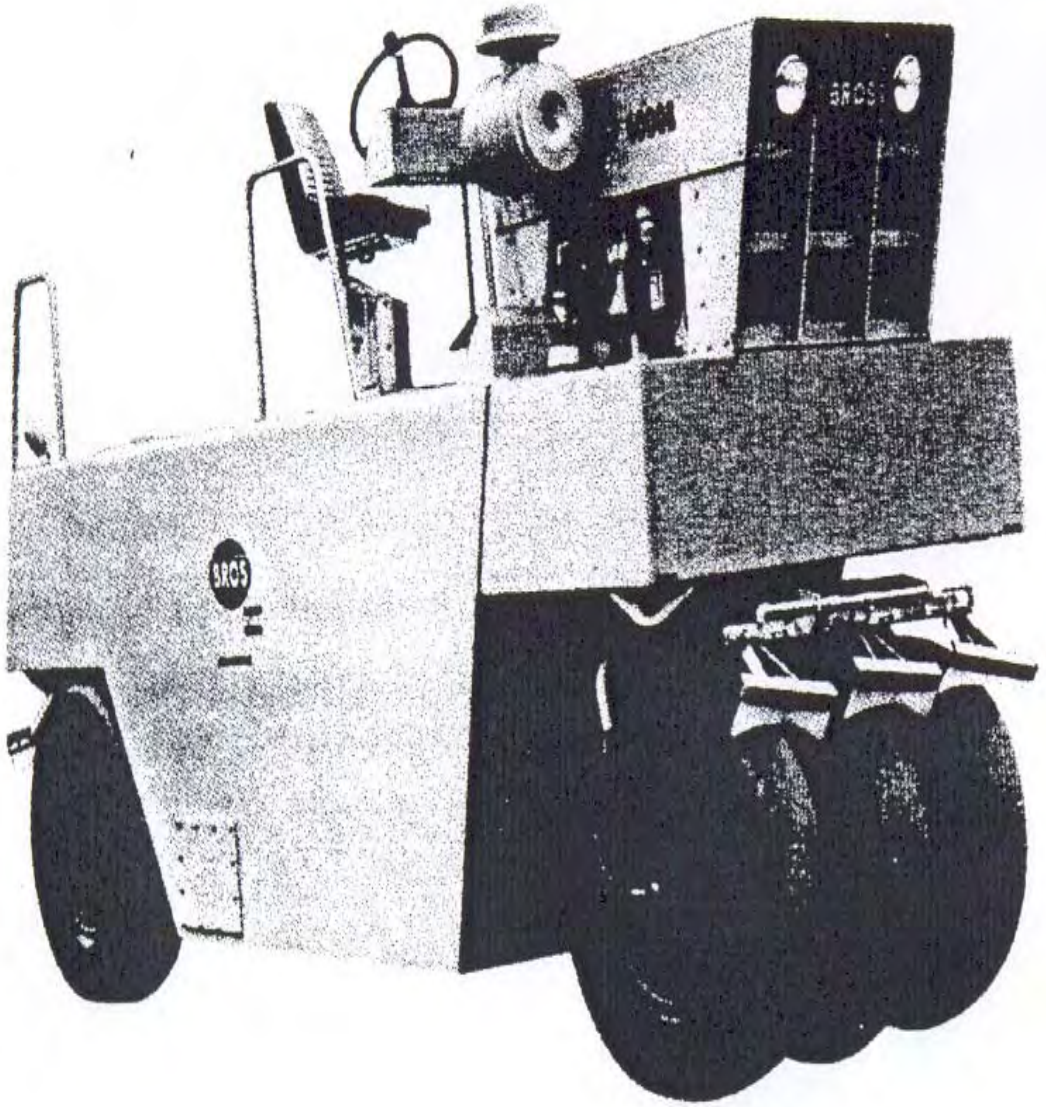


Figure 9. Self-propelled pneumatic-tired roller

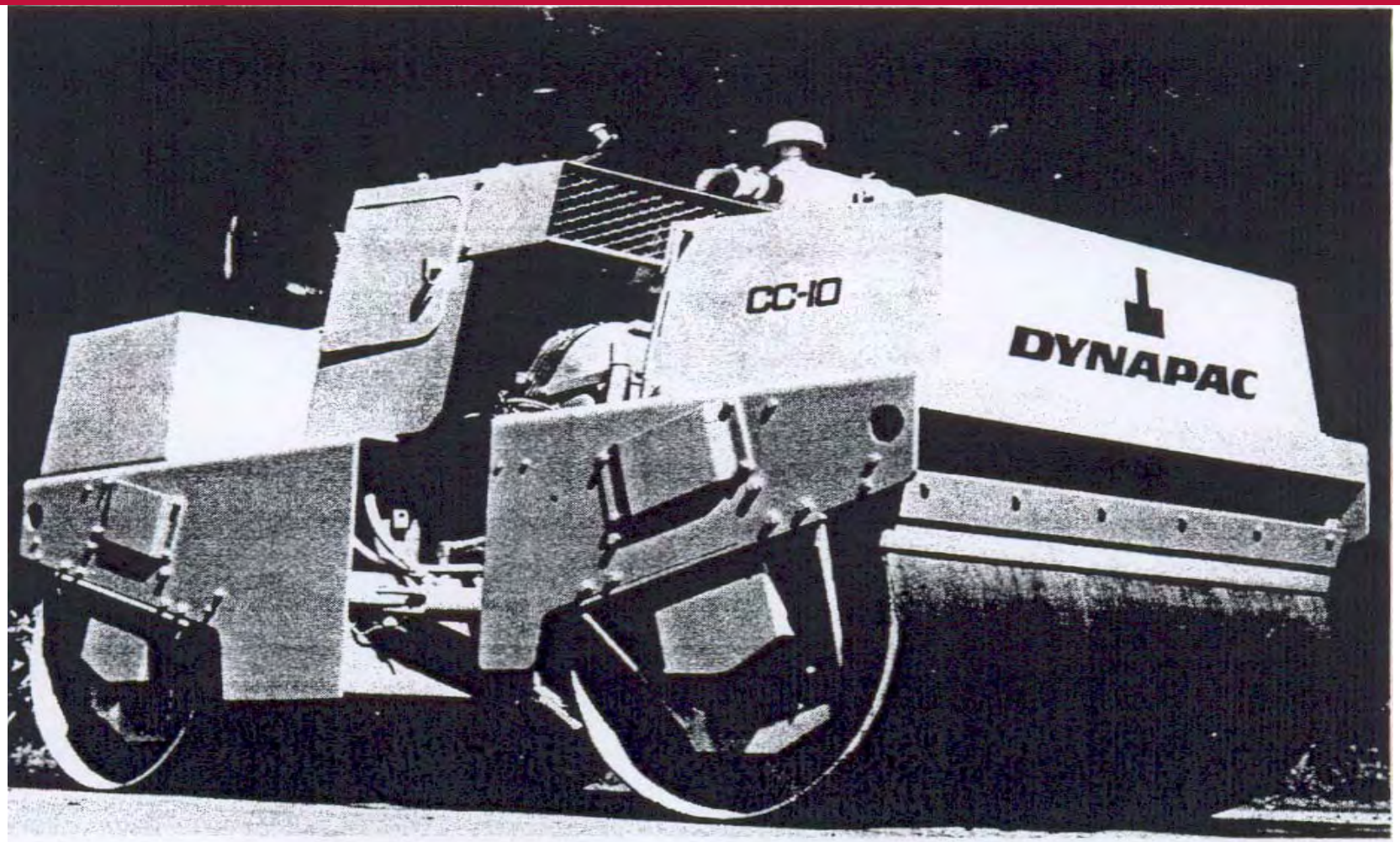
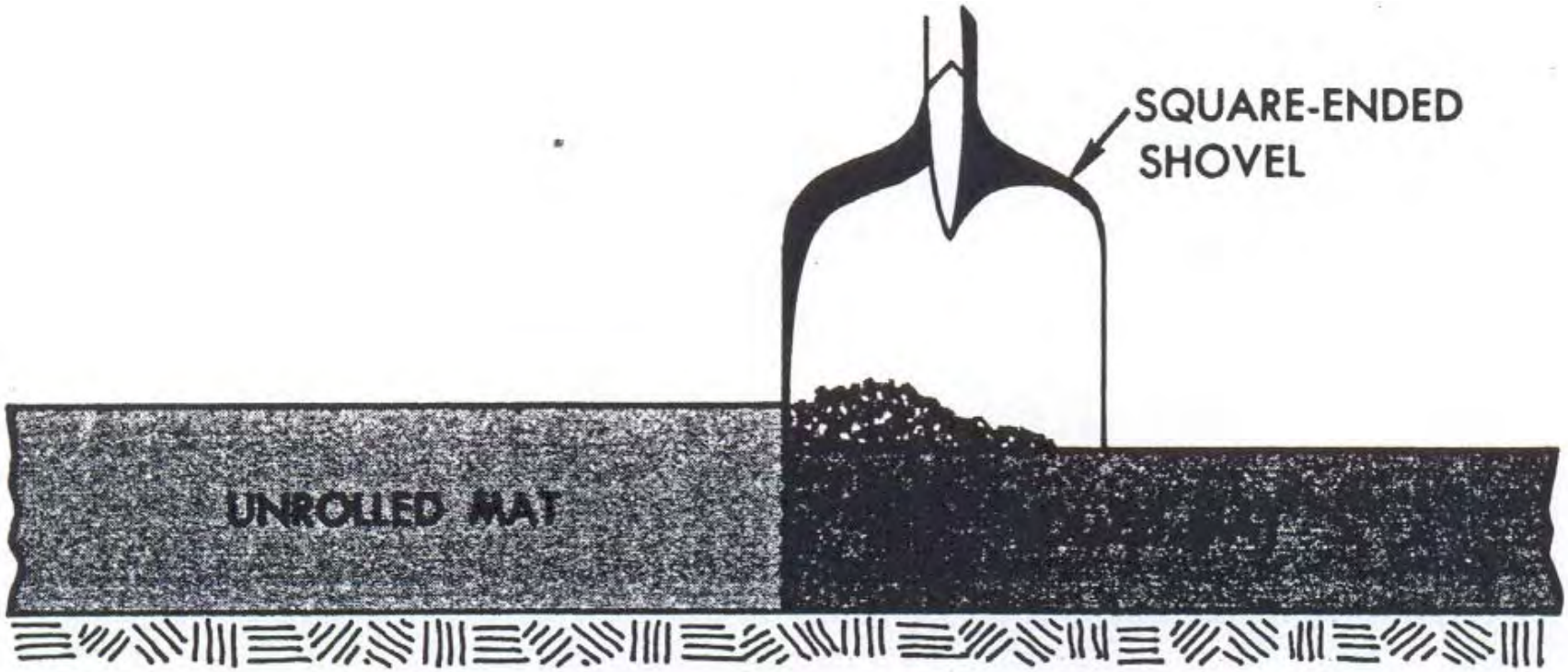
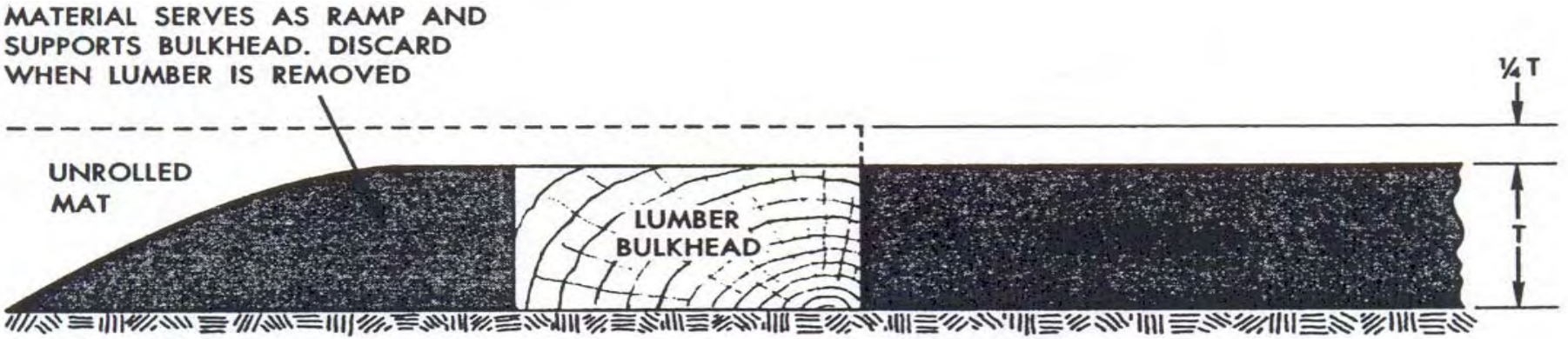


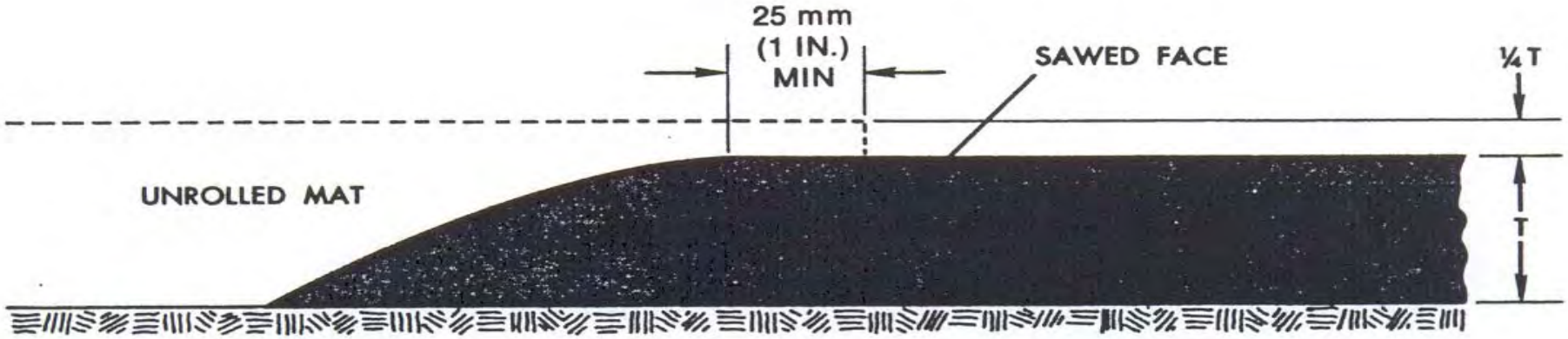
Figure 10. Self-propelled tandem vibrating roller
(Courtesy Dynapac Mfg. Co.)

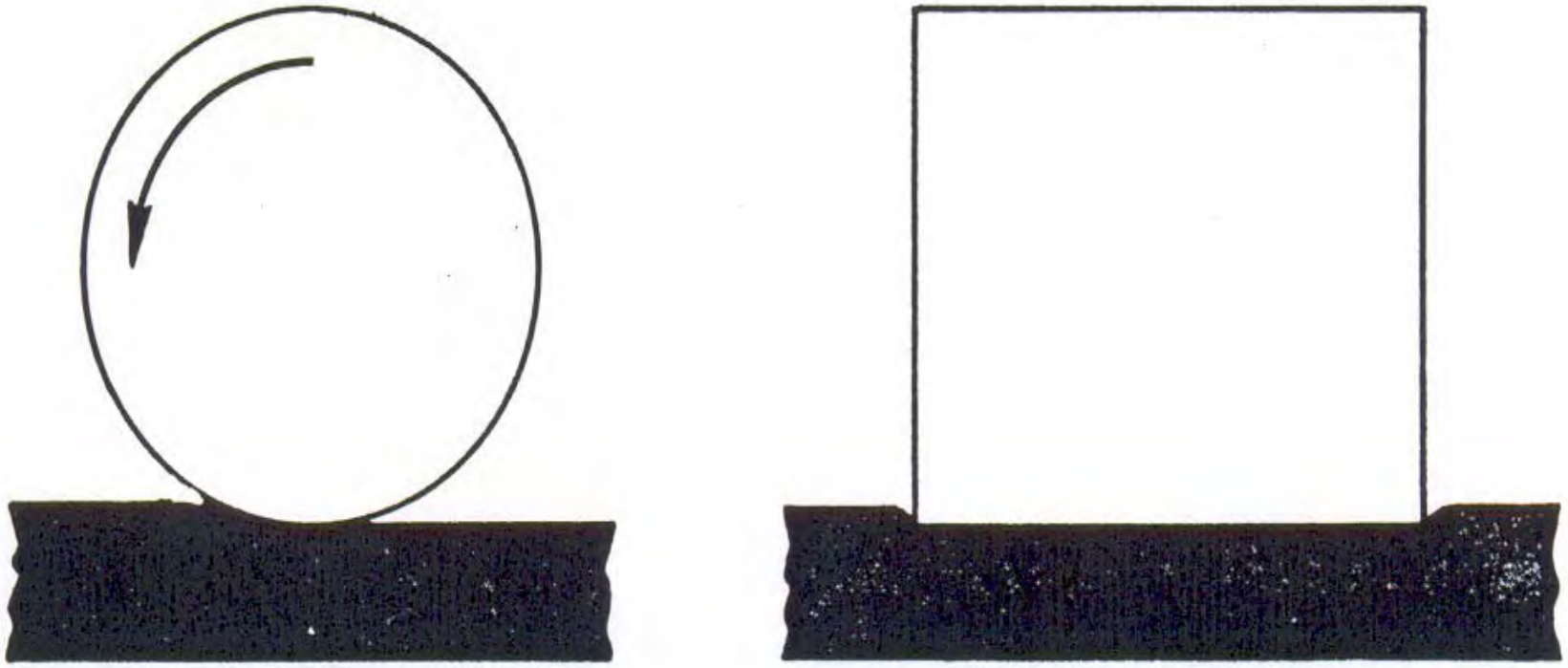


(c) MAKING A TRIMMED JOINT.



(a) TRANSVERSE JOINT CONSTRUCTED USING A BULKHEAD.





(b) MATERIAL COMPACTED BY ROLLER WITHOUT HORIZONTAL DISPLACEMENT OF MIX.

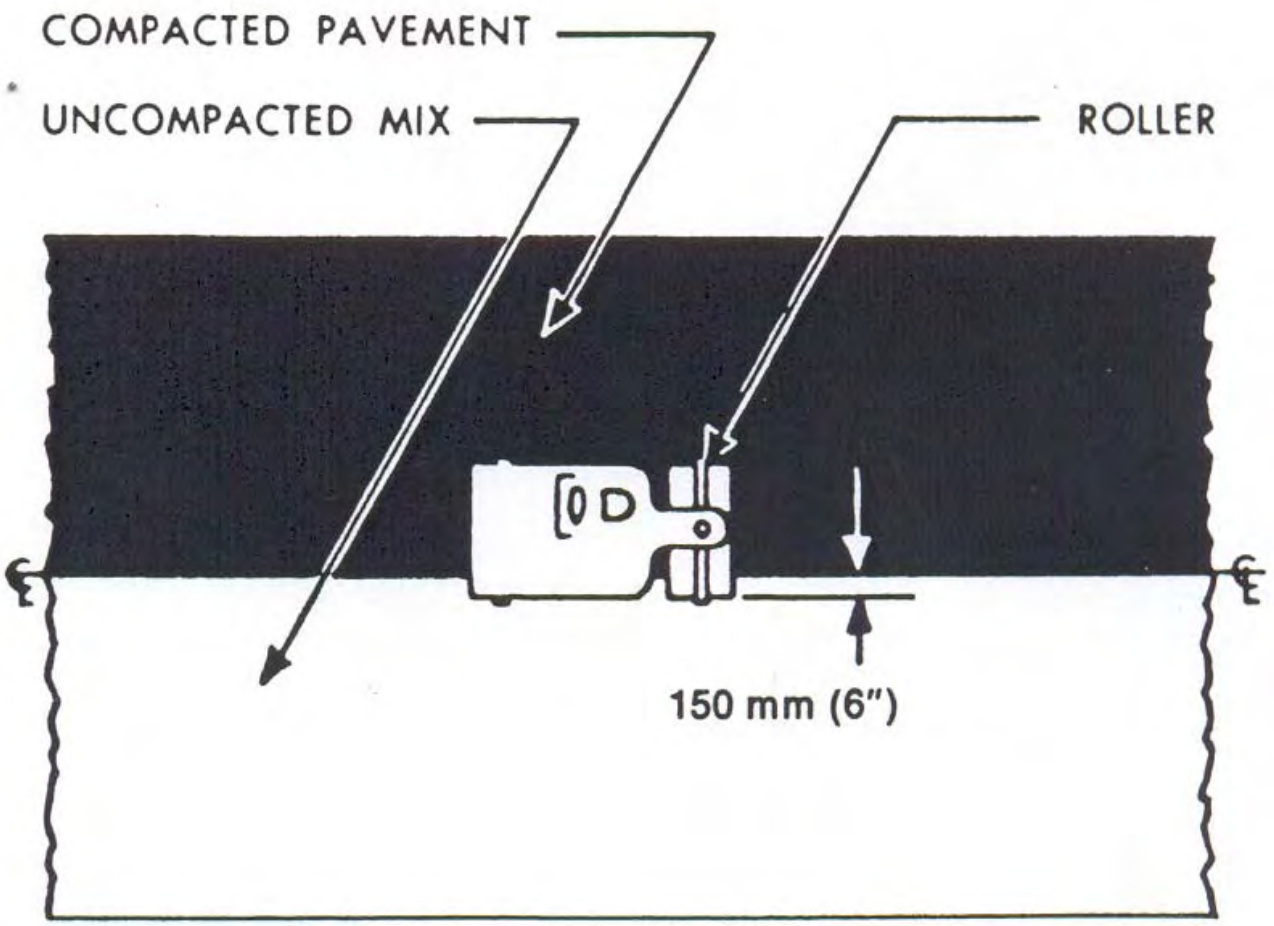
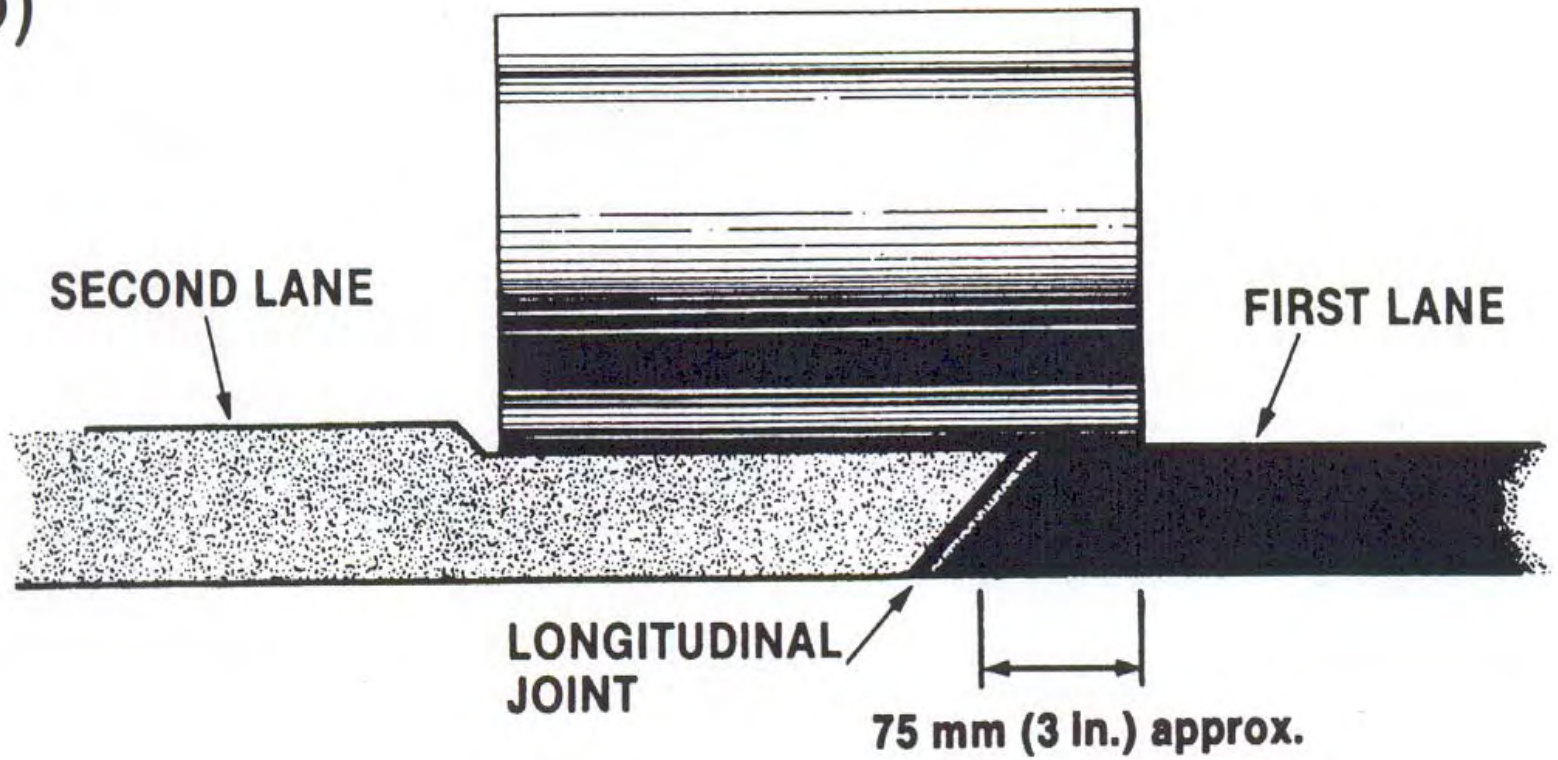
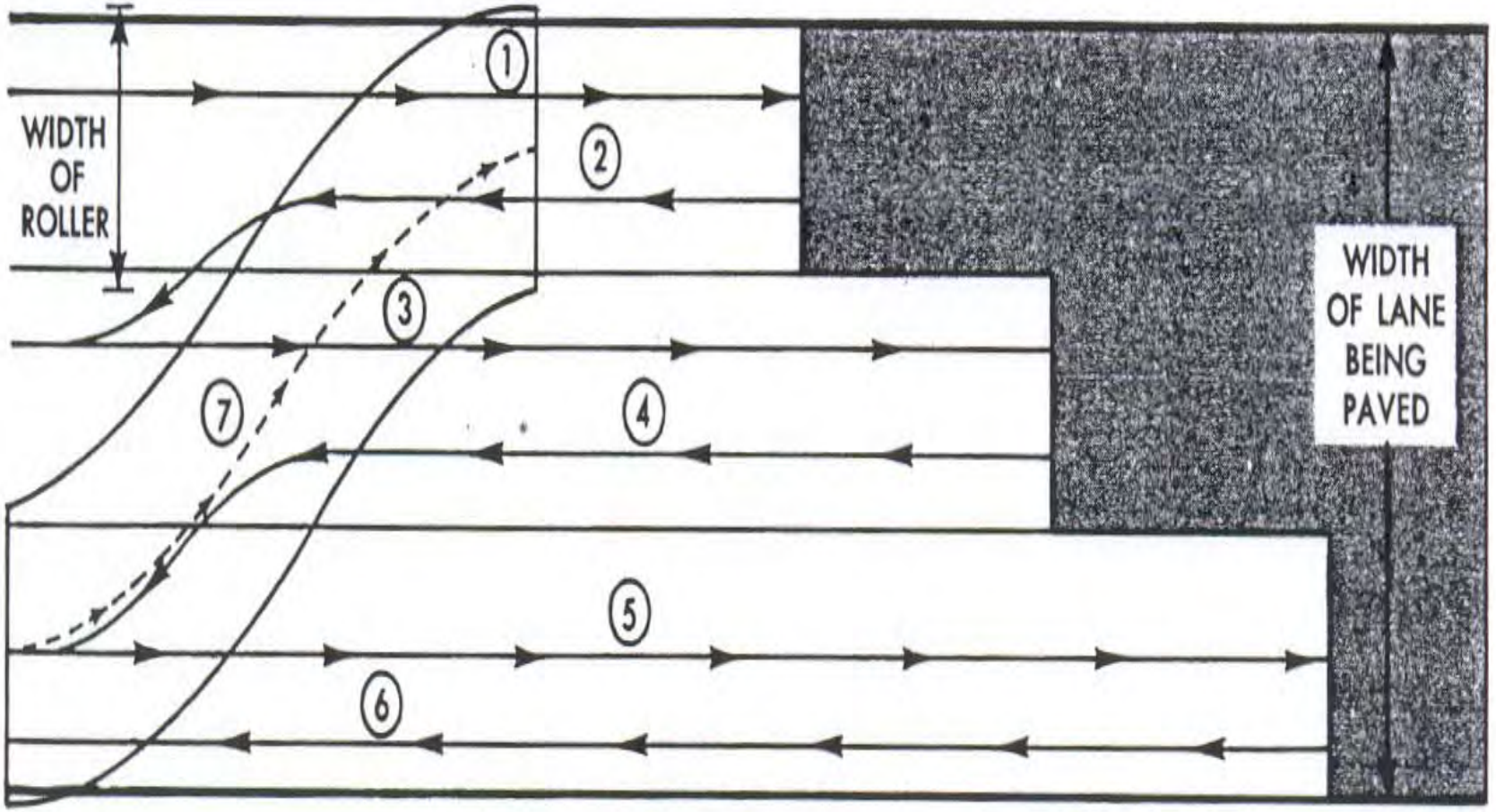
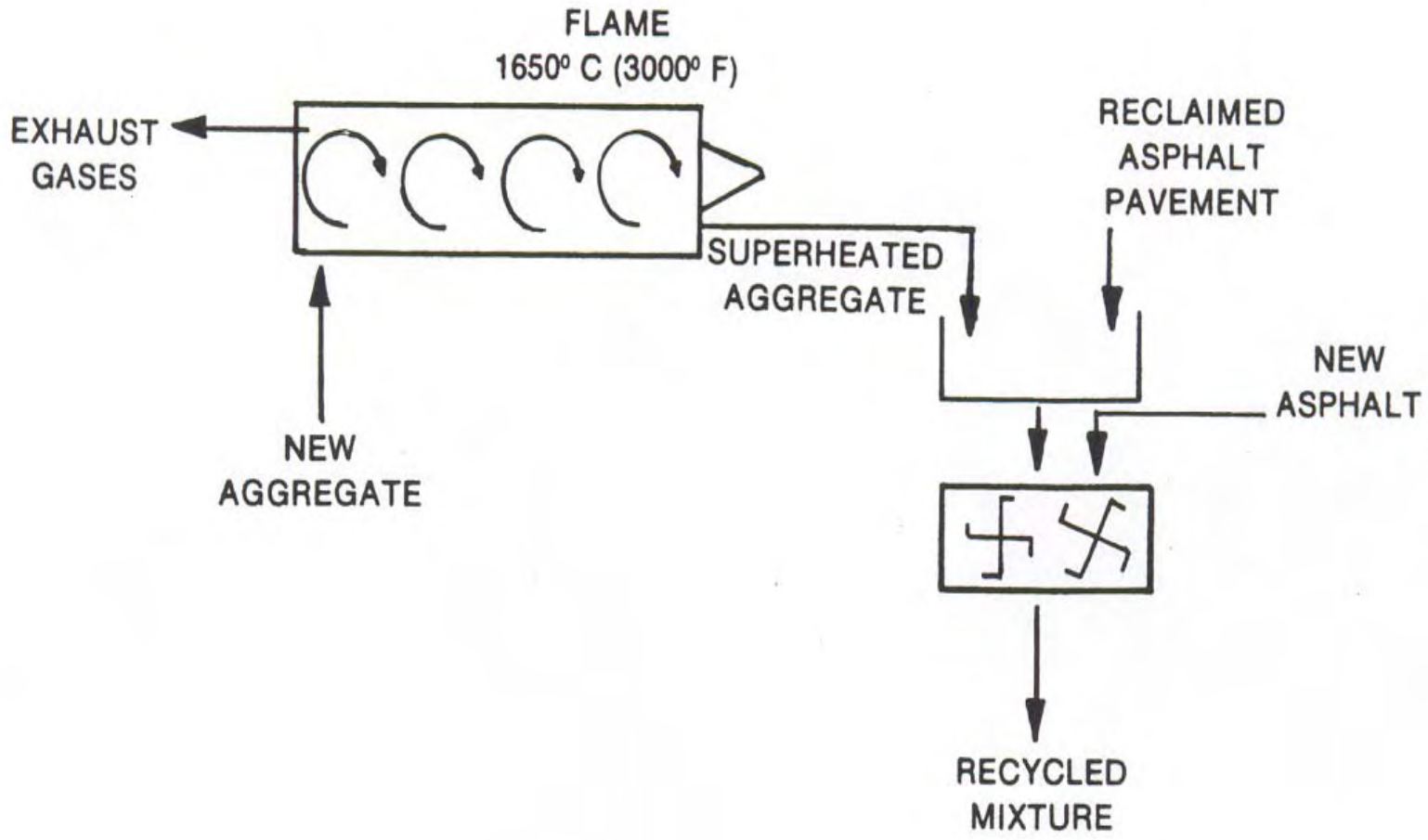


Figure 3. Rolling a longitudinal joint

(b)

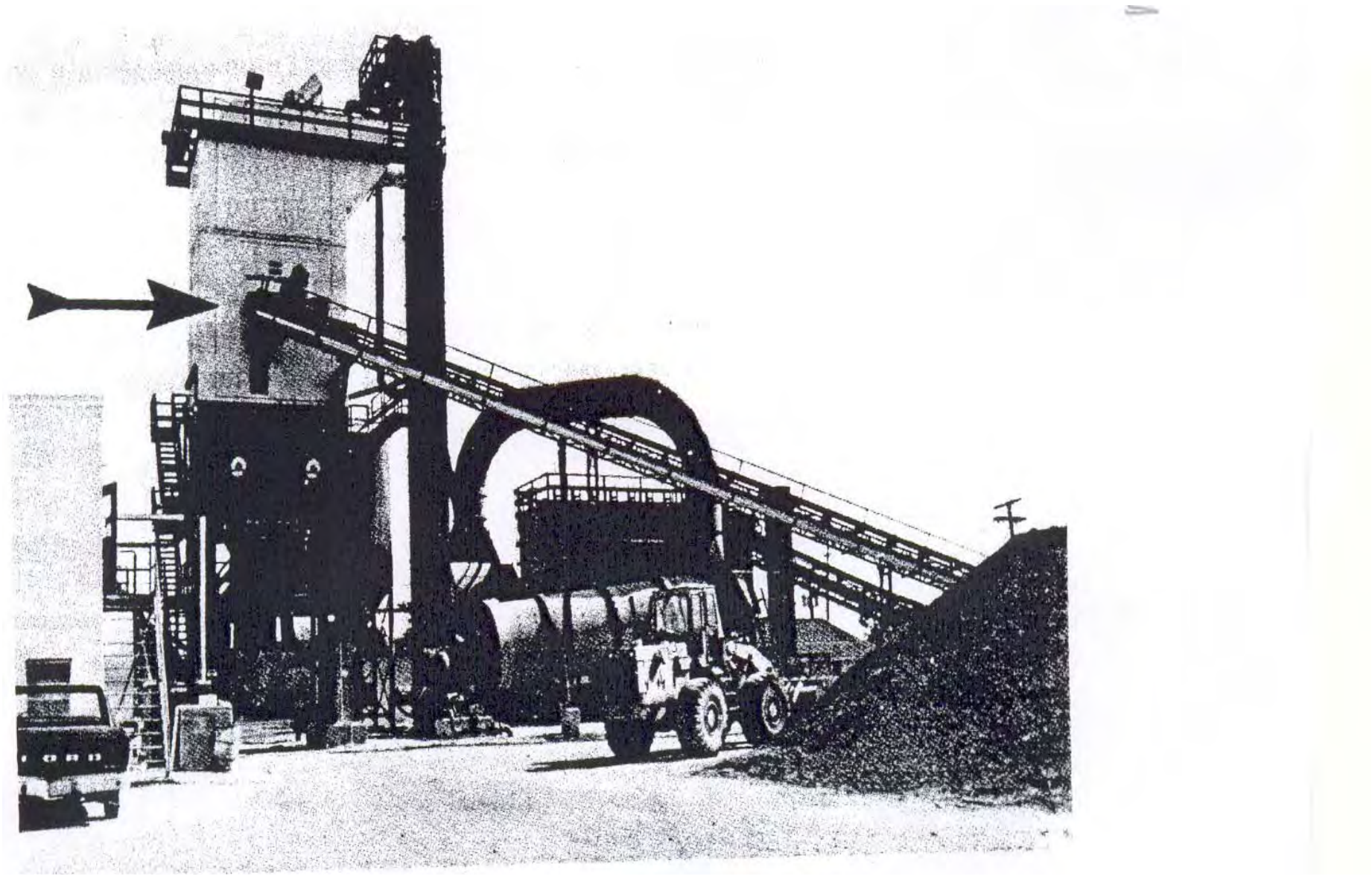



WIDTH OF ROLLER
1
2
3
4
5
6
7
WIDTH OF LANE BEING PAVED


FLAME
1650° C (3000° F)
EXHAUST GASES
RECLAIMED ASPHALT PAVEMENT
SUPERHEATED AGGREGATE
NEW ASPHALT
NEW AGGREGATE
RECYCLED MIXTURE

USAID | KOSOVO

NGA POPULLI AMERIKAN
OD AMERIČKOG NARODA



- **To be continued…….**

  Falemnderit