CHAPTER 3
RECYCLED COLD-MIX ASPHALT CONCRETE

3-1. General.

When a pavement has deteriorated to a point that the thickness of a conventional overlay required to satisfactorily provide a solution to the problem is not economical or is prohibited by existing grades, the use of recycled cold mix should be considered. A recycled cold mix involves the reuse of the existing pavement structure by reprocessing it and adding a binder to it without the use of heat. The binder is usually lime, portland cement, or asphalt. This chapter will address the use of asphalt as the binder in recycled cold mixes. Recycled cold mix in conjunction with a hot mix overlay can often be used to repair an existing pavement at lower cost than with a conventional overlay. The basic process is shown on the flow chart in figure 3-1.

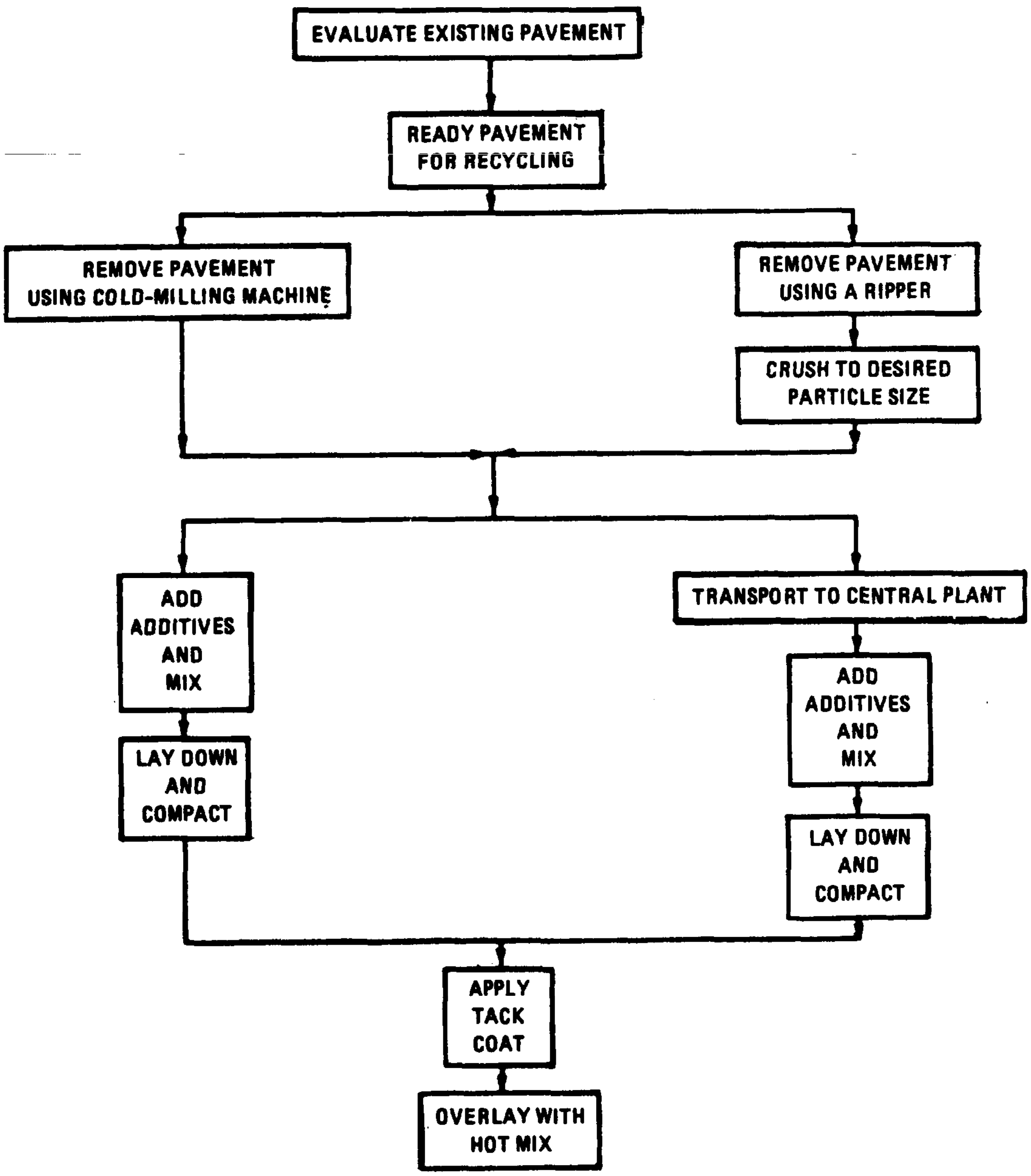

Figure 3-1. Cold-mix recycling flow process.

3-2. Equipment.

The equipment required for pavement removal and crushing is either conventional equipment for ripping and crushing or a cold-milling machine. For mixing and placing, a mix-in-place travel plant or a central plant and a conventional paver are required. The required equipment includes a distributor, trucks, brooms, rollers, and front- end loaders.

3-3. Pavement design.

The structural design of pavements using recycled cold-mix asphalt should be the same as that for the asphalt stabilized materials as provided in TM 5-825-2/AFM 88-6, chapter 2. The recycled cold mix should provide a structure whose performance is equal to that of the asphalt-stabilized material. Mixture design for recycled cold-mix asphalt concrete is important to ensure proper material proportions and to obtain maximum field density. When no new aggregates are to be added to the reclaimed materials, the mix design should be performed on the reclaimed materials as recovered. The maximum-size particles of the reclaimed asphalt concrete should not exceed the requirement, which is usually 1.5 inches. When new aggregates are to be added, the design should be performed on the desired mix of reclaimed aggregate and new aggregate.

3-4. Mix design.

Development of the mix design accomplishes two objectives: *(a)* determines the amount of new binder and rejuvenator required to obtain a durable and stable mixture, and *(b)* fixes the amount of moisture needed to provide maximum density.

a. Rejuvenator. A rejuvenator can be used in place of new asphalt in some instances to improve the old asphalt properties. A thorough blending of the rejuvenator and oxidized asphalt does not immediately occur when mixing the recycled cold mix. In fact, the rejuvenator initially coats the old asphalt and with time, probably months, will penetrate the old asphalt binder and produce an improved binder. During the first few months, the recycled cold mix may be unstable because of the film of rejuvenator around the oxidized asphalt and aggregate. After the rejuvenator penetrates the old asphalt and the binder material becomes more homogeneous, the recycled cold mix should perform satisfactorily. Because of the initial instability and increased costs created by rejuvenators, asphalt emulsions are usually used in recycled cold mixes.

b. Asphalt content. The amount of new asphalt needed in the recycled cold mix should be determined by conducting a conventional hot-mix design on the recovered aggregate. The laboratory density obtained in the hot-mix design is approximately equal to the maximum density that will be obtained in the field under traffic. The amount of asphalt added should be varied by 0.5 percent increments from 0 percent to the high side of optimum asphalt content. The samples should be compacted by the required effort, either 50 blows for low-pressure tires or 75 blows for high-pressure tires, and determinations should be made for density, stability, flow, voids total mixture, and voids filled with asphalt. These determinations should be plotted and curves drawn to select the optimum asphalt content. The optimum additional asphalt will often be between 0 and 1 percent. When the optimum additional asphalt to be selected is 0 percent, no additional asphalt should be added since it may cause the mixture to become unstable. When no asphalt is needed, only water should be added to lubricate the mixture so that the needed density can be obtained in the field.

c. Compacted samples. After the optimum asphalt content has been determined, samples should be made at the optimum asphalt content with varied water contents. These samples should then be compacted at room temperature using the same compaction effort as that used to determine optimum asphalt content. Next, the dry density for each of the compacted samples should be determined, a moisture/density curve should be plotted, and the moisture content that provides maximum dry density should be selected as the optimum moisture content. A design example is given in paragraph B-l.

3-5. Removal of in-place material.

The material to be used in the recycled cold mix can be removed from the in-place pavement by a number of methods. Two of the more common methods are identified. As discussed in paragraph 2-5, milling machines can be used to remove existing materials. When a milling machine is used, the existing asphalt pavement can be removed to any desired depth. Generally, the particle size of the removed material is satisfactory, and no further crushing is necessary. Another procedure for removing the pavement involves using a ripper tooth to remove the asphalt concrete (fig 3-2). When a ripper tooth is used, the asphalt concrete is removed full depth since there is no way to control the depth of material removed. When the asphalt concrete is removed by ripping, it must be further broken down by crushing in place with a pulverizer or other equipment or be carried to a crusher (fig 3-3). When this method is used, a significant amount of base repair will be required. While the old pavement is being removed, consideration should be given to drainage of the area to prevent unnecessary delays caused by rain. The exposed surface should be sloped to promote good drainage, and outlets or other means should be provided to prevent the ponding of water.

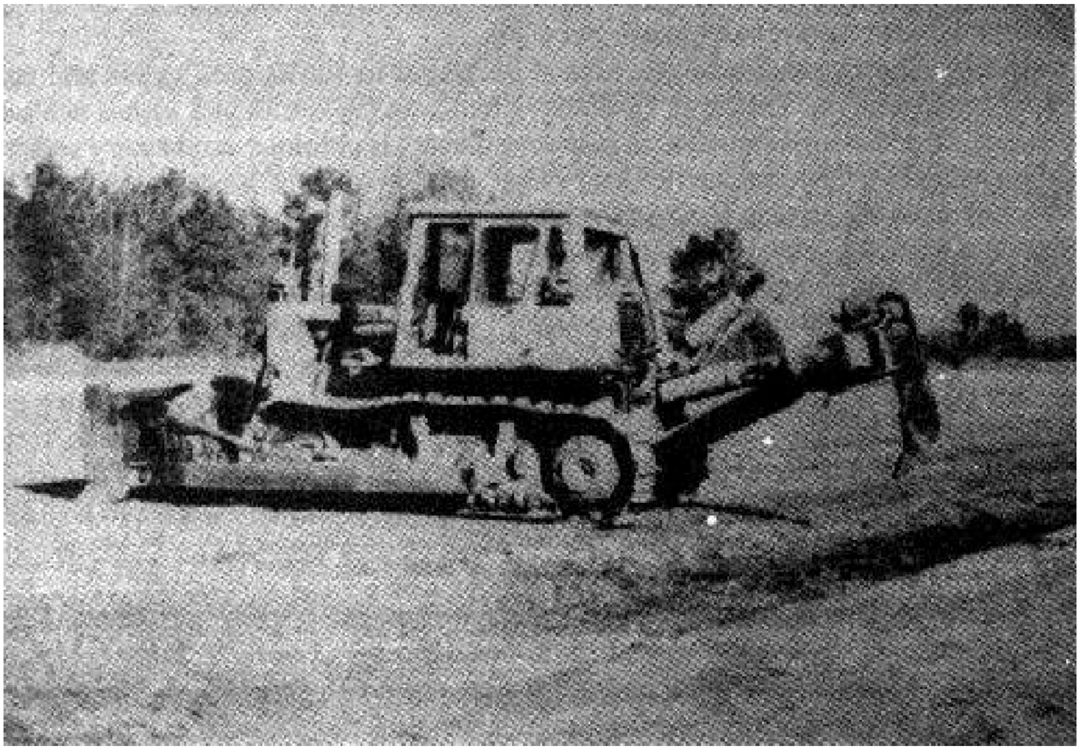

Figure 3-2. Pavement ripper attached to bulldozer.

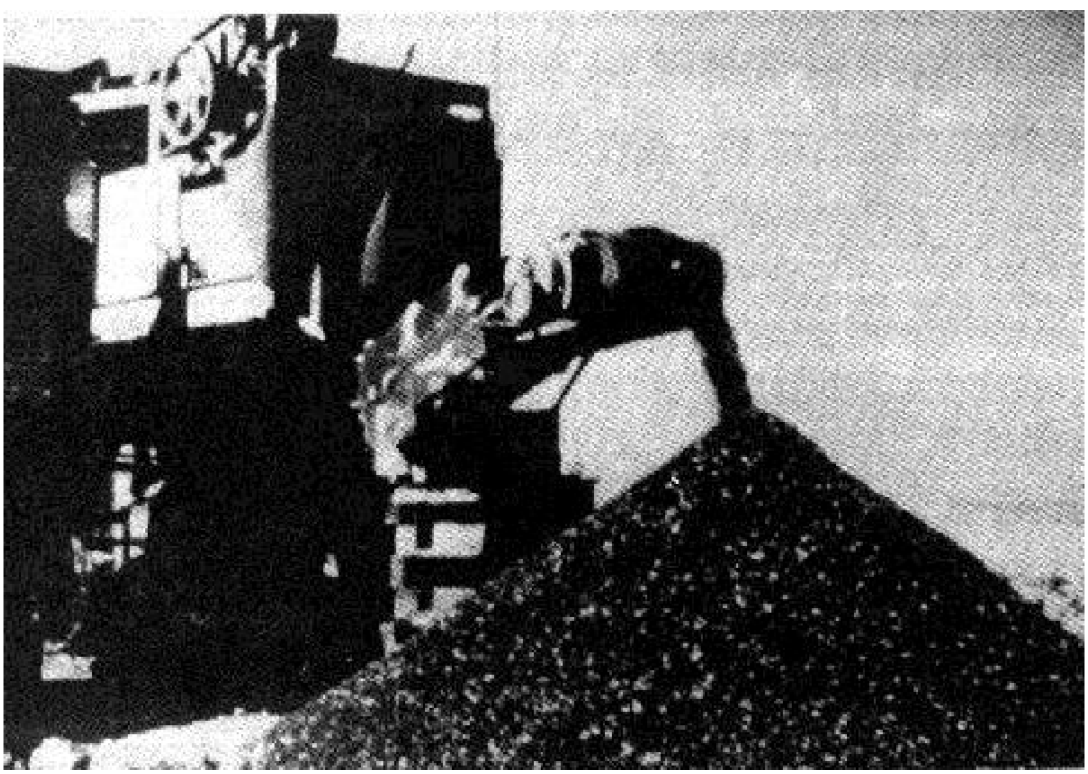

Figure 3-3. Old asphalt concrete pavement after crushing.

3-6. Construction.

After the asphalt concrete has been broken down to the desired particle size, it can be mixed with asphalt or other stabilizers and water in place or at a central plant. The in-place mixture produced by a travel plant is less expensive than the mixture produced at a central plant, but control of the quality is not as good. Either type of plant should be acceptable as long as the contractor can demonstrate that material meeting the specification requirements can be produced. To meet the specification requirements, the contractor must be able to control the amount of additional asphalt and water as well as the mixing time.

a. Recycled cold mix. The recycled cold mix should be placed to the desired grade and compacted to meet the minimum density requirements. The layer thickness should not be less than 2 inches compacted nor greater than 4 inches compacted. In order to ensure that satisfactory density is obtained, a vibratory roller and a pneumatic- tired roller should be available. The pneumatic-tired roller should weigh at least 20 tons and be capable of tire inflation pressures of at least 90 pounds per square inch.

b. Density. Since it is difficult to establish a laboratory density for comparison with field density, the theoretical maximum density (TMD) should be used to establish field density requirements. The theoretical maximum density is that density at which there would be zero air voids in the mixture. At least 86 percent of the theoretical maximum density should be obtained in the field to ensure that the voids in the field mixture are not excessive.

c. Cure time. Each layer of recycled cold mix should be allowed time to cure prior to being overlaid. The time needed to cure depends on many things such as air temperature, wind, type of asphalt used, layer thickness, and humidity, but as a general rule each layer of recycled cold mix should be allowed to cure for 10 days before being overlaid.

3-7. Field density measurements.

The field density should be determined from cores removed from the in-place pavement. With some mixes it will be difficult to obtain undamaged cores prior to curing the cold mix for a few days. When cores cannot be obtained within 24 hours of paving, other methods of obtaining samples should be considered. For example, ice placed on the sample locations for 1 to 2 hours prior to coring samples will cool the material and reduce damage caused by heat developed during the coring operation. Another approach is to use a concrete saw to cut small cubes from the pavement. Nuclear density gages can be used to obtain an indication of density, but actual samples should be taken to determine acceptability of the density of the in-place mixture.