4 Mix Composition and Production

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CHAPTER FOUR:
MIX COMPOSITION AND PRODUCTION

A HMA pavement is composed of binder and aggregate blended together. The individual material properties of each component may affect the overall performance of the pavement. If pavements are to perform long term and withstand specific traffic and loading, the materials making up the pavements are required to be of high quality.

This section covers in detail what material properties are necessary for high quality pavements. The materials covered in this chapter are aggregates and PG binders. Many of the tests are not required to be conducted by the Technician; however, a thorough understanding of the materials and test procedures to determine quality is a necessary background for the Technician. Converting that understanding into a working knowledge will assist the Technician in making accurate, reliable day to day decisions on the quality of the HMA at the paving site..

AGGREGATES

SOURCES

Aggregates for HMA are generally classified according to their occurrence. The three major sources of aggregates for INDOT use are sand and gravel operations, stone quarries, and industrial processing (synthetic aggregates). Crushed stone, sand, and gravel are classified as natural aggregates. Blast furnace slag, steel slag, granulated blast furnace slag, and wet bottom boiler slag are by-products of industrial processing and are classified as synthetic aggregates.

Sand and gravel generally occur together, where they were deposited by a stream or glacier. These aggregates may be produced either from a water-filled pit using a suction dredge or a crane and dragline bucket, or from a cut-back deposit, using end-loaders or shovels. The raw materials produced in this manner are, therefore, called either pit-run or bank-run materials. These materials require further processing, such as screening, washing and crushing, to produce aggregates of the proper size.

Crushed stone is produced from quarries where bedrock is blasted from a quarry face and then further processed by crushing and screening. Crushing is accomplished by processing the shot rock through a series of crushers until the desired top size is produced. Materials are then graded in a screening operation similar to the sand and gravel operations.

Synthetic aggregates are produced either from blast furnace slag, steel slag, or from wet bottom boiler slag. Blast furnace or steel slag is produced as a by-product of iron or steel production. These materials are non-metallic substances that rise to the surface of molten iron or steel during the smelting process. After being drawn off the surface of the melt, the slag is placed into a pit and is allowed to solidify by the prevailing atmospheric conditions. Granulated slag is blast furnace slag that has been solidified by quickly quenching the material in water. Wet bottom boiler slag is a by-product of coal-fired electric power plants and is commonly known as cinders.

PHYSICAL QUALITIES

Physical quality requirements for aggregates used in HMA are all Specification provisions other than those dealing with gradation or usage requirements. These quality requirements may be divided into five distinct groups as follows:

1) Absorption/Specific Gravity

2) Abrasion Resistance

3) Soundness

4) Deleterious Materials

5) Special Requirements

Absorption and Specific Gravity

The internal pore characteristics are very important properties of aggregates. The size, the number, and the continuity of the pores through an aggregate particle may affect the strength of the aggregate, abrasion resistance, surface texture, specific gravity, bonding capabilities, and resistance to freezing and thawing action. Absorption relates to the particle's ability to take in a liquid.

Density is the weight per unit of volume of a substance. Specific gravity is the ratio of the density of the substance to the density of water. The following chart includes these values for some common substances.

Substance	**Specific Gravity**	**Density (lb/ft^3)**
Water	1.0	62.4 lb/ft^3
Binder	1.02	63.7 lb/ft^3
Limestone	2.7	165 to 170 lb/ft^3
Lead	11.0	680 to 690 lb/ft^3

The density and the specific gravity of an aggregate particle is dependent upon the density and specific gravity of the minerals making up the particle and upon the porosity of the particle. These may be defined as follows:

1) All of the pore space (bulk density or specific gravity)

2) Some of the pore space (effective density or specific gravity)

3) None of the pore space (apparent density or specific gravity)

Determining the porosity of aggregate is often necessary, but is difficult to directly measure the volume of pore space. Correlations may be made between porosity and the bulk, apparent and effective specific gravities of the aggregate.

As an example, specific gravity information about a particular aggregate helps in determining the amount of binder needed in the HMA. If an aggregate is highly absorptive, the aggregate continues to absorb binder after initial mixing at the plant, until the mix cools down completely. This process leaves less binder for bonding purposes; therefore, a more porous aggregate requires more binder than a less porous aggregate. The porosity of the aggregate may be taken into consideration in determining the amount of binder required by applying the three types of specific gravity measurements.

In the example in Figure 4-1, the bulk specific gravity includes all the pores, the apparent specific gravity does not include any of the pores that would fill with water during a soaking, and the effective specific gravity excludes only those pores that would absorb binder.

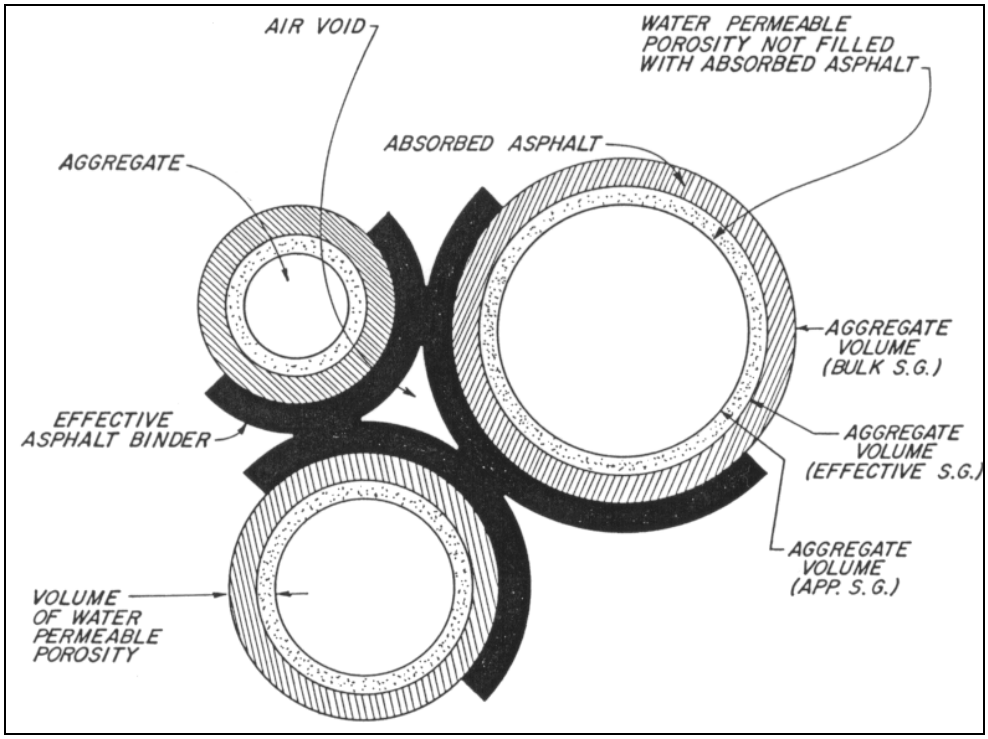

Figure 4-1. Aggregate Specific Gravities

Abrasion Resistance

For a coarse aggregate to perform satisfactorily in a pavement the material is required to be tough enough to withstand the action of rolling during construction and the action of traffic without breaking down under the imposed loads. The test used for evaluating this property is the Los Angeles abrasion test (**AASHTO T 96**). Briefly, the aggregate is placed in a metal drum along with a charge of steel balls, and the drum is rotated 500 times. The inside of the drum is equipped with an angle iron which runs longitudinally. This angle iron causes the charge of aggregate and balls to fall with a heavy impact once during each revolution, breaking the aggregate particles into smaller particles. At the completion of the test, the aggregate is shaken over a No. 12 sieve and the amount which passes through the sieve, expressed as a percentage of the total charge, is the Los Angeles abrasion value designated "percent wear". Very hard aggregates have values of 20 percent or less; softer aggregates, such as a limestone which may be scratched easily with a pocketknife, may have values over 40 percent. Aggregates, with the exception of Blast Furnace Slag, with a wear of over 40 percent are unsatisfactory for use in surface HMA. Class AS aggregate for use in SMA is required to have a maximum wear of 30 percent. Aggregate used in a base HMA may be softer than used in a surface HMA. The test equipment is illustrated in Figure 4-2.

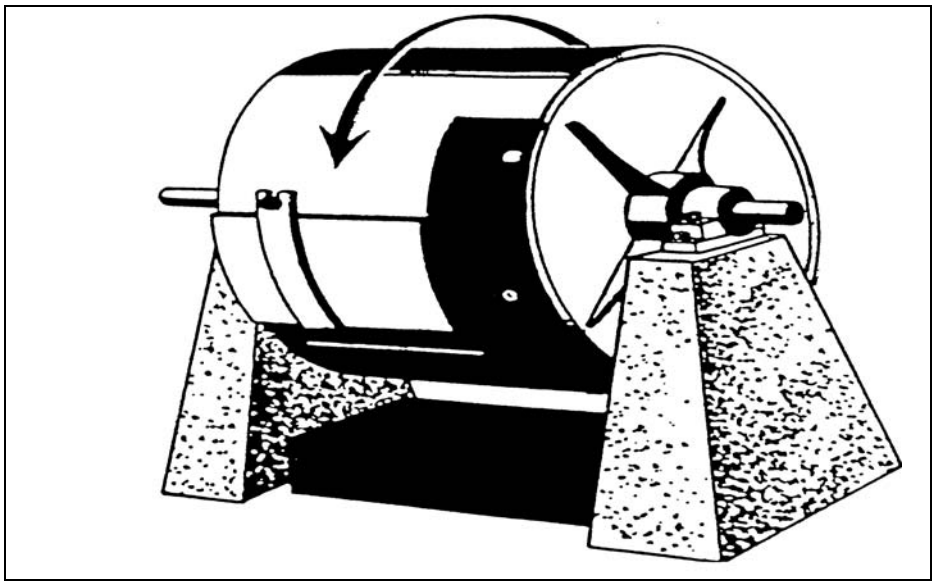

Figure 4-2. Los Angeles Abrasion Apparatus

Soundness

Aggregates which disintegrate badly under the force of weathering are termed unsound. Shale is a typical unsound material because water enters into the shale and freezes, causing expansion and disintegration. Also, exposure to air (oxidation) causes shale to flake. Unsound aggregates are obviously unsatisfactory for use in HMA, particularly for surface HMA, which are more exposed to the weather. INDOT subjects aggregates to three different test methods to evaluate soundness:

1) The sodium sulfate test in test method **AASHTO T 104**

2) The brine freezing and thawing test in **ITM 209**

3) The freezing and thawing test in test method **AASHTO T 103**

The sodium sulfate test requires immersing an aggregate sample in a sodium sulfate solution for a period of time and then determining the weight loss of particles on a given set of sieves. The brine freeze and thaw test requires the aggregate to be enclosed in a bag containing a 3 percent sodium chloride solution and subjected to 25 cycles of freeze and thaw. The water freeze and thaw test requires the aggregate to be sealed and totally immersed in water and subjected to 50 cycles of freeze and thaw.

The freezing and thawing in water test is the method that most accurately simulates actual field conditions, but the test requires a long period of time to conduct. The "quick" checks for soundness of the aggregate are the brine freeze and thaw and sodium sulfate test. If the aggregate fails either the brine freeze and thaw or the sodium sulfate test, the material is tested using the freeze and thaw method with water. An aggregate that reasonably fails the brine freeze and thaw and/or sodium sulfate test but then passes the freeze and thaw in water method is an acceptable material for use on INDOT contracts.

Deleterious Materials

Certain substances such as deleterious material in aggregates are undesirable for use in HMA. Therefore, the Specifications limit the amount of deleterious constituents to a level consistent with the quality sought in the final products. Figure 4-3 illustrates the materials which are classified as deleterious and the Specification limits for each. Of particular interest for avoidance in HMA is chert.

Chert is mineral matter composed of microcrystalline silica. When lightweight chert (less than 2.45 specific gravity) is present in aggregate used to produce HMA, the chert may undergo volumetric expansion sufficient to cause disruption of the mix, causing popouts, when the chert particles are located close to the surface. In addition, the binder is unable to coat the particles which leads to raveling of the pavement under traffic. Once either problem is initiated, the rate of deterioration of the surface is accelerated.

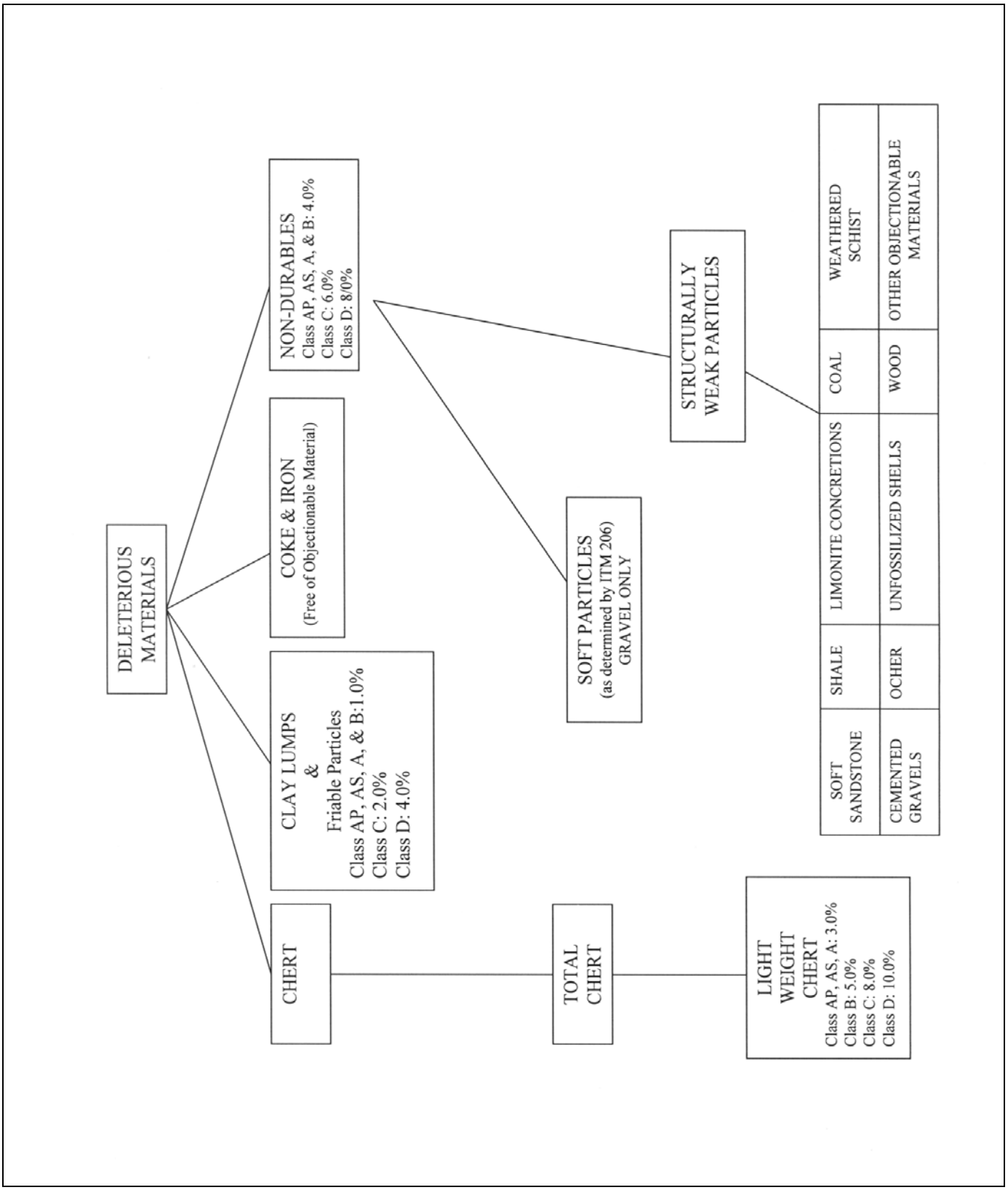

Figure 4-3. Deleterious Materials

Special Requirements

Particle Shape

The shape of the aggregate particles affect such things as:

1) The binder demands of HMA

2) The workability and the strength of HMA

The best aggregates to use for strength are crushed stone or crushed gravel. Crushed aggregates have irregular, angular particles that tend to interlock when compacted or consolidated.

The crushed stone or crushed gravel aggregate make the HMA somewhat difficult to place. To improve the workability, many mixes contain both angular and round particles. The coarse aggregate particles are usually crushed stone or crushed gravel, and the fine aggregate particles are usually natural sand.

Surface Texture

Like particle shape, the surface texture also influences the workability and strength of HMA. Surface texture has often been considered more important than the shape of the aggregate particles. A rough, sandpaper-like surface texture as opposed to a smooth surface tends to increase the strength of the HMA. Some aggregates may initially have good surface texture but under traffic may polish smooth.

Coatings

Coating is a layer of substance covering a part or all of the surface of an aggregate particle. The coating may be of natural origin, such as mineral deposits formed in sand and gravel by ground water, or may be artificial, such as dust formed by crushing and handling.

Generally, aggregates used in HMA are required to be washed to remove the coating (contaminant) left on the particles. The coating may prevent a good bond from forming between the aggregate surfaces and the binder. The coating may even increase the quantity of binder needed in the HMA. Also, if the quantity of the coating varies from batch to batch, undesirable fluctuations in the consistency of the HMA may result.

Coarse Aggregate Angularity

Crushed particles (coarse aggregate angularity) are necessary in HMA to assist in resisting shoving and rutting under traffic. The internal friction among the crushed aggregate particles prevents them from being moved past each other and provides for a stable mix. The test procedure used to define coarse aggregate angularity is **ASTM D 5821**.

The crushed particle requirement applies for HMA when gravel is used. Crushed particles are defined as those particles having one or more sharp, or slightly blunt edges. Fractured faces that have an area less than 25 percent of the maximum cross sectional area of the particle are not considered crushed.

Flat and Elongated Particles

Flat and elongated particles are undesirable because they have a tendency to break during construction and under traffic. This characteristic is defined as the percentage by weight of coarse aggregates that have a length in excess of five times the width in accordance with **ASTM D 4791**. Figure 4-4 is an illustration of the device used to measure these particles.

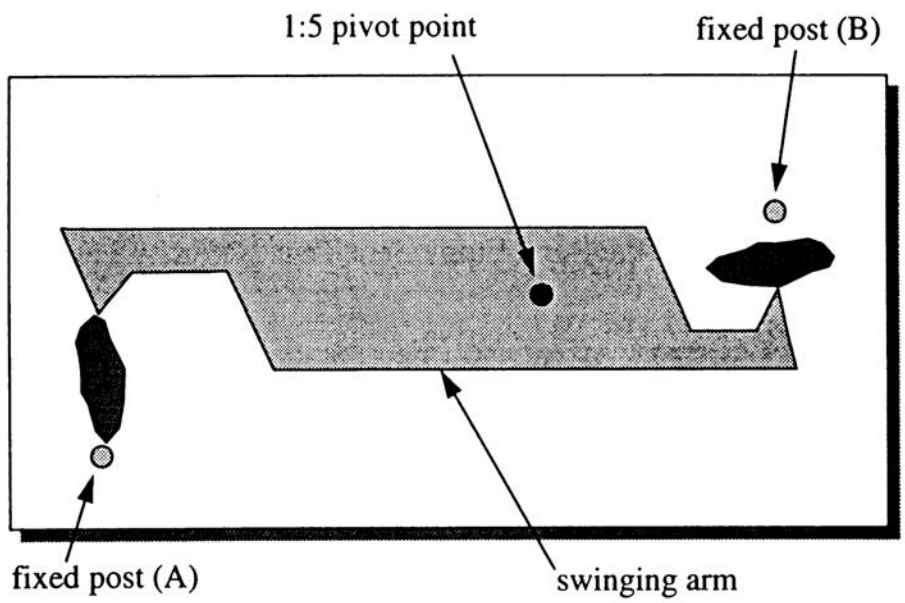

Figure 4-4. Flat and Elongated

Clay Content

Limitation of the amount of clay in aggregate strengthens the adhesive bond between the binder and the aggregate. Clay content is the percent of clay material contained in the aggregate fraction that is finer than a No. 4 sieve.

The test used for determining the clay content is the Sand Equivalent Test (**AASHTO T 176**). In this test, a sample of fine aggregate is placed in a graduated cylinder with a flocculating solution and agitated to loosen clayey fines present in and coating the aggregate. The flocculating solution forces the clayey material into suspension above the granular aggregate. After a period that allows sedimentation, the cylinder height of suspended clay and sedimented sand is measured (Figure 4-5). The sand equivalent value is computed as a ratio of the sand to clay height readings expressed as a percentage.

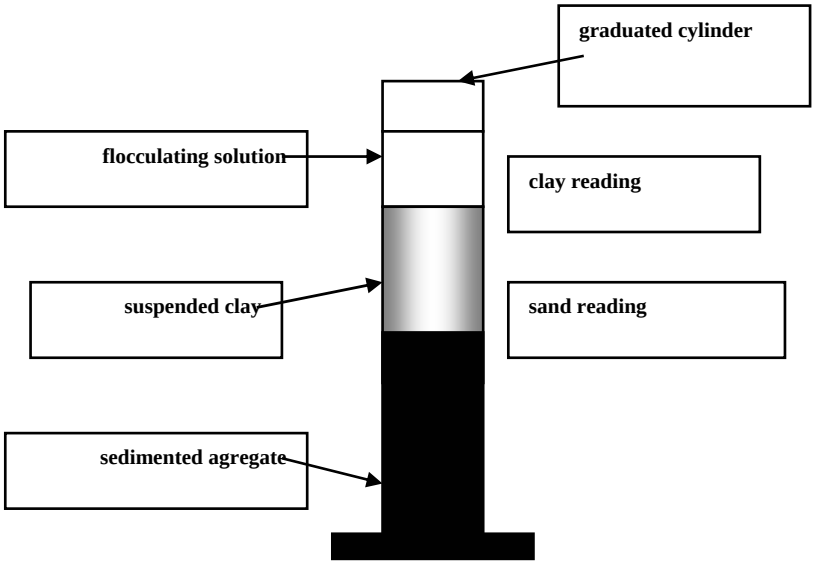

Figure 4-5. Sand Equivalent

Fine Aggregate Angularity

Fine aggregate angularity (FAA), like the crushed content of coarse aggregate, is necessary to achieve a high degree of internal friction and thus, high shear strength for rutting resistance. FAA is defined as the percent air voids present in loosely compacted aggregates finer than the No. 8 sieve.

The test used for determining the Fine Aggregate Angularity is the Uncompacted Void Content of Fine Aggregate Test (**AASHTO T 304**). In the test, a sample of fine aggregate is poured into a small calibrated cylinder by flowing through a standard funnel (Figure 4-6). By determining the weight of fine aggregate (W) in the filled cylinder of known volume (V), void content can be calculated as the difference between the cylinder volume and fine aggregate volume collected in the cylinder. The fine aggregate bulk specific gravity (Gsb) is used to compute fine aggregate volume.

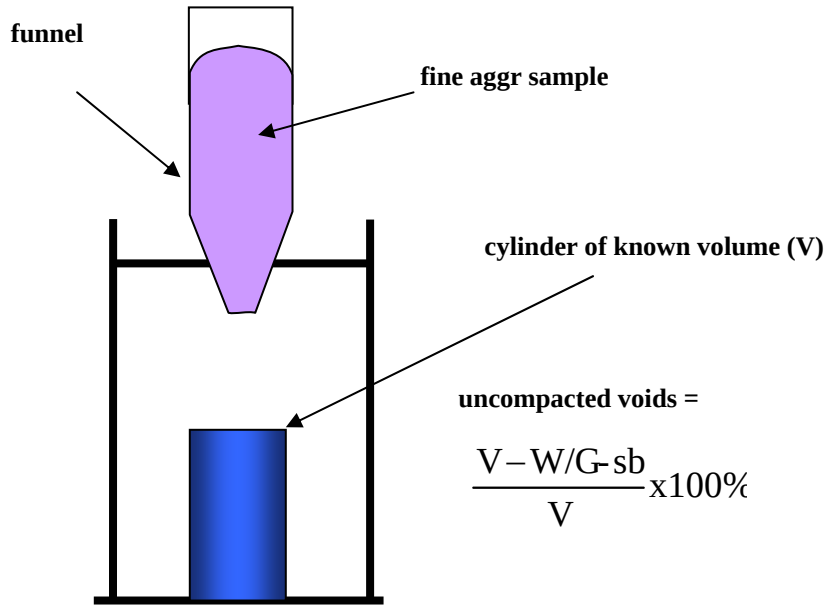

Figure 4-6. Fine Aggregate Angularity

Dolomitic Aggregates

There is a special requirement to be met when dolomitic coarse aggregates are used in HMA. These aggregates are specified under some conditions to obtain high-friction, skid-resistant HMA surface courses. **ITM 205** is used to ensure that the aggregate is a carbonate rock containing at least 10.3 percent elemental magnesium.

Polish Resistant Aggregates

Aggregates that meet the requirements of **ITM 214** may be used in place of dolomitic aggregates in HMA surface mixtures. The procedure for approval requires initial British Pendulum testing, placement of a test section on an INDOT project, and subsequent skid testing for two years.

Sandstone Aggregates

Sandstone is required to meet the Class B quality requirements of the Specifications, and may only be used in HMA surface mixtures. The definition of sandstone is described in Section **904.01**.

Slag Aggregates

When slag is furnished as an alternate to natural aggregate, payment is made on a weight basis. Adjustments are required to be made to compensate for the difference in specific gravity of the slag compared to the specific gravity of the natural aggregate. For any pay item less than 500 tons on a contract, no adjustment is made. The following typical values should be used.

Typical Values for Specific Gravity	
Natural aggregates (both fine and coarse)	2.6
Air cooled blast furnace slag coarse aggregate	2.3
Air cooled blast furnace slag fine aggregate	2.6
Granulated blast furnace slag fine aggregate	2.1
Steel furnace slag, both fine and coarse	3.2

Steel furnace slag for use in SMA is required to meet additional requirements for control of the specific gravity in accordance with Section **904.01.**

STOCKPILING

Segregation is probably the greatest problem of stockpiling and handling, but certainly other problems such as degradation and contamination may adversely affect product quality. Every possible precaution should be taken to protect product quality from initial stockpiling to the point where the material is loaded into the HMA plant.

The majority of aggregate stockpiles at the HMA plant are built by dumping individual truckloads of material. The best truck-built stockpiles are those that are constructed one dump high with each dump placed against previously dumped material. Here, because of the low profile, roll-down segregation is minimal and may be reduced by reasonable remixing effort during loading of the cold bins. However, these stockpiles require a large area. A technique that may help reduce the required area is to restock some dumps on top of other dumps with a large endloader operating from ground level. In this case, care should be taken to place the upper lift back from the edge far enough that a long sloped face is not created that would cause segregation.

Occasionally aggregate is dumped over a quarry or pit face to form a stockpile. This tends to cause considerable segregation, particularly with larger and long graded aggregates. In general, the larger particles work to the outside and base of the pile. The extent of segregation varies with the height of fall, gradation of the material, moisture, and other conditions. Segregation typically occurs as shown in Figure 4-7.

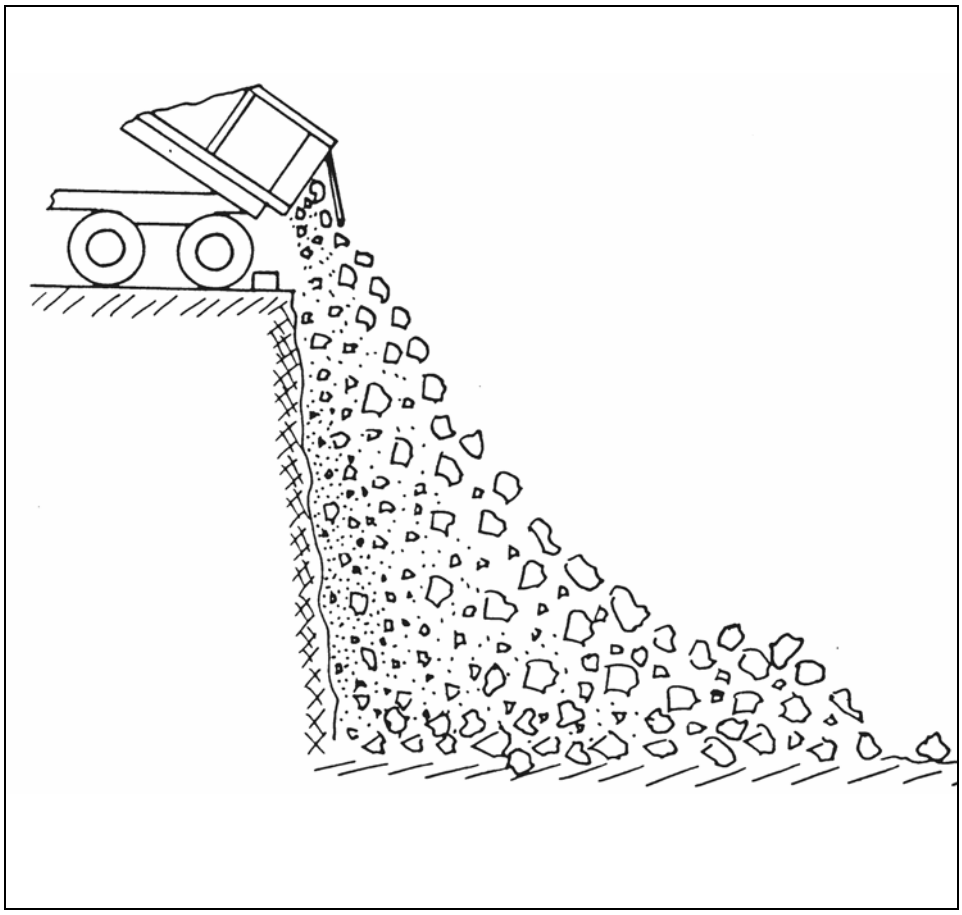

Figure 4-7. Stockpile Segregation

GRADATION

Particle gradation is determined by a sieve or gradation analysis of aggregate samples. A sieve analysis involves passing the sample through a series of sieves, each of which has openings of specific sizes (Figure 4-8). Sieves are designated by the size of their openings. Coarse particles are trapped in the upper sieves; medium-sized particles pass through to the mid-level sieves; fines pass through to the lowest sieves.

The aggregate gradation considers the percentage by weight of the total sample that passes through each sieve. This is determined by weighing the contents of each sieve following the sieve analysis, then calculating the percentage passing each sieve.

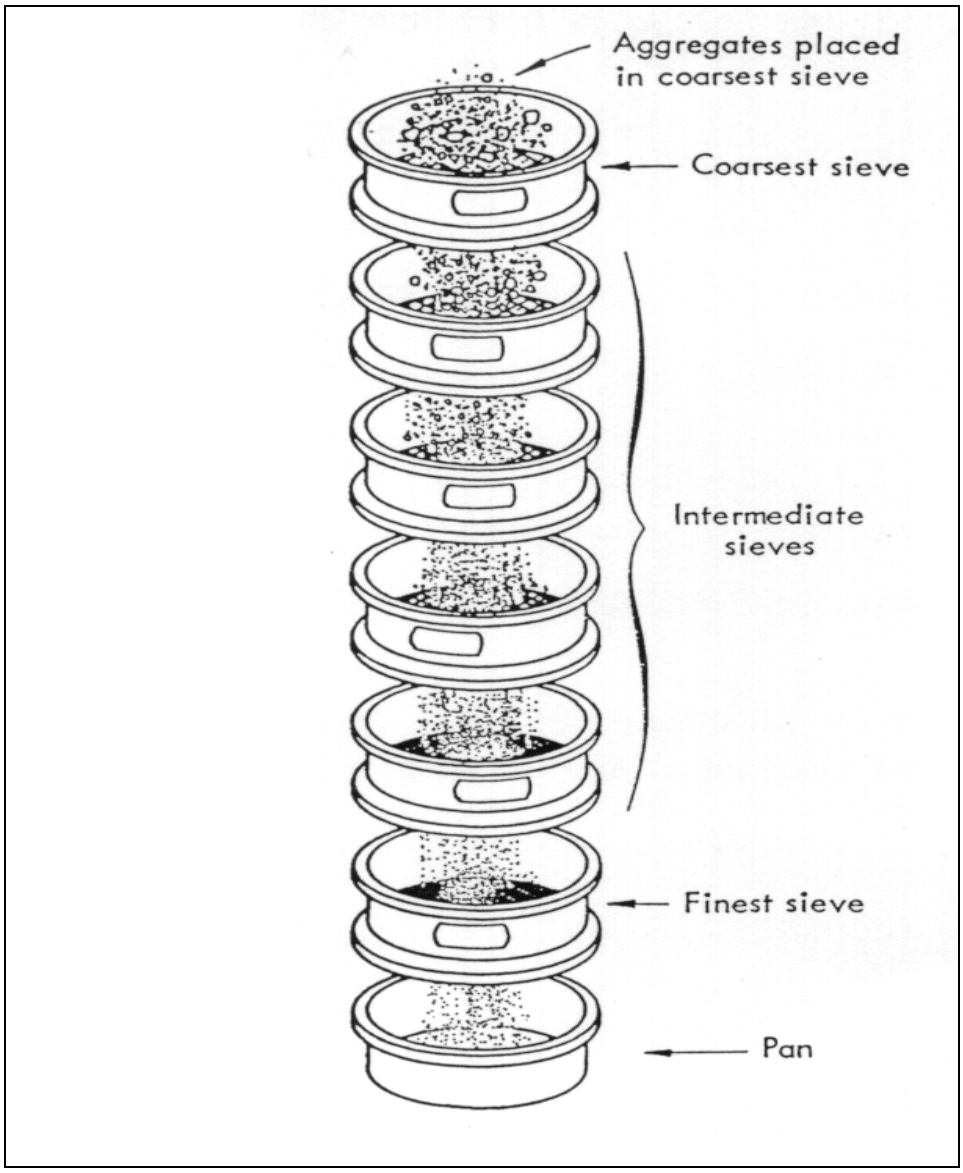

Figure 4-8. Sieve Analysis

For the purpose of description, certain terms are used in referring to aggregate fractions. They are:

Coarse aggregate - material that has a minimum of 20 percent retained on the No. 4 sieve

Fine aggregate - material that is 100 percent passing the 3/8 in. sieve and a minimum of 80 percent passing the No. 4 sieve

Nominal Maximum Particle Size - smallest sieve opening through which the entire amount of the aggregate is permitted to pass

Maximum Particle Size - largest sieve size listed in the Specification through which all material is required to pass

Aggregate gradation specifications may be presented graphically; Figure 4-9 is a typical gradation chart. On the chart, sieve sizes are presented horizontally and percent passing each sieve is shown vertically.

Certified Aggregate Producer Program

The Certified Aggregate Producer Program (CAPP) is a program in which a qualified mineral aggregate Producer desiring to supply material for INDOT use may do so by assuming all of the Plant site controls and a portion of the testing responsibility that had been previously assumed by INDOT.

The benefit of the CAPP is that the Producer is providing material that has a consistent gradation. Documentation of gradation test results for both during production and as the aggregate is loaded-out is available at any time. This information may save the Contractor time and money in designing the HMA. Also, problems that may occur during production of the HMA due to inconsistent gradations may be quickly traced with information readily available at the aggregate source on all aspects of production of the material

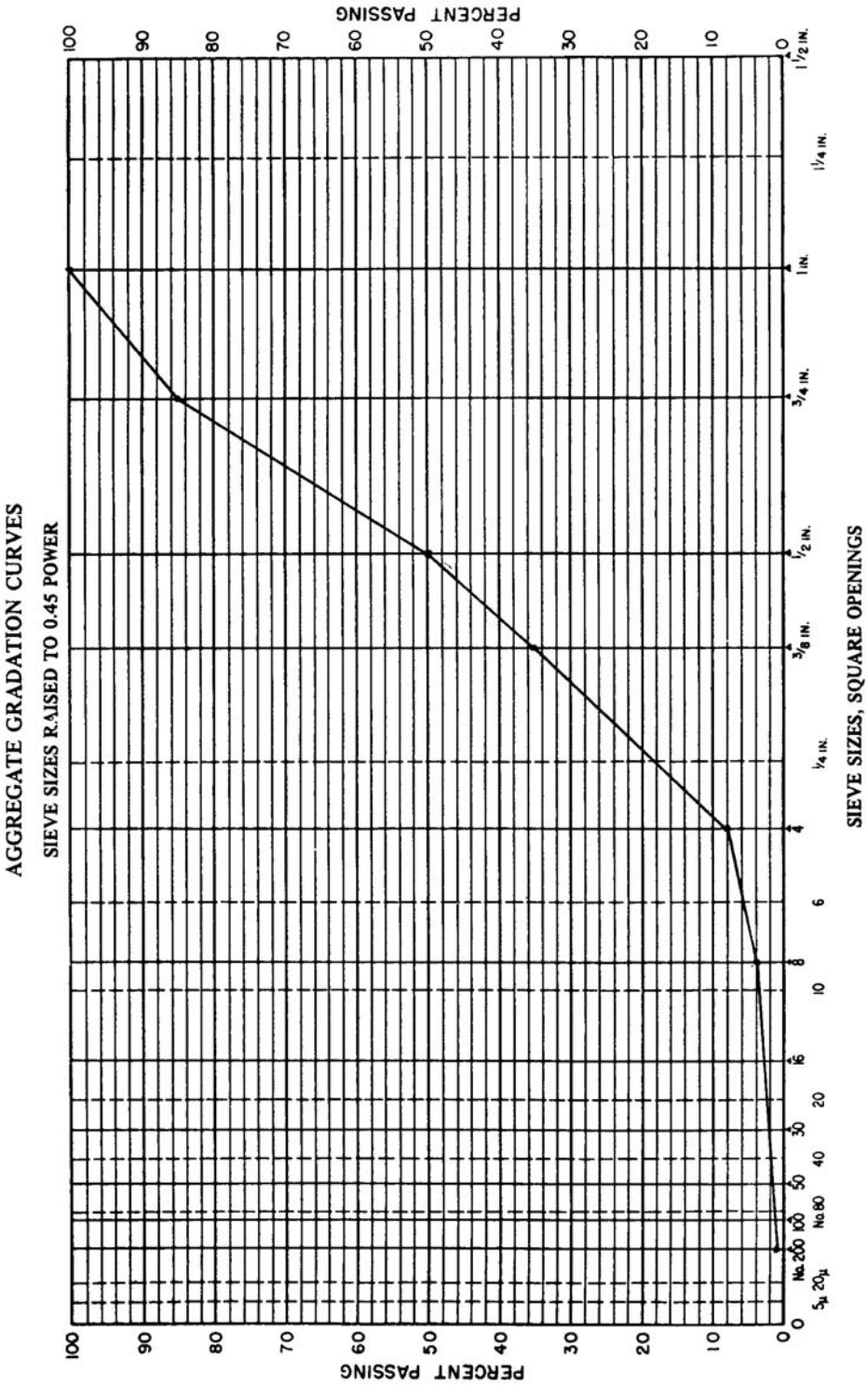

Figure 4-9 Gradation Chart

ASPHALT

Asphalt is a black, cementing material that varies widely in consistency from solid to semisolid (soft solid) at normal air temperatures. When heated sufficiently, asphalt softens and becomes a liquid, which allows the material to coat the aggregate particles during HMA production.

Asphalt is made up largely of a hydrocarbon called bitumen. Virtually all asphalt used in the United States is produced by modern petroleum refineries and is called petroleum asphalt. The degree of control allowed by modern refinery equipment permits the production of asphalts with specific characteristics suited to specific applications. As a result, different asphalts are produced for paving, roofing and other special uses.

Paving asphalt, commonly called binder, is a highly viscous (thick), sticky material. It adheres readily to aggregate particles and is therefore an excellent cement for binding together aggregate particles in HMA. The binder is an excellent waterproofing material and is resistant to most acids, alkalies (bases) and salts. This means that a properly constructed HMA pavement is waterproof and resistant to many types of chemical damage.

Binder for paving may also contain modifiers to improve performance properties. Some of these binders require special storage and handling. The material suppliers recommendations should be followed to insure that these performance characteristics are not altered or lost before mixing and placement of the HMA.

Binder changes when the material is heated and/or aged. Binder tends to become hard and brittle and therefore lose some of its ability to adhere to aggregate particles. These changes may be minimized by understanding the properties of the binder and taking steps during construction to ensure that the finished pavement is built in a way that retards the aging process
.

SOURCE AND NATURE OF ASPHALT

Because asphalt is used for many purposes, there is sometimes confusion about where asphalt comes from, how the material is refined, and how the material is classified into grades. There is similar confusion about terms related to asphalt properties and use.

Petroleum Refining

Crude petroleum is refined by distillation, a process in which various fractions (products) are separated out of the crude. Distillation is accomplished by raising the temperature of the crude petroleum in stages. As shown in Figure 4-10, different fractions separate at different temperatures.

The lighter fractions are separated by simple distillation. The heavier distillates, often referred to as gas oils, may be separated only by a combination of heating and applying a vacuum. The product which cannot be distilled under vacuum distillation is asphalt.

Figure 4-11 is a schematic illustration of a typical refinery. The schematic shows the flow of petroleum during the refining process.

Asphalt Refining

Different types of asphalt are required for different applications. To produce asphalts that meet specific requirements, refiners are required to have a way to control the properties of the asphalts they produce. This is often accomplished by blending crude petroleums of various types together before processing. Blending allows refiners to combine crudes that contain asphalts of varying characteristics in such a way that the final product has exactly the characteristics required by the asphalt user.

Once the crude petroleums have been blended together, there are two widely used processes by which asphalt may be produced from them: vacuum distillation and solvent extractions.

As discussed above, vacuum distillation involves separating the asphalt from the crude by applying heat and a vacuum. In the solvent extraction process, additional gas oils are removed from the crude, leaving residual asphalt.

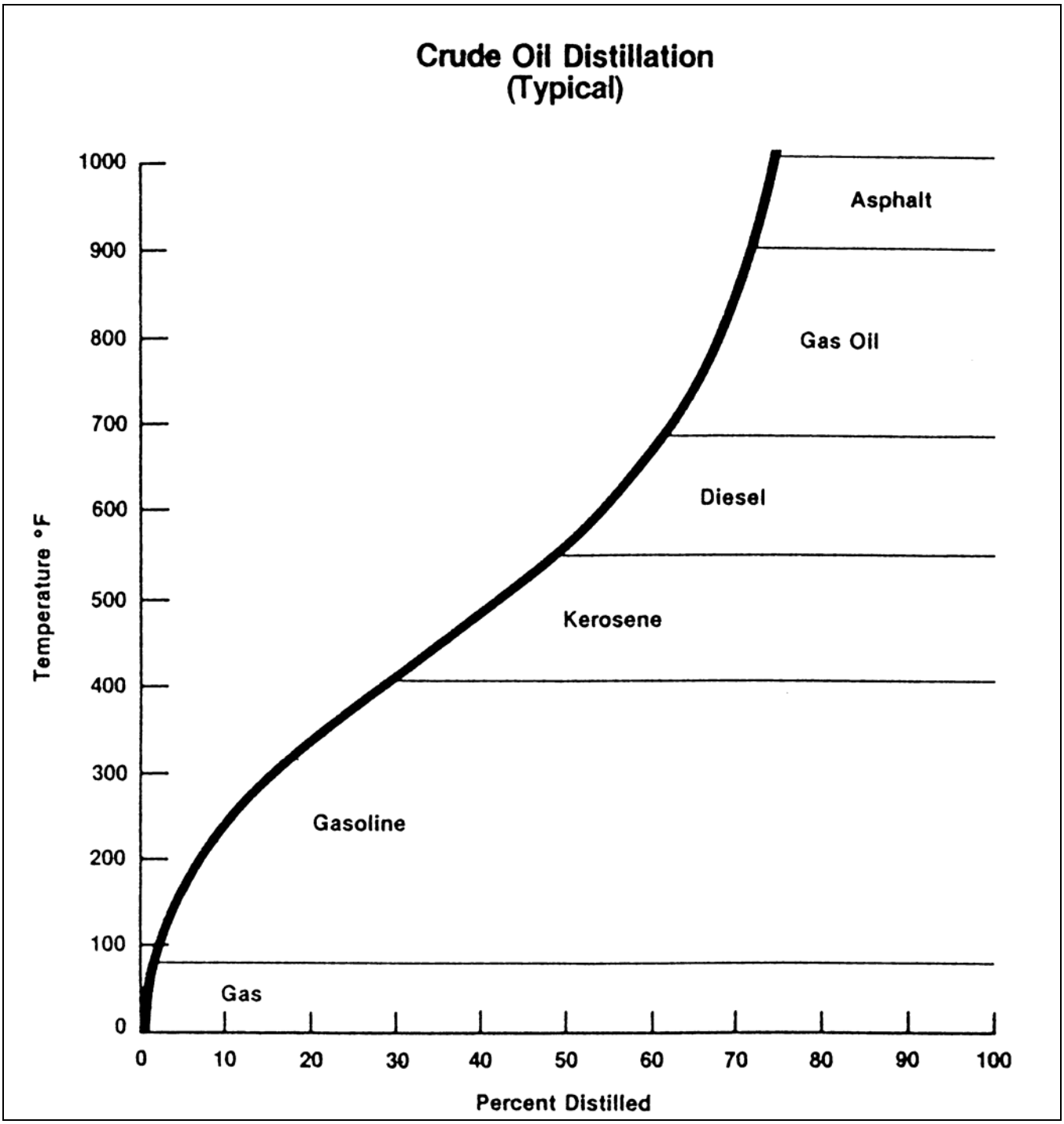

Figure 4-10. Typical Distillation Temperatures and Products

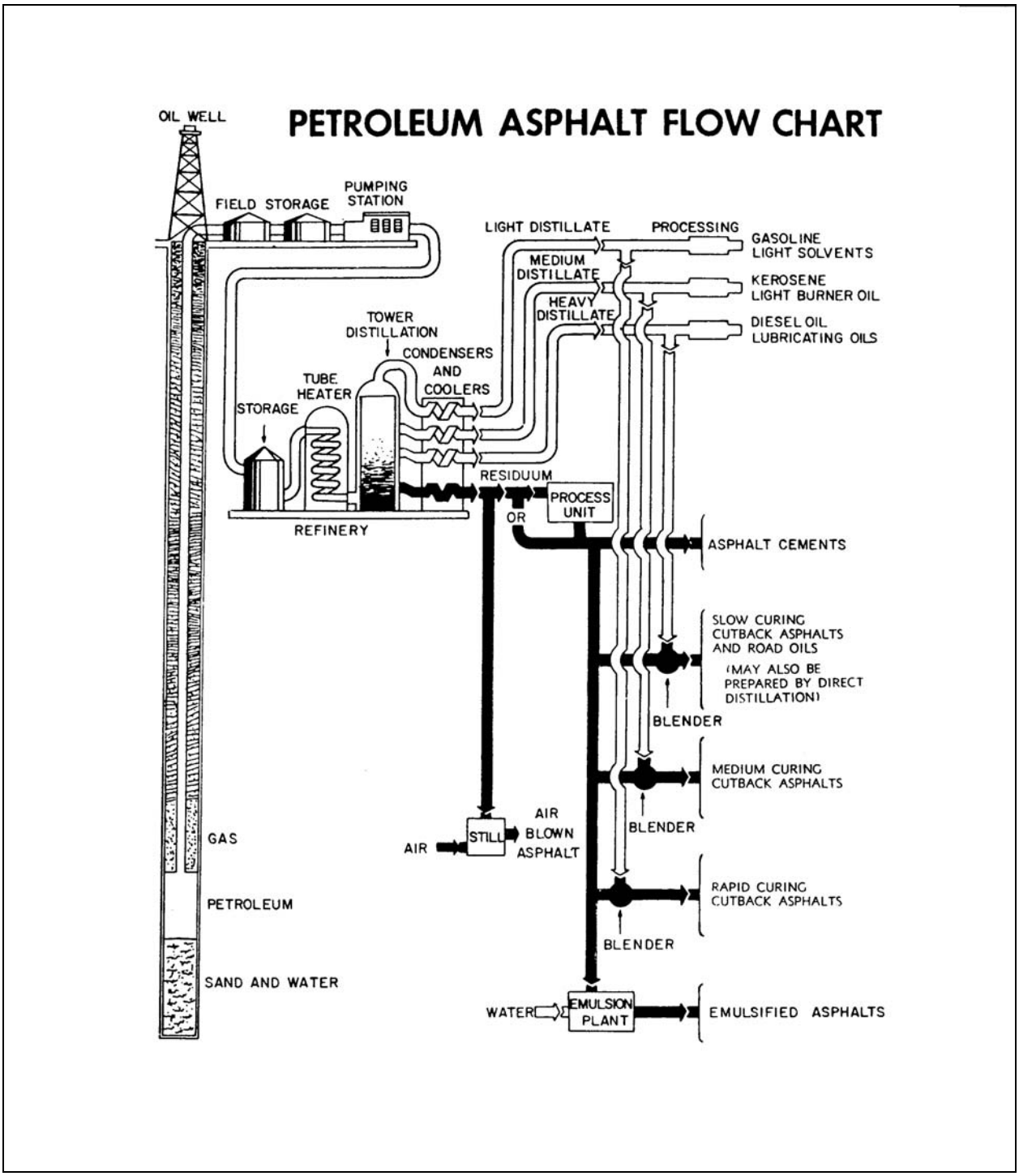

Figure 4-11. Typical Refining Process

PERFORMANCE GRADED BINDER

The binder Specifications are based on fundamental properties which are measured at actual in service temperatures where the critical distresses occur. The upper temperature extreme is designated as the average 7-day maximum pavement design temperature. This temperature is obtained by accumulating the temperature from each successive 7-day period throughout the summer, and choosing the 7-day period which yields the largest average. The lower temperature extreme is designated as the minimum pavement design temperature. An example of how this grading system works is shown in Figure 4-12. The specification limits for the PG Binders are listed in Section **902.01**.

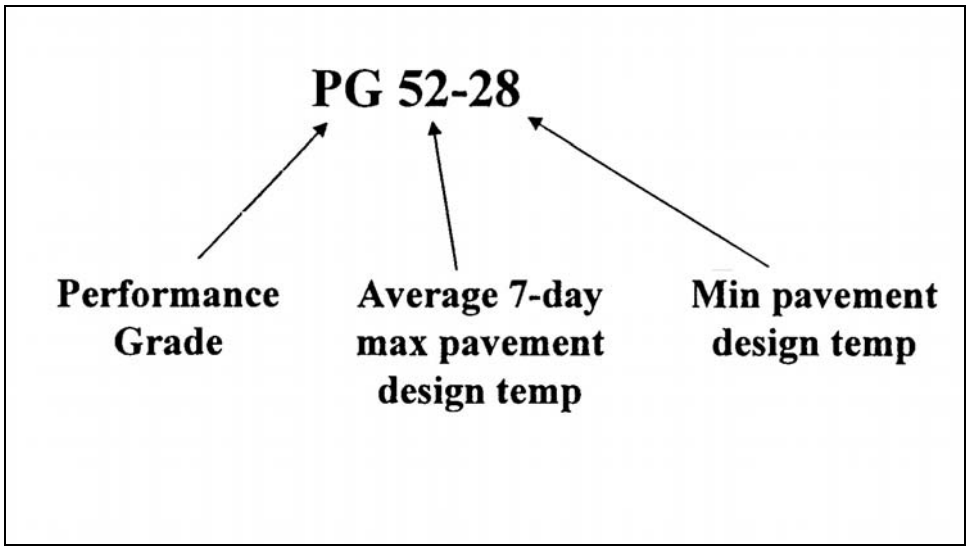

Figure 4-12. PG Grading System

HOT MIX ASPHALT

Hot mix asphalt is a combination of two basic ingredients, asphalt and aggregates. The asphalt accounts for 3 to 8 percent of the mixture by weight while aggregates account for the remaining 92 to 97 percent.

PAVING COURSES

On typical HMA contracts there are three distinct HMA courses or layers which may be placed; base, intermediate and surface.

The base course is a foundation course consisting of larger aggregate sizes to provide stability and strength.

The intermediate course is an intermediate layer of medium-sized aggregates which act as a barrier to keep surface material from being pushed into the base material. Intermediate materials may also be used as a base or as a wedging and leveling course.

The surface course is a smooth, skid resistant layer made up of smaller aggregates.

MIX GRADING

HMA mixtures may also be open graded or dense graded mixtures.

Open graded HMA mixtures usually consist of larger aggregates with few small aggregates or fines. The open grading of the mix permits water to flow through the pavement. One use of this mix is to provide a free draining base course.

Dense graded mixtures contain more small and fine aggregates to close up any spaces between the larger aggregates. Dense graded mixtures shed water from the surface better, provide a smoother ride, and are typically used for base, intermediaate, or surface courses not requiring free drainage.

DESIGN MIX FORMULA

Precise proportions of asphalt and aggregates are blended together to produce HMA paving mixtures. The types of asphalts used and the proportions of each component vary among mixtures. As a result, each mix has a different set of characteristics and properties.

Prior to any mix production, the Contractor is required to submit a Design Mix Formula (DMF) for each mixture supplied to the contract. The DMF specifies the exact types and quantities of asphalt and aggregates to be used to produce the mix. The Contractor develops a mix design that is within the Specification guidelines regarding that particular mix. The mix design is then submitted to district Testing for approval. No mix may be used on the contract until the DMF has been approved.

The Technician is required to know what the pay item description is for each mix used. The pay item description indicates whether the mixture is QC/QA HMA in accordance with Section **401,** HMA in accordance with Section **402**, or SMA in accordance with Section **410.**

The PE/PS receives a copy of the approved Design Mix Formula. The HMA Technician is required to check the Design Mix Formulas for the contract to verify what materials are to be used to produce the mix that is inspected each day.

MIXING PROCESS

A HMA plant is an assembly of mechanical and electronic equipment where aggregates are blended, heated, dried, and mixed with binder to produce HMA meeting specified requirements. The plant may be stationary (located at a permanent location) or portable (moved from contract to contract). There are numerous types of plants, including batch plants, continuous mix plants, parallel-flow drum plants, counter flow drum plants, and double barrel drum plants to name a few. In general, however, the majority of plants may be categorized as either a batch plant (Figure 4-13), or a drum mix plant (Figure 4-14).

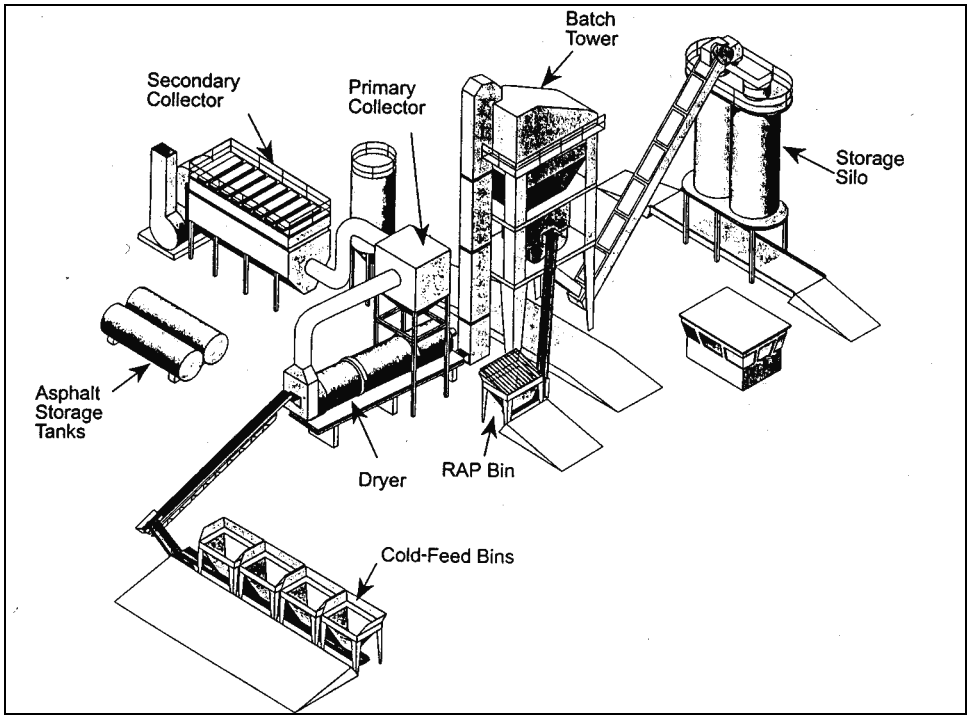

Figure 4-13. Typical Batch Plant

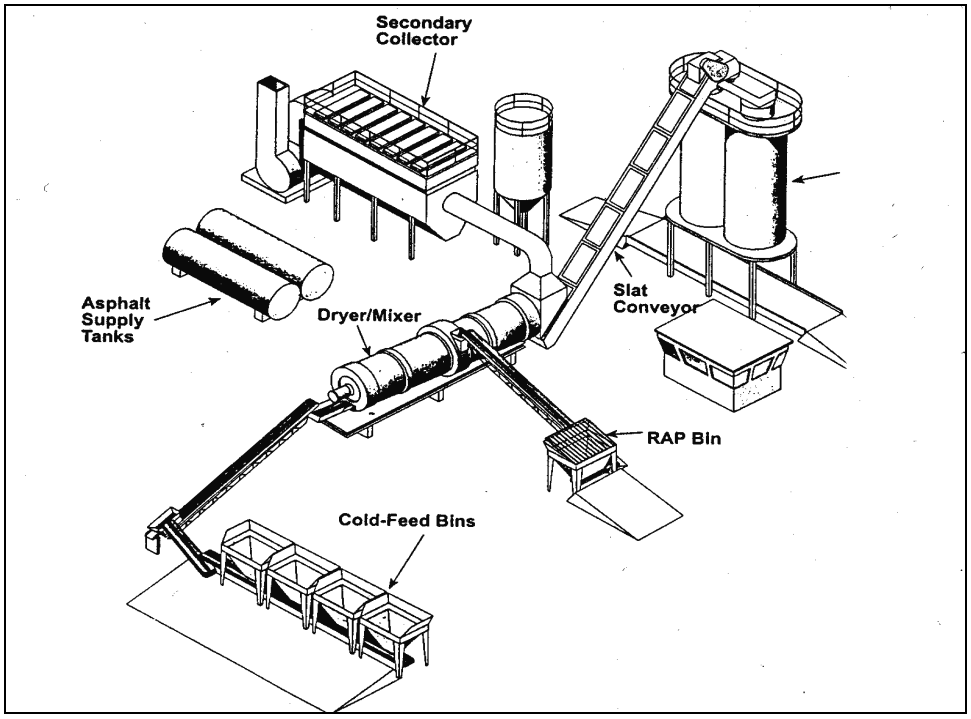

Figure 4-14. Typical Drum Plant

BATCH PLANTS

Batch plants obtain their name from the fact that during operation the HMA is produced in batches. The size of batch varies according to the capacity of the plant pugmill (the mixing chamber where aggregate and binder are blended together). A typical batch is approximately 6000 lb.

Batch Plant Operations and Components

At a batch plant, aggregates are blended, heated and dried, proportioned, and mixed with binder to produce HMA. A plant may be small or large, depending on the type and quantity of HMA being produced, and also may be stationary or portable.

Certain basic operations are common to all batch plants:

1) Aggregate storage and cold feeding

2) Aggregate drying and heating

3) Screening and storage of hot aggregates

4) Storage and heating of binder

5) Measuring and mixing of binder and aggregate

6) Loading of finished HMA

Figure 4-15. illustrates the sequence of these operations.

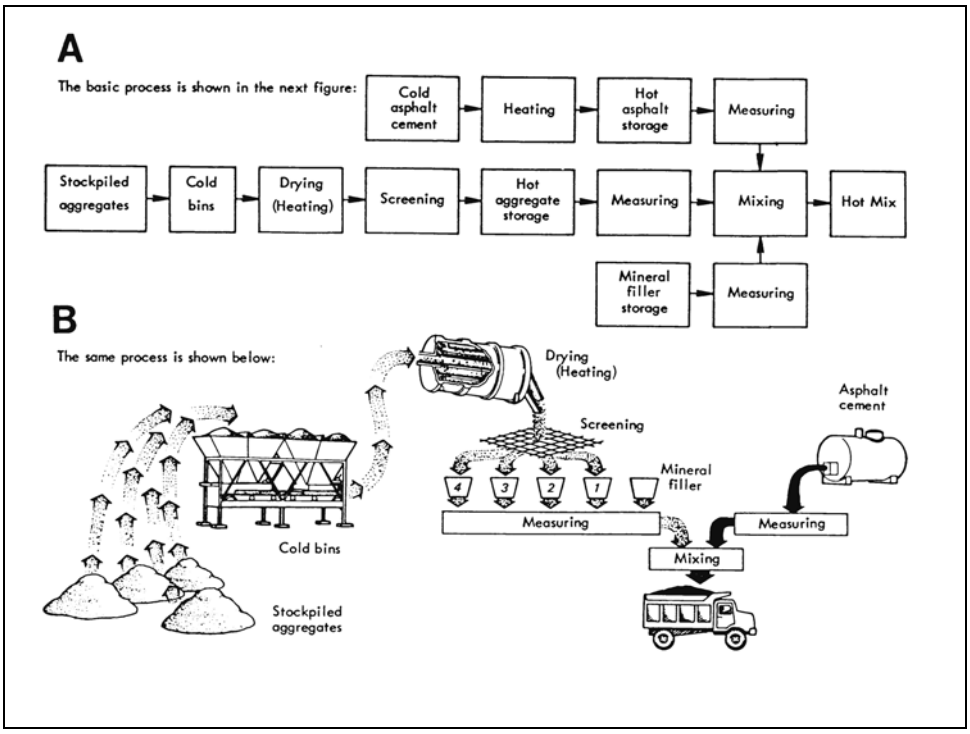

Figure 4-15. Basic Batch Plant Operations Shown (A) in flow chart form and (B) schematically

Aggregates are removed from storage or stockpiles in controlled amounts and passed through a dryer to be dried and heated. The aggregates then pass over a screening unit that separates the material into different sized fractions and deposits them into bins for hot storage. The aggregates and mineral filler (when used) are then withdrawn in controlled amounts, combined with binder, and thoroughly mixed in a batch. The HMA is loaded directly into trucks or placed in a surge bin, and hauled to the paving site.

Figure 4-16 illustrates the major components of a typical batch plant. An overview of the processes involved in plant operations as follows is intended to help the technician understand the functions and relationships of the various plant components.

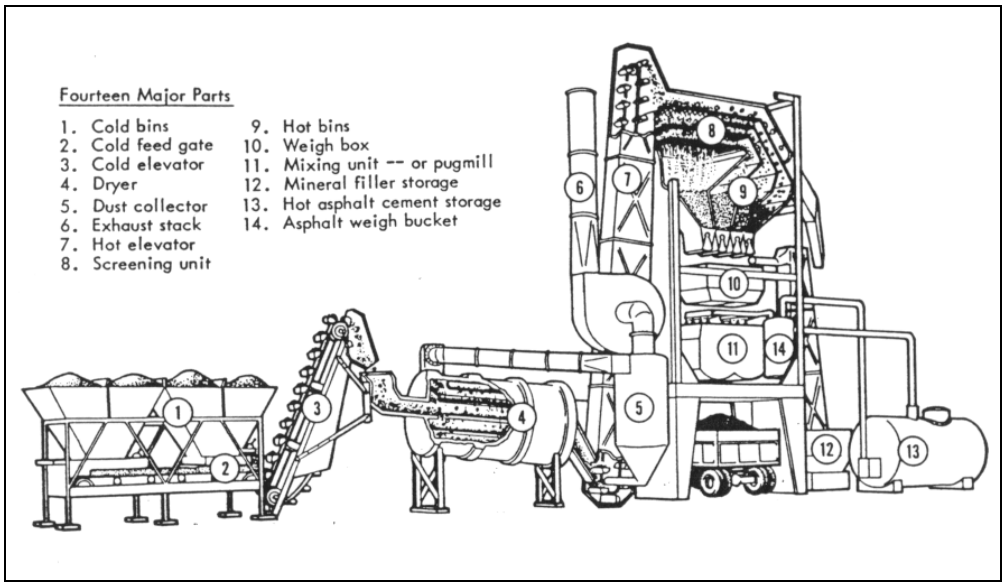

Figure 4-16. Major Batch Plant Components (Many plants also include a baghouse in addition to the dust collector shown in number 5 above.)

Cold (unheated) aggregates stored in the cold bins (1) are proportioned by cold-feed gates (2) on to a belt conveyor or bucket elevator (3), which delivers the aggregates to the dryer (4), the aggregate is dried and heated. Dust collectors (5) remove undesirable amounts of dust from the dryer exhaust. Remaining exhaust gases are eliminated through the plant exhaust stack (6). The dried and heated aggregates are delivered by hot elevator (7) to the screening unit (8), which separates the material into different sized fractions and deposits them into separate hot bins (9) for temporary storage. When needed, the heated aggregates are measured in controlled amounts in to the weigh box (10). The aggregates are then dumped into the mixing chamber or pugmill (11), along with the proper amount of mineral filler, if needed, from the mineral filler storage (12). Heated binder from the hot binder storage tank (13) is pumped into the binder weigh bucket (14) which weighs the binder prior to delivery into the mixing chamber or pugmill where the binder is combined thoroughly with the aggregates. From the mixing chamber, the HMA is deposited into a waiting truck or delivered by conveyor into a surge bin.

DRUM PLANTS

Drum mixing is a relatively simple process of producing HMA. The mixing drum (Figure 4-17) is very similar in appearance to a batch plant dryer drum. The difference between drum mix plants and batch plants is that in drum mix plants the aggregate is not only dried and heated within the drum, but also mixed with the binder. There are no gradation screens, hot bins, weigh hoppers, or pugmills in a drum mix plant. Aggregate gradation is controlled at the cold feed.

As the aggregates (correctly proportioned at the cold feed) are introduced into the drum mix plant for drying, the binder is also introduced into the drum. The rotation of the drum provides the mixing action that thoroughly blends the binder and the aggregates. As the HMA is discharged from the drum, the mixture is carried to a surge bin and subsequently loaded into trucks.

Figure 4-17. Drum Mix Plant

Drum Mix Plant Components

The fundamental components of the drum mix plant (Figure 4-18) are:

1) Aggregate cold-feed bins

2) Conveyor and aggregate weighing system

3) Drum mixer

4) Dust collection system

5) Hot mix conveyor

6) Mix surge bin

7) Control van

8) Binder storage tank

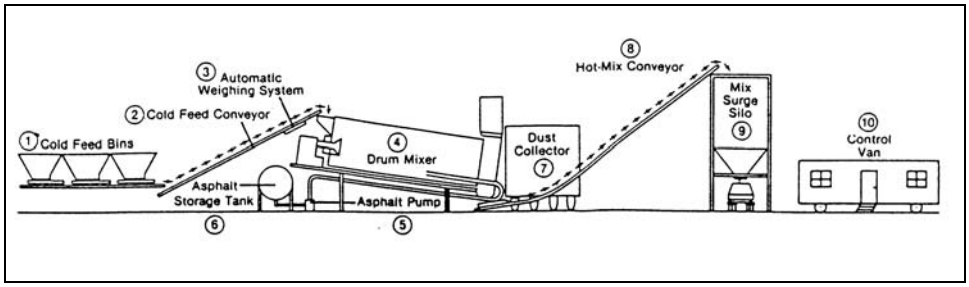

Figure 4-18. Basic Drum Mix Plant

Referring to Figure 4-18 the following is a brief, general description of the sequence of processes involved in a typical drum mix plant operation: Controlled gradations of aggregates are deposited in the cold feed bins (1) from which the aggregates are fed in exact proportions onto a cold-feed conveyor (2). An automatic aggregate weighing system (3) monitors the amount of aggregate flowing into the drum mixer (4). The weighing system is interlocked with the controls on the binder storage pump (5), which draws binder from a storage tank (6) and introduces binder into the drum where binder and aggregate are thoroughly blended by the rotating action of the drum. A dust collection system (7) captures excess dust escaping from the drum. From the drum, the HMA is transported by hot mix conveyor (8) to a surge bin (9) from which the mixture is loaded into trucks and hauled to the paving site. All plant operations are monitored and controlled from instruments in the control van (10).

The mixing process is essentially similar in all drum mixing plants; however, there are several plant designs available. These include the counter-flow drum, which has the burner located near the outlet end of the drum, and the unitized counter-flow drum, which has an outer mixing drum that surrounds the dryer drum.