a) Inspection Handbook
INSPECTION OF RUBBERIZED ASPHALT CONCRETE

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INSPECTION OF RUBBERIZED ASPHALT CONCRETE

COURSE CONTENT

This course will concentrate on the role of the public works inspector as it relates to the construction of asphalt concrete and rubberized asphalt concrete pavements.

REFERENCE MATERIAL

- Inspection of Rubberized Asphalt Concrete, a Field Guide for the Construction Inspector.

INTRODUCTION

The construction inspector serves as the link between the designer and the contractor. The inspectors’ mission is to verify that the final field product is in conformance with the plans and specifications. The plans show what the contractor is to build. The specifications detail how it is to be built. Remember, the contract documents (plans, specifications, etc.) represent the minimum quality of materials and workmanship that the contractor is to provide. Your ob is to verify that these requirements are reflected in the end result.

RESPONSIBILITIES OF THE CONSTRUCTION INSPECTOR

- Be completely familiar with the plans and specifications in order to verify that the finished product is in conformance.
- Do not require work not called for in the contract.
- Keep in close contact with the work as it progresses. You cannot inspect the work if you are not there.
- Record all work in your daily log as it is completed.
- Reject all unsatisfactory work or materials. Timing is critical. Unsatisfactory work must be rejected immediately.
- Submit progress pay estimates in a timely manner.
- Be safety minded.
- Act in a responsible manner.
RELATIONSHIP WITH THE CONTRACTOR AND THE PUBLIC

- Be friendly (on a professional level), fair and firm.
- When answering questions, remember that your prime responsibility is to the agency.
- You may not be able to give the contractor or the public what they want.
- If you do not know the answer to a question or a problem, do not try to bluff. Find out and get back to the person.
- Be diplomatic.
- Do not superintend the work.
- Offer advice only if asked.
- Be aware of your authority and legal responsibilities

TOOLS AND EQUIPMENT

- Plans and specifications.
- Forms, diary, logs.
- 4-foot level, ruler, tape.
- Camera.
- Thermometers (surface type, air, probe type, heat gun).
- Safety equipment (hard hat, vest, boots, etc.).

CHARACTERISTICS OF A CONSTRUCTION INSPECTOR

- Honesty
- Stability
- Reliability
- Common sense
- Fairness
- Friendliness
- Good health

QUALIFICATIONS

- Mathematical skills.
- Ability to understand plans and specifications.
- Knowledge of materials and construction techniques.
- Ability to communicate orally and in writing.
- Knowledge of the difference between inspecting the work and supervising the work.
RUBBERIZED ASPHALT CONCRETE, WHAT IS IT?

Rubberized Asphalt Concrete (RAC) is a blend of crumb rubber from scrap tires or other high natural rubber sources, asphalt cement, and properly-graded, sound aggregates. RAC is produced in three ways:

- The Wet Process
- The Dry Process
- The Terminal Blend (Refinery) Process

The asphalt rubber binder, which makes up about eight percent of the mix by weight, consists of approximately 80 percent asphalt cement and 20 percent crumb rubber.

The Wet Process:

This is the process by which most of the RAC produced is manufactured. In the wet process, special equipment blends the crumb rubber modifier (CRIVI) in the proper proportions (20 percent CRIVI, 80 percent asphalt cement) with the hot asphalt cement. The mixture is then transferred to larger tanks and agitated in order to thoroughly blend the crumb rubber with the asphalt cement. After a 30-45 minute blending (reaction) period, the viscosity is checked. When the viscosity reaches the specified range, the asphalt rubber binder is added to the aggregates.

The Dry Process:

In the dry process, the CRIVI is blended with the hot aggregates just before the hot asphalt cement is added. No special blending equipment is needed. The binder and aggregates are mixed for a slightly longer time than with conventional asphalt concrete to ensure that it is well blended and that all of the CRIVI particles are encapsulated by the asphalt cement.

The Refinery (Terminal Blend) Process:

In this process the CRIVI is completely digested into the asphalt cement at the refinery. This process uses about half the CRIVI as the wet or dry process. The advantage of this process is that the asphalt rubber binder can be shipped to a plant in the same manner as asphalt cement is delivered. No modifications or special equipment at the plant are needed.

Which process produces the best RAC pavement? The wet process has been proven over the last 30 years to perform better than conventional asphalt concrete. The dry process is being used extensively in Southern California with results very similar to the wet process. Inspectors report that the dry process RAC is easier to place and requires less sanding if traffic needs to be placed on the compacted mat before the mat reaches
150°F. The terminal blend process has been used in Texas for the last five years and also shows good results. The asphalt rubber binder in the terminal blend is about 5.5 percent versus 8.5 percent in the other processes. This results in a thinner film around each aggregate particle which may result in faster oxidation of the asphalt binder and less resistance to reflective cracking. The proponents of this process indicate that Superpave testing shows the pavement to be equal to the other processes. Time will tell.

**COMPOSITION OF RAC**

RAC (ARHM-GG-C, wet process; CRUMAC-GG, dry process; TMAC, terminal blend process), consists of a gap graded aggregate, a crumb rubber modifier (CRM), and an AR 4000 asphalt cement.

The CRM makes up about 20 percent of the total asphalt rubber binder (10 percent in TMAC). The asphalt rubber binder is 7.5 percent to 8.7 percent of the total mixture (5.0 percent to 6.0 percent in TMAC). About 30 pounds of CRM is contained in a ton (2,000 pounds) of RAC. The CRM can consist wholly of crumb rubber from scrap tires or 75 percent from scrap tires and 25 percent from other sources with a high natural rubber content.

**MIX DESIGNS AND CERTIFICATIONS**

In RAC, the mixture of aggregates, CRM, and asphalt cement must be blended in precise proportions. The relative proportions of these materials determines the physical properties of the mix and how the mix will perform as a pavement. Of the two methods for determining the best proportions, the Marshall Method and the Hveem Method, the Hveem Method is generally preferred. Specifications generally require the contractor to submit a mix design for approval at least 15 working days before paving commences. Mix designs must use the same materials that will be used in the actual paving. If a different aggregate or asphalt cement is used, the mix design will not be applicable.

In general, mix designs determine the optimum amount of asphalt rubber binder to be used with a particular aggregate. The design focuses on four characteristics of the mixture and the influence these characteristics are likely to have on mix behavior. The four characteristics are:

- **Density:** A dense mix will last longer and provide better performance than a loose mix. The laboratory density is used as a benchmark for the field density. The required field density is 95 percent of the lab density.

- **Air Voids:** Air voids or small pockets of air between the coated aggregate particles are necessary in the mix to allow for movement of the binder as the mix is compacted under the wheel loads. The optimum amount of air voids in the compacted mix is between three percent and five percent. Too few air voids will result in the asphalt cement bleeding to the surface
creating slick pavement. Too many air voids will create excessive permeability and reduced durability as water tends to strip the binder from the aggregates. Density and air voids are directly related. The higher the density, the lower the air voids, and vice versa.

- **Voids In Mineral Aggregate (VMA):** VMA represents the total space in the aggregate that is available to accommodate the asphalt rubber binder. Based on the fact that the thicker the film of binder around each aggregate particle the more durable the mix will be, a minimum VMA is specified. Specifications generally require 18 percent VMA.

- **Asphalt Rubber Content:** The optimum asphalt rubber content depends on the aggregate gradation and the absorptiveness of the aggregate. A coarse aggregate with less surface area requires less binder to coat the particles than a dense mix with more surface area. The gap graded aggregate used in RAC requires less binder to coat each particle but also allows additional binder to provide a thicker film around the aggregate particles. This increases the life of the pavement by providing more resistance to oxidation and more flexibility to resist reflective cracking for a longer period of time.

**PROPERTIES CONSIDERED IN MIX DESIGN**

RAC pavements function well because they are designed, produced, and placed in such a way as to give them certain desirable properties. The inspector should be aware of what each of the properties is, how it is evaluated, and what it means in terms of pavement performance.

- **Stability:** Stability in a RAC pavement is its ability to resist shoving and ruffing under traffic loads. Stability standards should be designed for the type of traffic. High stability design produces a pavement that is too stiff and therefore less durable. Low stability results in ruts, ripples, and other signs of movement. Stability is the result of friction between the aggregate particles and the cohesion provided by the asphalt rubber binder. Lowered stability is caused by excessive binder, excessive medium sand, or excessive rounded aggregates.

- **Durability:** Durability is the ability to resist changes in the asphalt such as polymerization or oxidation, disintegration of the aggregate, and stripping of the asphalt rubber binder from the aggregate. Durability is enhanced by providing the maximum amount of binder and by compacting the mixture to reduce the air voids to between three percent and five percent. Poor durability is the result of too little binder, improper compaction, or water susceptible aggregates.
• **Impermeability**: Impermeability is the resistance of a RAC pavement to allow water to pass through. A gap graded RAC pavement is more permeable than a dense graded pavement mix. However, the additional binder in the gap graded mix compensates for the stripping effect of a permeable mix and provides a highly skid resistance surface that seems to absorb rainwater without the splash effect of a conventional dense graded mix.

• **Workability**: Workability is the ease with which a paving mixture can be placed and compacted. The workability of a RAC mix is somewhat less than a conventional mix and requires special considerations during construction. First, RAC cannot be easily raked. Therefore, it is necessary that the screed height be set so that the compacted mat is even with the adjacent pavement. Second, the breakdown rolling must be completed before the mat reaches a temperature of 290°F. Two breakdown rollers are strongly suggested. RAC cannot be compacted at cooler temperatures as well as conventional asphalt concrete. Poor workability is the result of excess coarse aggregate, low temperatures, excess medium sand, or improper mineral filler content.

• **Flexibility**: Flexibility is the ability of a pavement to adjust to gradual settlements and movements without cracking. A gap graded or open graded mix is more flexible than a dense graded mix. This is one of the reasons RAC has a high resistance to reflective cracking.

• **Fatigue Resistance**: Fatigue resistance is the pavement’s resistance to repeated bending under wheel loads. Air voids and binder viscosity have a significant influence on fatigue resistance. Poor fatigue resistance is caused by low asphalt or asphalt rubber content, high air voids (mix design), inadequate compaction of the pavement, or inadequate pavement thickness. Recent studies have shown that a reduced thickness of RAC (one half) resists fatigue cracking 1.5 times longer than a full depth thickness of a dense graded conventional asphalt concrete. A minimum thickness of 1-1/2 inches of RAC is recommended.

• **Skid Resistance**: Skid resistance is the ability of a pavement surface to minimize skidding or slipping of vehicle tires by reducing the effects of hydroplaning. A gap graded RAC pavement has a high skid resistance value due to the open nature of the surface and its ability to resist bleeding or flushing. Poor skid resistance is caused by excess asphalt rubber binder (flushing), improperly graded aggregates, or soft aggregates resulting in polishing of the aggregate at the surface.
EQUIPMENT

Except for the blending unit required for the wet process, the equipment used to manufacture and construct RAC is the same as for conventional asphalt concrete. Rubber tire rollers are not allowed because the hot RAC tends to stick to the roller tires. A vibrating steel wheeled roller is required to ensure good compaction.

SURFACE PREPARATION

Surface preparation is virtually the same as for conventional asphalt concrete. All cracks greater than 1/4 inch should be filled and any badly deteriorated pavement should be removed and replaced with conventional asphalt concrete before the RAC is placed. These issues are generally considered during the design of the project. With RAC, lightly alligatored pavement may not need to be removed and replaced.

The existing surface must be clean and a tack coat applied before the RAC is placed. Placing RAC (or conventional AC) over a dirty street will result in slippage.

RAC is difficult to feather due to the sticky nature of the binder and the lack of fines in the aggregate. Therefore, it is necessary that all transverse and longitudinal joins be milled prior to placing the RAC. A milling item is generally placed in the bid by the designers. If a contract does not have a milling item or it is not covered in other ways, a change order should be written.

INSPECTION AT THE PLANT:

To be effective, the inspector must have a basic knowledge of how the two types of asphalt plants, the batch plant and the drum dryer plant, work. The inspector must also be aware of the proper procedures for handling, storing, and sampling aggregates; the operation of the cold aggregate feed system; and the basic sampling and testing procedures for checking hot mix characteristics.

At the plant, aggregates are blended into the proper gradation, heated, dried, and mixed with an asphalt rubber binder to produce RAC. The primary function of the plant inspector is to observe plant operation, take tests and samples, and verify that the mix produced is in accordance with the specifications. The inspector should NEVER assume responsibility for adjusting plant controls or setting any dials, gauges, or meters. That responsibility belongs solely to the plant superintendent. The inspector should be aware of all that is going on in order to bring any detected potential problems to the attention of the plant supervisor quickly.

A listing of various duties of the plant inspector is shown on Page 9 of the Field Guide.
STORAGE AND HANDLING

Aggregates are generally stored in bins or bunkers equipped with a bottom weighing device and a dump mechanism which drops the correct amount of a certain sized aggregate onto a cold feed belt.

In a drum dryer plant, the rate at which aggregates from each bin are dropped onto the belt is controlled by computer to achieve the proper aggregate gradation. It is very important that the inspector check that the proper sized aggregates are in each bin. If a fine aggregate is inadvertently placed in the coarse aggregate bin, the computer will consider it a coarse aggregate and the mix will be out of specification. A visual check of the bins and regular sieve analysis from samples off of the belt will verify that the gradations are correct.

In a batch plant, the heated aggregates are screened into three or four bins of different sized aggregates. A specified amount of aggregates from each bin is then dropped into the pugmill and asphalt rubber binder is added and mixed to produce RAC. The inspector should check to see that screens are in good shape, the scales are certified, and aggregates are not being spilled over into an adjacent bin.

STORAGE AND HANDLING OF THE ASPHALT AND CRUMB RUBBER

**Wet Process:** In the wet process, the crumb rubber is generally delivered to the plant in 2,000 pound bags. The bags are emptied into a high shear mixer and added to the hot asphalt cement in 500 gallon increments. The hot asphalt rubber binder is then transferred to interim storage tanks where it is agitated and heated for 30 to 45 minutes before being added to the properly graded, heated, and dried aggregates.

**Dry Process:** In the dry process, the crumb rubber from the high shear mixer is added to the aggregate about ten seconds before the hot asphalt cement (AR 4000) is added. Specialized blending equipment is not required in the process.

**Terminal Blend Process:** In the terminal blend process, the crumb rubber is digested into the asphalt cement at the refinery and delivered to the plant in the same manner as asphalt cement without rubber. No modifications to the plant are required in this process.

**SAMPLING AND TESTING ASPHALT RUBBER BINDER**

Crumb rubber and asphalt cement samples should be taken on a regular basis (at least one sample of each per day). Sampling must be done properly to ensure that the samples are representative of the entire batch.
Asphalt cement samples are taken from the sampling valve on the tank. Allow at least one quart of liquid to run out before placing the asphalt cement into a clean, dry sample container. Seal and label filled containers carefully. Follow recommended safety procedures while sampling the hot liquid.

Crumb rubber samples should be taken from the middle of the bag. Do not sample from the top. The finer particles of the rubber tend to float to the surface during transport. A sample from the top of the bag will not show a representative gradation.

The viscosity of the asphalt rubber binder should be taken frequently to ensure that the mixture has had sufficient time to "react" (wet process only). The viscosity will rise, peak, and then fall as the binder is agitated in the interim storage tanks. The proper viscosity should be obtained just after it starts to decrease. Check the specifications for the proper viscosity values.

**INSPECTION AND SAMPLING OF THE HOT MIX**

The temperature of the RAC is very critical. RAC needs to be placed and compacted at a higher temperature than conventional AC; therefore, the temperatures at the plant must be watched carefully. A visual inspection can often determine whether the temperature of the mix is within specifications. Blue smoke is an indication of overheating. A sluggish appearance as it is dumped into the truck may be an indication that the temperature is too low.

The inspector should take measurements with a thermometer. The stem of the thermometer should be stuck into the mix at least six inches and the material must be in direct contact with the stem to get a good reading. A gun-type thermal meter can also be used, but it should be directed at the stream of RAC as it leaves the discharge chute rather than in the truck. The temperature at the surface may not be an accurate indication of the temperature within the mix.

Samples of the RAC should be taken to the laboratory for testing for aggregate gradation and binder content. These samples will be invaluable if a problem such as bleeding, instability, or raveling occur on the job.

**INSPECTION RECORDS**

The inspectors written records furnish the basis upon which the material's compliance with the specifications is determined. To be valid, records and reports must be completed at the time of a test or measurement and must be kept up to date.

Good records may mean the difference between the contractor paying to remedy a problem or the agency paying for it. If your agency does not have record forms, the inspector should keep a job diary. The diary should show the inspectors name, the
date, the job name and number, the type of mix, the location of the plant, a narration of the days activities including test results, and any unusual occurrences. Accuracy and consistency are extremely important in record keeping. Report only the facts, not assumptions or hearsay.

SAFETY

The inspector must always be safety conscious and on alert for potential dangers to personnel and property. Dust, noise, moving belts, moving equipment, and high temperatures of the material can lead to safety problems. If you see a potential problem notify the plant supervisor immediately.

INSPECTION AT THE JOB SITE

The efforts and skills of the job site inspector can mean the difference between a well-compacted, durable, smooth-riding pavement and a rough, unsound pavement that irritates drivers as they ride over it. Some examples of nice things we hear after a good RAC job are "boy, this pavement looks good", or "this really rides nice", or "it's so quiet". These comments are worth the effort. For an inspector, there is nothing worse than a bad job. Even though the contractor did the job, everyone including the inspector, gets the blame.

It is always a good idea to hold a job conference with the paving contractor before the job starts. At this conference, the details of the plans and specifications should be reviewed. It is especially important to note the differences between paving with RAC and paving with conventional AC.

TEMPERATURE! TEMPERATURE! TEMPERATURE!

RAC is extremely temperature sensitive. This does not mean that it is more difficult to place. It only means that the temperature of the mix at the completion of the breakdown rolling must be at least 290°F. Most of the compaction is achieved during breakdown rolling. Make sure that the contractor understands this. Two breakdown rollers should always be used. This is good insurance at low cost. Other items such as scheduling, location of the plant, and traffic control should be discussed at this meeting.

PRIOR TO PAVING

Since RAC is generally used for resurfacing over existing pavement, emphasis will be on this type of project. Many of the ideas discussed also apply to new construction.

The existing surface must be properly prepared. Have all cracks over 1/4 inch been filled? Have the badly -deteriorated areas been removed and replaced? Is the street clean? Are the joins milled? Has the tack coat been properly applied?
Check the ambient and surface temperatures. Are they over 55°F and rising? Remember, RAC is temperature sensitive. A cold surface or a cold day will cause the mat to cool too quickly and 95 percent compaction may not be achieved.

Check the equipment. Is the paver in good working order? Is the automatic screed skid adjusted properly and in good working order? Flip the sensors while the paver is moving to see if the screed height changes.

Are the rollers in good working order and of the vibrating steel wheel type? Rubber tired rollers are not allowed on RAC jobs. **Note: An exception to this rule is rubberized asphalt chip seals.** There, rubber tired rollers are specified in order to roll the sand into the hot binder without crushing the rocks or bridging over rutted areas. The hot binder does not pick up on the tires because the tires are only in contact with the aggregates.

Verify that the method of delivery is appropriate for the job. Can bottom dumps be used or would end dumps be better suited for the job conditions (traffic, business access, temperature, etc.)? Potential problems resolved do not become problems later.

**PAVING**

Pavers are self-propelled machines designed to place the RAC mixture on the roadway to a specific depth and to provide initial compaction of the mat under the screed. The paver must be in good condition. Loose parts will result in a chattering pavement surface. The hopper, the slats on the feed conveyor, the flow gates, and the augers should be checked for excessive wear. The speed of the conveyor and the opening of the control gates at the back of the hopper should be adjusted so that sufficient material is delivered to the auger to keep the augers moving about 85 percent of the time. This will allow a uniform quantity of a mix to be maintained in front of the screed.

The screed unit has two major functions. It strikes off the mix to the set grade and thickness and provides a degree of initial compaction of the mix. If the screed can be extended to lay a wider mat, the extension should have a tamper bar.

Specifications require automatic screed controls. A 30-foot skid is attached to the paver to maintain a relatively constant thickness of mat while compensating for surface irregularities. The use of a properly adjusted skid results in a smooth finished surface.

Trucks should back up to the paver carefully and let the paver push the truck forward without losing contact with the paver. This prevents RAC from spilling onto the street ahead of the paver. If RAC is spilled, it should be shoveled back into the hopper before the paver continues. End dump trucks work best with RAC because they dump the mix directly into the hopper without losing much heat. Bottom dump trucks can be used in hot weather if the windrows are kept close to the paver. Remember, temperature is critical to a good RAC project.
As the trucks deliver the mix, look for the following signs which reflect potential problems: blue smoke indicating an overheated mix; a stiff appearance indicating a cool mix, a slumped mix indicating excessive asphalt rubber binder or moisture, a lean, dull appearance indicating too little asphalt rubber binder, or rising steam indicating excessive moisture.

The temperature of the RAC as it is placed into the hopper should be checked regularly.

The inspector should collect load tickets on a regular basis to ensure that the correct mix is being delivered to the job. Yield calculations will determine whether the proper thickness is being placed. Conventional asphalt concrete weighs about 12 pounds per square foot per inch of thickness. RAC is about 5 percent lighter due to the gap graded aggregate and the crumb rubber.

The paver should be operated at a speed consistent with the delivery of material in order to minimize stopping and starting. When the paver sits for too long, the mix under the screed cools. When the paver starts again the cooled RAC tends to hold the paver causing it to jerk as it breaks free.

When a lane is ended, the contractor should construct a bulkhead transverse joint or a papered transverse joint. In either case, the idea is to provide a compacted vertical joint to begin the lane the next day.

Longitudinal joints in a resurfacing operation are generally cold joints. To ensure a good bond, the joint should be tacked prior to paving the adjacent lane. The screed should overlap the previously paved mat slightly and should be set at the exact height above the mat to allow for compaction. RAC cannot be easily raked so the screed setting is critical.

**COMPACTION**

Compaction is the process of compressing a given volume of mix into a smaller volume. It is accomplished by pressing the asphalt rubber coated aggregate particles closer together by eliminating excess air voids.

Rolling is probably the most important operation in a RAC project. RAC that is not compacted to the proper density will not last as long as compacted RAC. Raveling will occur as the loose material is disturbed by rainwater and traffic.

Loosely compacted RAC allows an excessive amount of water to penetrate into the mix, stripping the binder from the aggregate. It also allows air into the mix which accelerates the oxidation process. Inadequately compacted pavement will tend to rut under wheel loads.

How do you make sure that compaction is achieved? To start with, compaction depends largely on temperature (as well as compaction effort). **RAC (or conventional**
AC) will not compact unless the temperature of the mix is high. The temperature is even more critical in RAC because the gap graded mix does not allow the aggregate particles to move within the mix under the roller as easily as a dense graded conventional AC. The contractor should make sure that the breakdown rolling is completed before the mat cools to 290°F. The inspector should take the temperature of the mat as it leaves the paver and after the breakdown rolling is completed. If the contractor is not rolling fast enough or the temperature of the mat behind the paver is too low, the operation should be stopped until the problem can be corrected. It is easier to correct a problem during the operation than it is to correct it after the contractor finishes paving.

The thickness of the lift, the surface temperature, and the ambient temperature will have an effect on the compaction. **TEMPERATURE IS THE KEY.** Thin lifts cool faster and cool surfaces and low ambient temperatures cause the mix to cool more quickly.

A thin-lift nuclear gauge can be used to verify the density of the compacted mat; however, cores should also be taken randomly to check the accuracy of the gauge.

The inspector should verify that the roller operator always has the drive wheel forward. An exception to this is on steep grades where it may be best to have the drive wheel in back to take advantage of the increased weight on the back wheel to eliminate spinning. Rolling with the drive wheel forward tends to tuck the mix under the wheel as it moves rather than pushing the hot mix forward in front of the wheel. The drive wheel is also larger than the tiller wheel and presses with a flatter contact surface on the mix.

Breakdown rolling must be completed before the mat cools to below 290°F. Two breakdown rollers are strongly recommended.

Rolling should be done in the following manner:

1. Roll transverse joints.
2. Roll longitudinal joints.
3. Breakdown rolling, beginning on the low side and progressing toward the high side.
4. Intermediate rolling, following the same procedure as in breakdown rolling.
5. Finish rolling.

When rolling transverse joints, only about six inches of the roller wheel should be on the uncompacted mat. When rolling longitudinal joints with a vibratory roller, only about six inches of the drums should be on the adjacent, compacted mat.
ACCEPTANCE OF THE WORK

The quality of the finished pavement depends on all of the factors we have just mentioned. Each step in the process is important. Before a project is accepted, the inspector should verify that the surface texture and smoothness of the pavement is of acceptable quality and that the proper density of the RAC has been achieved. Any imperfections such as surface scarring, bleeding, or raveling should be evaluated and corrected if necessary.

CONCLUSION

Remember, quality construction can only be obtained through quality inspection -- you are the key.
b) Acceptance Testing
Acceptance Testing

Asphalt concrete shall be compacted between a minimum of 92 percent and a maximum of 97 percent of Maximum Theoretical Density as determined by the American Society of Testing Materials (ASTM) D-2041.

It has been recognized that improper compaction (or void content) is the most significant factor affecting mix performance. An increase in void content leads to a decrease in modules, fatigue life, and resistance to permanent deformation. These reduced factors equate to a great reduction in pavement life. A decrease in void content beyond an optimum range leads to flushing and reduced skid resistance. As such, all finished asphalt concrete pavements which do not conform to the specified relative compaction requirements will be paid for using the following pay factors:

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<thead>
<tr>
<th>In-Place Relative Compaction</th>
<th>Pay Factor</th>
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<tbody>
<tr>
<td>97.1 or higher (Over-asphalted mix)</td>
<td>90% Pay factor</td>
</tr>
<tr>
<td>92 - 97.0% (Ideal)</td>
<td>100% Pay factor</td>
</tr>
<tr>
<td>89 - 91.9% (Marginal air voids)</td>
<td>85% Pay factor</td>
</tr>
<tr>
<td>88.9% or less (Unacceptable air voids)</td>
<td>60% Pay factor</td>
</tr>
</tbody>
</table>

All materials testing necessary to determine conformance with the requirements specified in this section will be performed by the County without cost to the Contractor, with the exclusion of the bituminous distributor testing.

Pavement density will be determined by comparing the average density of cores taken from the compacted pavement to the density of Maximum Theoretical Density as determined by the American Society of Testing Materials (ASTM) D-2041.

(a) Lot Sizes: The pavement will be accepted for density on a lot basis. A lot will consist of 500 tons or portions thereof. Lot sizes shall be 250 tons in secondary test sections. (See “Test Section” of these Special Provisions).

(b) Laboratory Density: Bituminous mixture for laboratory-compacted specimens will be sampled on a lot basis per Section 39-3.04 of the State Standard Specifications. The lot size will be the same as indicated in paragraph (a). One sample shall be taken from each lot on a random basis. One laboratory-compacted specimen shall be prepared from each lot.

(c) Core Density: Cores for determining the density of the compacted pavement will be taken on a lot basis, a minimum of three cores per lot. The lot size shall be the same as indicated in paragraph (a). A minimum of three cores shall be taken from each lot on a random basis. The cores shall be taken in accordance with these
Special Provisions and as directed by the Engineers Representative. The density of each core shall be determined in accordance with ASTM D 2726-89.

Core samples for determination of the density of completed pavements shall be obtained by the Contractor at his own expense, and no additional compensation will be allowed therefor. The core samples shall be 4” in diameter. In order for the contractor to monitor their performance, it is recommended that the Contractor utilize a nuclear density gauge for preliminary testing. Dry ice may be used for cooling the pavement prior to coring. The number and locations of the samples will be as agreed upon in the field by the Engineer and the Contractor. Samples shall be neatly cut with a saw, core drill, or other approved equipment. The Contractor shall provide the core samples to the Engineer within two (2) hours after final compaction. The Engineer has the ability to provide compaction testing result within (2) hours of the final core sample taken from the field. Special arrangements must be made with the County Material Testing Laboratory if the contractor wishes test results within (2) hours for night paving or normal work performed late in the day.

The Engineer shall meet in the field with the Contractor and mutually agree on several locations for compaction testing for the given lot and tie them out to the sidewalk or side of the road. The actual test location will be randomly selected from the several agreed upon locations.

**Test Sections**

The first 1,500 tons of each asphalt concrete type to be placed for the project shall constitute a test section for the placement of asphalt concrete for the balance of the project. The location of the test section shall be decided by the Contractor, subject to approval by the Engineer. The equipment used in the test section construction shall be the same type and weight to be used for the balance of the project. Placement of the test section shall be in conformance with the State Standard Specifications, these Special Provisions and as directed by the Engineer, and no additional compensation will be allowed therefor.

The Contractor shall submit to the Engineer a written construction plan to be used for the project. This plan shall be based on the test sections for each asphalt type and shall include; sweeping and cleaning equipment, paving equipment and speed, breakdown and finish roller type, roller speed and number of passes required, amplitude and period of roller vibration (if used), and truck haul route, number of trucks and rate of material delivery. No paving will be allowed until the written construction plan is submitted.

The following matrix shall be used to determine the necessary procedures and secondary test sections needed if any lot in the test section falls out of the acceptable operating range specified.
<table>
<thead>
<tr>
<th>COMPACTION RESULTS</th>
<th>ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>97.1% and greater</td>
<td>Work shall not be continued. A mandatory meeting shall be held between the Contractor and the Engineer. The Contractor shall propose adjustments to his materials and/or procedures in order to meet required compaction, to the satisfaction of the Engineer. Paving may then resume, after the 24-hour mandatory waiting period, with a 750 ton maximum secondary test section.</td>
</tr>
<tr>
<td><strong>OR</strong></td>
<td></td>
</tr>
<tr>
<td>88% to 91.9%</td>
<td></td>
</tr>
<tr>
<td>87.9% and less</td>
<td>The Engineer shall stop the work. At the Contractor's expense, an independent engineering consultant acceptable to the Engineer shall be hired to analyze mix design, structural adequacy of existing road and overlay, placement and/or compaction methods, and test data. Working days shall cease for a maximum period of 10 calendar days while the engineering consultant is selected and the investigation perform. Paving may then resume by incorporating the recommended changes of the engineering consultant with a 750 ton maximum secondary test section.</td>
</tr>
</tbody>
</table>

No more than one secondary test section shall be allowed. If compaction results from the secondary test section do not fall within 92% to 97%, and at the sole discretion of the Engineer, all remaining paving work and any associated work (striping, shoulders, etc.) may be terminated per Section G5 -18 of the Standard Construction Specifications. Payment for work performed to this point shall be per Section 4-1.03B of the State Standard Specifications.