QUALITY CONTROL OF RECYCLED ASPHALT CONCRETE MIXTURES

Donald R. Gallagher, Gallagher Asphalt Corporation

This report addresses the numerous considerations a contractor must give to material quality and process quality control as they relate to the recycling of asphalt pavement. Suggested quality control procedures are described, beginning with the pre-bid evaluation of the asphalt pavement being considered for recycling. Also described are the quality parameters that influence this evaluation. Removal methods and the stockpiling techniques employed are discussed as well as the process control which occurs when the recycling is done. Differences between actual and anticipated field conditions are mentioned throughout the report. Considerable emphasis is placed on the inadequacy of the present standard testing methods and procedures when used for process control of recycled asphalt. The serious shortage of qualified technicians needed to fill the positions recycling has created for them is also discussed.

Gallagher Asphalt Corporation has been in the asphalt recycling business since April, 1977 with the first pile of salvaged mix, or as it's called now RAP. That means Reclaimed Asphalt Pavement. All the reasons for being in this business will be apparent after listening to three days of recycling talks.

Unfortunately, today too many people are too contented with the status quo. Far too many federal, state, county, city, and consulting engineers are contented with the way things have "always" been. Far, far too many brother and sister contractors fall into this category too. It's truly amazing how much foot dragging goes on in this business, but that's human nature. When the funds go flat, and the resources go flat, and the competition for work gets vicious, there'll be a great deal more interest in this "new idea" from both sides of the marketplace.

Today the most beneficial thing to do is provide, or highlight, the challenges, and the opportunities that face the pioneers in this hot recycling game with emphasis on quality control in project selection. The following statements are practical and realistic insofar as hot mix recycling is concerned.

1. There must be a true economic benefit to both buyer and seller.
2. There must not be any significant reduction in performance in the finished pavement.
3. There must be a means and a method to control the finished product that will provide quality assurance to the buyer and product confidence to the seller.

Of these three points, economics and performance will be thoroughly treated at this Seminar. Quality control probably will not get the emphasis it deserves because today it offers many more problems than it does solutions. There is much to be done by industry and technologists in the area of quality control of recycled mix. The approach in this paper will be to look at things as they are for Gallagher Asphalt today, and also as they will become when recycling finally is a fully accepted practice and is generally permitted for all types of bituminous work. This is in contrast to the way most recycling has been done to date--a few large, carefully selected jobs involving both the removal of old pavement and its re-use on a specified project.

Most of the recycling in the future will be done as a contractor option on all types of work and the salvaged asphalt used will not have been earmarked for such use in advance. It will come from accumulated piles of RAP hauled in from prior asphalt removal jobs and stored in the contractor's yard for later use on some, as yet unknown, job. Much of the quality control, or rather quality assessment, is done (or should be done) long before there is an actual recycling.

Assessments of the Existing Pavement Quality

As stated in the beginning, there must be an economic benefit to both buyer and seller and an economic evaluation is always the first thing to be done. Along with, and a vital part of the economic assessment, is a quality evaluation. The old adage "you can't make a silk purse out of a sow's ear" still applies. The potential, ultimate use of salvaged pavement must be decided before doing anything. Once this is determined, then economic criteria can be applied and a rational decision made to recycle or waste the reclaimed pavement.

How is this done? There is just one way--sample and test, sample and test. That's the name of the game. Contractors rarely do a thorough job of this and the reason most of the materials that have been salvaged to date for the most part were originally built under modern specifications, using the same raw materials used today. This is true in Gallagher Asphalt's case as their asphalt plants have been in Thornton for over 50 years. For many people this won't be the case. Then a more or less extensive sampling and testing program needs to be carried out.

It's worthy of mention here that sometimes the method of removal of the old pavement could make or break the possibility for future recycling. If the upper levels of the roadway are composed of high quality materials and the lower strata is inferior, for whatever reason, recycling potentials can't be evaluated without also deciding on the removal method.

It is of prime importance that this be considered by all those concerned with the project. At times an excavator ends up as low bidder on a pavement removal project and naturally figures the cheapest way to remove the pavement, never

considering the potential of re-use or re-sale of the RAP to an asphalt producer. Valuable material can be lost forever because it was contaminated in the removal process.

Perhaps a simple note in the bid proposal stating that a certain portion of the "to be removed" pavement has recycling potential would be all that is needed. This should alert the bidders to a potential cost benefit when figuring the work. It is not advocated as a bidding requirement that pavement be removed in a certain manner so that it can be recycled. Free market competition should prevail so that the taxpayer gets the best buy all around, with or without recycling. However, it might be a good reminder for a while to mention this potential in the bidding documents, since it is such a new concept to most people.

Assuming the contractor doesn't have any knowledge of how good or how bad pavement to be removed is, he must go out and sample it. This presents at least two problems.

1. The owner probably didn't allow enough lead time for the contractor to do much or any testing prior to bidding, and
2. The owner doesn't really want hordes of contractors punching holes all over the project before it's even let.

The only solution is for the owner to determine the quality of existing pavement and publish these data in the bid documents. Again, there are trade-offs to consider. Is the potential decrease in the bid price worth the cost to do the testing prior to issuing proposals? Each authority must make this judgment on the pavement removal projects under their jurisdiction.

Handling the Reclaimed Asphalt Pavement

Assuming the pre-bid testing has been done and the recycler has made a judgment in favor of retaining the salvaged material for future recycling, the second stage of quality control begins. If the material is removed in layers by means of planers, and some degree of job control is exercised to keep the surface material separate from the binder, etc., there is a good chance for some real high quality material that can be recycled at a high ratio in a surface mix. If, however, the job control and/or stockpiling techniques are poor, there could result a stockpile combination that is only good for base work due to the blending of gradations. It's important that everyone be fully aware of the intended uses of this salvaged material so that it is handled by the contractor's own forces as a raw material with real value.

For a lot of years, job foremen have sent this material to refuse dumps for disposal, and it's going to be some time before they are re-trained to realize that this is a valuable commodity whose quality must be maintained. To illustrate, there are continual problems with field people disposing of old planer teeth, lunch bags, beer and pop cans, two-by-fours, concrete curb, broken sewer castings, etc., etc., in the would-be reclaimed material.

When running a recycled mix through a batch plant, a broken sewer casting can sure shatter all dreams of profit when it hits the pugmill. In more extreme cases, state forces cleaning up the shoulders, ditches, and catch basins ahead of the milling or planing operations have deposited this trash in front of the planer to save time. Even the situation where the street sweeper subcontractor dumps the sweeper in front of the milling machine to save trip time to the dump has occurred.

Once the material is loaded and brought to the plant site, there is the potential for a lot of triage. It must then be decided what gets dumped where. This is a problem now, but in the future it's going to get a lot worse. If it's known what is in those truckloads of salvage mix, that's a big edge on the problem. If the material quality is unknown at this time, it can be a serious problem. Generally speaking, the contractor should try to keep piles separated by mix type--base, binder, and surface but also have a GOK pile. Translated, that means God Only Knows.

It's fortunate to have predictable sources of RAP so that gradation, asphalt content, and aggregate quality are quite consistent for each type of mixture stockpiled. Twice blessed are those who have a good bit of stockpile space at the plant, and can afford the luxury of numerous, separate piles. Contractors not situated to handle this inventory problem are at a disadvantage to stockpile RAP and speculate on future uses for it.

It isn't necessary to do a great deal of testing prior to stockpiling if the quality and uniformity of the RAP are pretty well known before it's ever tested. Most contractors simply don't have enough skilled manpower to perform much testing; and the testing, to be very helpful, would need to yield fast answers so that decisions as to where the material should be piled could be made promptly. No existing test procedures are that "quick".

Recycled Mix Quality Control

Asphalt Content

This leads to the next problem level of quality control--how to maintain on-going mix quality control? Given a shortage of capable technicians, time, and testing methods, it is very difficult. Any experience with any of the popular extraction testing techniques will show that none of them are very fast and all are of questionable accuracy and reproducibility, especially when using different technicians and test methods. On top of this is the fact that extractions of RAP require considerably more time to complete than does a conventional mix extraction--moisture, hard asphalt and generally higher 200 mesh material add hours to the time needed to complete these tests. Under preset methods one can expect to get two RAP extractions maximum a day--usually only one per technician. The present state-of-the-art in mix extractions is the major impediment in good quality control of RAP.

To illustrate this with some figures, an Illinois DOT materials man using the Colorado vacuum extraction--the fastest method available--takes 3 to 3½ hours to wash the reclaimed aggregate sample clean and uses 2 to 3 times as much solvent as normally would be used on a virgin mix extraction test. It takes from 2½ to 3½ hours just to dry the sample to a constant weight. The Illinois DOT central lab tried it in a reflux extractor and it took 2 days to complete one test. This is not an acceptable length of time for RAP testing.

The asphalt industry deperately needs a better and faster method of determining the asphalt content and gradation of mixtures. The three popular extraction methods--reflux, centrifuge, and Colorado vacuum--are not good enough today. These methods require too much "operator technique" and too much time. This is not only true of RAP, but also the regular or conventional virgin mixtures. Someone out there must come up with a better mousetrap.

Generally stockpiling RAP occurs before it's known where, when, or even if it will be used, so it's usually stockpiled on the South 40. When a job comes along and the RAP material that can be used in conjunction with virgin aggregates and asphalt to turn out an acceptable mix is available in the back lot, this stockpiled material is moved into a "working pile" close to the plant. This pile must be tested once or twice each day and, if necessary, the mix adjusted. Gallagher Asphalt uses a running average of the last three extractions as a "representative sample" (see Table 1). The State of Illinois DOT uses a running average of 10 extractions. Perhaps 10 are too many and 3 are not enough--this will, in time, be fine tuned and will probably end up with five extraction samples as being most "representative". Again it should be noted that faster testing would dramatically improve control.

RAP Percentage

One final way, and the best way today, to hedge uncertainty is to limit the percentage of reclaimed material used in the recycled mix. Illinois DOT permits a 50/50 proportion in batch plants, but at such a ratio temperature, gradation, and asphalt control become critical. To limit risk, it is a good idea to recycle at lower RAP percentates. Gallagher Asphalt typically recycles at 30% RAP, but frequently will use as little as 10%.

For the time being, the available supplies of RAP will be used up even at low recycle ratios, and by maintaining lower percentages there is a lot better chance of turning out a high quality product. The cost savings on a fixed available quantity are the same no matter how fast it's used, so the contractor should be conservative and recycle at low ratios. This does not mean to say that one must recycle at this low a percentage--it just seems more prudent to do so at this point in time. As RAP becomes more available, higher recycling ratios will be necessary in order to utilize the maximum benefits of the "new" material.

Gallagher Asphalt Test Program

The method of quality control used by Gallagher Asphalt is as described, that is to say, on pavement removal jobs where the company has been involved in the original construction and/or has gathered information concerning the material and mixture used in the original construction, assumptions are made as to the mixture grading and A/C content. If such information is not available, samples are taken on a random basis from the roadway, usually at 500 ± foot intervals per lane. At least 10 samples per job are obtained. Based on extractions of these material samples the potential value of the RAP for recycling is evaluated.

Once the job has been awarded and removal has started, the plant dump location is selected based on what the initial assumptions and/or sample reports showed concerning gradation--if it's typical of binder that is in the stockpile now, the material is added to that pile; if it's surface, the same is true; and finally if it's base, it is added to the base pile. Generally speaking, if it's a conglomeration of binder and surface, or base, binder and surface, or just base, these materials are all mixed together in the base pile. These materials are then used only for base construction.

When the time arrives to use the material, it is moved from the stockpile area into the working pile. This is a relatively small pile of material located close to the plant. The in-process quality control routine then begins. This routine involves daily samples (usually one or two) of the working pile. Based on the average of the last three samples extracted from this working pile, adjustment is made of the gradation and/or asphalt content of the mixture.

So far this routine has worked satisfactorily, however, if reclaimed aggregate percentages greater than 30% were used, one would question the reliability of the meager extraction data gathered for this purpose. Naturally once the RAP material is combined with the virgin materials in the asphalt plant, on-going extractions of the completed mixture are conducted which are compared with the preliminary calculated mix proportions.

The Future of Recycling

So what's ahead and where is change needed? The industry is just beginning to grasp the potentials of recycling pavements. In the not too distant future, recycling will go on all the time on all types of work. The road planer or roto-mill has just begun to reshape thinking about roadway rehabilitation and maintenance. At this time, structural pavements made from recycled old pavements and surfaced with skid resistant wearing courses which themselves will be reclaimed and re-used as they become ineffective or "worn out" seems a reasonable projection.

There is economic pressure for more and more use or re-use of materials such as the many types of slags, glass, fly ash, kiln dust, incinerator residue, etc. Though it's nice

Table 1. Percent A/C Contributed by RAP - Recycle (RAP) for Kingery BAM & Binder RAP

Tested By	Date 1980	Today's A/C Content of RAP	Avg. of Last 3	Residual A/C Contributed by RAP % RAM Added to Mixture 15	18	21	24	27	30
HLC	5/14	4.3							
HLC	5/15	4.9							
HLC	5/16	4.3	4.5	.7	.8	.9	1.1	1.2	1.4
GACO	5/16	4.9	4.7	.7	.8	1.0	1.1	1.3	1.4
HLC	5/17	4.4	4.5	.7	.8	.9	1.1	1.2	1.4
GACO	5/17	4.6	4.6	.7	.8	1.0	1.1	1.3	1.4
GACO	5/20	4.9	4.6	.7	.8	1.0	1.1	1.3	1.4
GACO	5/21	4.7	4.7	.7	.8	1.0	1.1	1.3	1.4
HLC	5/21	4.6	4.7	.7	.8	1.0	1.1	1.3	1.4
HLC	5/22	4.4	4.7	.7	.8	1.0	1.1	1.3	1.4
GACO	5/22	5.0	4.7	.7	.8	1.0	1.1	1.3	1.4
HLC	6/5	5.1	4.8	.7	.9	1.0	1.2	1.3	1.5
GACO	6/16	5.0	5.0	.6	.9	1.1	1.2	1.4	1.5
HLC	6/17	4.7	4.9	.7	.9	1.0	1.2	1.3	1.5
HLC	8/6	4.8	4.8	.7	.9	1.0	1.2	1.3	1.5
HLC	8/7	4.7	4.7	.8	.8	1.0	1.1	1.3	1.4

to think these things are being used for "patriotic" or some other high sounding reason, the truth is they're used because they have become economically feasible. Depletion and high energy costs have turned the tables on "the way we always done it". With this increased use of waste products and re-use of finished products, it is a totally new ball game.

Can industry, associated technical schools, colleges, and the school of hard knocks meet the demands of this new way of doing business? From the way things look right now, this industry just won't be tooled up in time. Most contractors are ill equipped to handle the varieties of materials and technology that will be needed to cope with these new problems. The availability of any skilled technician is horrible right now and tends to get worse rather than better as time goes on. The states and other public agencies are cutting their field and lab manpower at an ever increasing rate.

Consider this--back in the days when it was grounds for celebration when a plant produced 1,000 tons a day, there were several state people in the plant inspecting everything all the time. Now, when plants are capable of 6,000 tons per day on a routine basis, the state department of transportation has difficulty finding one plant inspector or proportioning engineer and he's so busy filling out forms he can't inspect anything anyway.

The only hope is to encourage the contractors to get into in-house quality control programs, convince the powers that be (that means politicians and bureaucrats) that the action that counts is in the field not in the piles of "documentation" they presently require, and immediately develop better and faster testing methods and equipment. Finally, and perhaps the most vital, encourage the trade schools, colleges, and universities to offer and promote more courses on quality control in this field of construction materials.