Charles McDonald Father of Asphalt Rubber

The late Charles McDonald was the father of asphalt-rubber pavement. It is important to remember Charlie and acknowledge his role because with the passage of time it is easy to forget how it all started. He developed the concepts that led to the asphalt-rubber pavement product that is used today. Charlie was assisted by Joe Cano who later carried on Charlie's work and it was Joe who designed the asphalt rubber gap-graded mix design now widely used for surface paving on major roadways, but that is getting ahead of my story.

Charles McDonald was an engineer with the federal highway system. He was from the old school. His time was largely before the freeway system that emerged in the late 1950s. He was very familiar with construction of asphalt pavements for two-way highways that pre-dated the freeways. Charlie was concerned about maintenance cost and the fact that pavement deterioration can be expensive to repair. Cracking of the pavement surface allows water to get into the sub-grade and that hastens deterioration, especially in areas where there is heavy traffic. He envisioned that if the cracks in the surface of the pavement could be effectively sealed, the life of the pavement could be prolonged many years with only minimal maintenance versus having to completely rebuild the roadway. The problem was that with conventional overlays and repair compounds, even if the cracks were sealed, they would open up in time. Those cracks would reflect through new overlays and the rapid deterioration would continue. Charlie envisioned an elastic substance that could allow some flexing without rupturing. And if it did rupture, had the ability to heal and maintain that water-tight surface. I don't know just when Charlie conceived the idea of mixing rubber with asphalt, but, in any case, Charlie retired from the federal highway system sometime around 1960 and came to Phoenix, Arizona. Charlie was a friend of the late Fred Glendenning. Fred was the City of Phoenix Public Works Director/Deputy City Manager in the 1960s through the mid-1970s. In the early 1960s, the City of Phoenix engineering function was growing from a small division of the Public Works Department to a standalone Engineering Department, and the materials testing activity was emerging from a small windowless room, where a couple of guys broke concrete cylinders with a hand operated hydraulic press and made soil proctors behind the file cabinet in the old Traffic Engineering office, to a fully functioning section of the Engineering Department with all of the test equipment and duties of a municipal engineering lab. Fred recruited Charles McDonald to come to Phoenix to run the material lab. Charlie wanted to continue his experiments with pavement repair compounds, primarily with the asphalt-rubber. Fred recognized that such experimenting could lead to improvements is pavement maintenance and related pavement life, which would be a substantial benefit to the city of Phoenix, so he agreed with Charlie's request. With that understanding, Charlie became Engineering Supervisor of the City of Phoenix Engineering Department, Materials Testing Lab sometime in the early 1960s.

I was working as an Engineering Technician in the 1960s. I had been going to night school pursuing an engineering degree. Having exhausted the night school program, I needed to transfer to a position where I could work a split shift and take the required day school classes. Working in a materials lab afforded that opportunity and in April 1967 Charles McDonald offered me a technician position in the

Lab. All of Charlie's testing and experimenting with pavement repair compounds required us to write up a report explaining the procedure, describing observed results, and drawing a conclusion. Charlie liked the way I wrote reports so, during the three year stint from 1967 until I got through school in 1970, I did virtually all of his experimental work, primarily with asphalt-rubber mixtures although there were other repair products we also tested. I remember one which involved a poly fabric of some sort supplied by Phillips Petroleum. We put down a bed of emulsion, laid the fabric over the cracked pavement, another layer of emulsion, and then chip seal. We monitored the results for several weeks, perhaps several months. Initially it seemed to work well, but eventually the cracks came through. There was also the use of latex rubber in an asphalt mix that was placed on a repaired street before I came into the lab; we were still observing this test section during my three year lab tenure and, as I recall, it was holding up well.

One concept that Charlie pursued at some length was the possibility of having an asphalt-rubber patch that could be placed over a pothole and it would seal the pothole area and prevent further deterioration. It would be much like patching an inner tube on a tire. We made a series of patches varying the asphalt-rubber content and aggregate mix therein and placing them at various locations around town and observing the results. In most cases, these hot asphalt rubber mixes were poured on a backing of release paper. We would put the patchface down on the street, leave the release paper in place, and let traffic wear it off over time. Those patches seemed to work fairly well, but Charlie knew no bounds as far as experimenting. He wanted every conceivable option tried. Once he told me to put the patch down and pull the release paper off as soon as I had wheel rolled the patch in place. I ask him to repeat the instructions because it was a hot day and I didn't think this was going to work too well, but he insisted that was the way we were to do it. I remember well what happened. We put the patch down, I wheel rolled it, pulled the release paper off, and pulled our vehicle out of the way. I think it was the second or third car through that the patch wrapped itself around the rear wheel. The car continued down the street with the asphalt-rubber patch flailing and breaking loose and the driver with a bewildered look on his face. I also remember the timely words of my companion technician who said "Let's get out of here." It was good advice and I took it without further questions or delay.

In doing Charlie's testing, if something did not appear to be working I was never allowed to say at the conclusion of a test that"this does not appear to be a viable application or viable process" I would have to change my conclusion to read something like "further testing required." Charlie wanted an accurate description of the process and the procedures that we followed in developing the test item, but he wanted nothing negative in the conclusion – perhaps with good reason, because with some of the early testing and application there was reason to believe this asphalt-rubber thing was not going to work and we should go do something else for a living.

I remember the first attempt to use the hot asphalt-rubber for chip seal. At that time we didn't have the proper equipment to do this. Later on Saguaro Asphalt developed a truck with an internal pug mill for mixing the asphalt and rubber, but for this particular application we had a conveyor belt running up to the top of the truck. We had the hot asphalt in the truck tank, two laborers would break bags of crumb rubber and put them on the conveyor belt, which would dump the rubber into the hot asphalt tank; two other laborers stood on top of the truck with pneumatic drills with long shaft propellers, mixing the

rubber with the asphalt. This procedure took at least a couple of hours to get the truck ready to distribute the mix. When we tried to spray it, it came out in windrows. It was awful. I don't know how they got that mix out of the truck. After that I did some experimenting for Charlie to show him what happened when you mix rubber crumb with hot asphalt. Initially you got a substantial change in volume, perhaps on the order of 200% increase, but the volume curve decayed very rapidly and within 30 minutes you were fast approaching the original volume. Initially the low velocity resulting from the volume increase would have made it easy to spread the mixture, but as the volume decay progressed, the material became more jelly like, the viscosity greatly increased and it simply became unworkable. Charlie's initial solution, as I recall, was to add kerosene to the mix to lengthen the decay time. Also, somewhere about that time frame, in the late 1960s, Charlie linked up with an individual supplier who was providing crumb rubber. The rubber was from old tires and, with the assistance of a professional photographer that the rubber supplier brought with him, they filmed some of these early attempts at placing asphalt-rubber. (There is one short clip of me placing down an asphalt-rubber patch over a pothole in the street and then driving away). The film must be in the archives somewhere. It would be a good history lesson for those interested in asphalt-rubber development to go back and look at that film and view some of the applications that were being tried at that time.

In 1969, James Attebery was appointed city engineer. Jim had previously served as Deputy City Engineer and was the Assistant Public Works Director at the time of his appointment. He had worked closely with Fred Glendenning and shared Fred's vision of encouraging efficiency and innovation in design and construction as related to city projects and city growth. His appointment assured continued work not only on asphalt rubber pavement development but also on other materials evaluation and design. (This encouragement to continue research and cost effective design resulted in the City of Phoenix receiving the prestigious PTI {Productivity, Technology, and Innovation } Award . Given to the city in 1989 the year following Jim Attebery's retirement, it was the result of several years' work done by the city engineering materials section in conjunction with ASU to develop an improved, more cost effective, pavement design).

I graduated from school and left the lab in June 1970. Shortly after I left, Russ Schnormeier joined Charlie. Russ, like Charlie, was a PE. He was very interested in paving materials and together the two of them continued to develop the asphalt-rubber product focusing, as I recall, primarily on chip seal. By the mid-1970s, they had perfected the asphalt-rubber chip seal applications. I used to have a pavement core on my desk that was taken from the intersection of Third Street and Indian School Road. It clearly showed a crack through the underlying pavement and above that an asphalt-rubber chip seal, followed by subsequent layers of conventional chip seal. The pavement had been in service for a number of years. The crack from the original pavement did not come through the asphalt-rubber. Clear evidence that Charlie's concepts were good and, that the product was a very viable maintenance tool for extending the life of pavements at a nominal cost. Another application for asphalt-rubber chip seal was what was called a "Sami." The Sami was used in new pavement construction and was placed like a sandwich between the lifts of dense graded asphalt mix. One street that was reconstructed by this method was Indian School Road between 19th Avenue and I-17. That roadway was rebuilt about 1986. I believe that road is still holding up well with no visible signs of pavement deterioration.

Unfortunately, chip seal in all forms became a political liability in the City of Phoenix. By the late 1980s, the City Council voted unanimously to forbid its use within the City of Phoenix. (Maricopa County still uses chip seal widely throughout the county. Many county roads in the rural areas consist of multiple layers of chip seal including, asphalt-rubber chip seals.)

The other asphalt rubber mix that evolved during this time, which is still in use today, is the gap-graded hot-mix surface course that is widely used by ADOT, MCDOT and valley cities as a finishing course on major streets and freeways. As I recall, we first used this on a major street in the City of Phoenix about 1989. The street was Seventh Street north of Northern. When the work was completed, an unexpected benefit was that traffic noise was much less. Several local citizens called in and asked what we had done. They were so happy with the work because they noticed that the traffic noise was greatly muffled. This was an unanticipated benefit, but one that everyone involved gladly accepted.

Russ Schnormeier and Joe Cano worked closely with Charlie McDonald. In fact, Joe began his career as a technician and did some of the very early testing work for Charlie. Later, Joe accepted a supervisory position within the lab. He, like me, went to school part time and received his engineering degree in due course. He got his P.E. and continued to work with Russ Schnormeier following Charlie's retirement. Both Russ and Joe developed considerable expertise with asphalt-rubber mixes. It was Joe Cano who designed the gap-graded surface course pavement now in wide use. Russ Schnomeier left the lab in the late 1980s to form his own consulting firm. Joe Cano then became the Engineering Supervisorof the lab, carrying on Charlie's work until his retirement in 1992. Following his retirement from the City, Joe worked for a private firm for a number of years that specialized in asphalt-rubber pavements. He is currently the Materials Engineer for the Bureau of Indian Affairs, Western Region.

Charles McDonald passed away a number of years ago. Sometimes when I'm driving on a local surface street or freeway and I see a surface pavement operation going on that I recognize as asphalt-rubber overlay, I think of Charlie, the vision he had and the work he did. He would be proud to see how things turned out. Undoubtedly, he would be right out there taking pictures of the process as the asphalt rubber pavement was being placed and he would have a pavement core on his desk – probably one that showed some form of deteriorated underlying pavement with a asphalt-rubber topping that provided that seal that he envisioned so long ago.

O.D. Park, P.E. October, 2011

{Note: Mr. Park worked for the City of Phoenix Engineering Department for 31 years, retiring as Deputy City Engineer in 1991. Following his retirement, he served 4 years as Construction and Operations Manager for the Flood Control District of Maricopa County, followed by 14 years with Parsons Brinckerhoff, Inc.

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