Asphalt Rubber and Smoothness – A Winning Combination
One Contractor’s Experience

Mark Belshe and Kevin Turner

FNF Construction, Inc.
115 S. 48th Street
Tempe, Arizona
85281
USA
mark@fnfinc.com
kturner@fnfinc.com

ABSTRACT: The production and placement of Asphalt-Rubber materials requires some extra attention to detail. The by-product of this extra effort is a smoother road. Routine construction practices for asphalt-rubber mixes provides the requirements for obtaining a smooth surface. This paper discusses some of the standard practices required for asphalt-rubber mixes and also discusses methods used to increase a contractor’s ability to place a smoother, long lasting asphalt pavement.

KEY WORDS: asphalt, rubber, smoothness, incentives, partnering, innovations.
1. Introduction

FNF Construction, Inc. was founded in 1984 in Phoenix, Arizona. With a marketing strategy focused on performing asphalt paving for the Arizona Department of Transportation (ADOT), FNF quickly grew to be the dominant contractor in the state in this area. Acquiring the most experienced and knowledgeable personnel available and maintaining equipment and tools that were state-of-the-art, the company realized that to be successful it must constantly innovate. A corporate philosophy and culture emerged where it was expected to be on the leading edge of new ideas and technologies.

Eventually the company acquired three portable hot-plants which, combined with some mixes purchased from outside sources, allowed the company to place 1.8 million tons (1.633 t) of hot-mix in 1999 alone. With 75% of the company’s business today centered around paving, FNF on any given day will have six lay-down crews placing mixes on roads and highways in as many as four different states.

2. Partnering Solves Problems

During the same period of time, the mid to late 1980’s, ADOT also was undergoing many management changes and finding new ways to approach old problems. By the early 1990’s ADOT had fully embraced the concept of partnering for the administration of all their construction contracts. Approaching the work with the realization that all parties to the contract have legitimate and, often common, interests, the atmosphere of partnering fostered a climate where new ideas were readily accepted and experimented. Nationally, ADOT became known as a leader not just in partnering but also other areas of innovation. The use of asphalt rubber, particularly after the expiration of related patents in 1992, was fully embraced by ADOT. Initially using asphalt rubber as the preferred binder for open-graded mixes as a surface course, ADOT eventually used the asphalt rubber with great success for structural effectiveness in gap-graded mixes. Developing its own criteria for mix designs and usage, ADOT grew its success slowly with time-tested, often empirical, data. Over the years ADOT’s approach has proven itself out. Today ADOT views its use of asphalt rubber as routine and asphalt rubber mixes are often requested by District Engineers to solve onerous problems.

3. Smoothness Requirements Develop

In the early 1990’s ADOT also began to working on solving, or at least improving, the age-old problem of constructing a smooth road [CAR 92]. Smoothness has become recognized as an important, if not the most important, issue with the ultimate customer of the road construction industry, the travelling public. In a survey conducted by the U.S. Department of Transportation for the National Quality Initiative, respondents identified surface quality as their number one priority for highways [FHA 99]. Further, research has shown that smoothness can pay big dividends in other areas besides a comfortable ride. At WesTrack, an accelerated pavement test facility in Northern Nevada, rough pavements were reconstructed.
Using before and after comparisons of data regarding fuel consumption with large trucks, a 4.5 percent saving in fuel was documented [EPP 99]. All of this is attributable to a smoother road.

Besides fuel consumption savings, the travelling public also saves in vehicle maintenance and repairs. According to The Road Information Program (TRIP) U.S. motorists are spending $23 billion on extra vehicle repairs due to rough roads every year. That translates into about $126 per each motorist annually [TRP 00]. Smoothness pays big dividends to all concerned.

The agencies constructing the roads also stand to reap direct benefits themselves from smooth roads. Because a smoother road means that truck tires don’t bounce on the pavement creating impact loads, there are fewer instances of pavement deformation and fatigue [GIL 98]. This translates into longer lasting roads and less expenditures for road maintenance. According to ERES Consultants Inc., “At least a 9 percent increase in life (could be shown) corresponding to a 25 percent increase in smoothness (in Hot Mix Asphalt pavements studied).” [NAP00] The importance, and benefits, of smoothness is receiving increasing national attention in the U.S. today and ADOT’s early work had thrust it forward as the national leader in implementing smoothness.

Through design, and perhaps some luck, ADOT by the mid-1990’s had assembled many of the essential elements to achieve smooth roads. A partnering atmosphere to problem solving, a motivated and attentive management team, a receptive contracting community and early experience with new tools and products, including asphalt rubber, set the stage for this nationally recognized success.

4. Asphalt Rubber Production

ADOT at this time had become FNF’s largest customer. FNF also fully embraced the use of asphalt rubber and subsequently entered the asphalt rubber industry as a producer in 1992 shortly after the expiration of patents. This market-driven demand eventually led the company to acquire 5 mobile blending plants. Each year the company produces between 40,000 and 60,000 liquid tons (36287 and 54431 t) of asphalt rubber binder. This is used in about 600,000 tons (544311 t) of asphalt rubber mixes, both open-graded and gap-graded. High production equipment, compatible with FNF’s hotplants, made this possible.

Prior to 1992 asphalt rubber binders using the wet-process, or the “McDonald” process, were produced by the patent holder or its franchised agents. The equipment was generally limited in production capacity and rates primarily because, until that time, the projects themselves were small in scope. Crumb rubber was often delivered to the projects in 50 lbs (23 kg) paper sacks, which were manually busted open by laborers. In keeping with its corporate philosophy of innovation FNF sought out new equipment and methods to automate the process while allowing for higher production rates. This would lead to lower costs and more competitive bidding. The company approached one of its reliable vendors of heat tanks, CEI of Albuquerque, New Mexico, and together the engineers of both companies designed new equipment that reduced the labor demand of the process while increasing its
Asphalt Rubber and Smoothness a Winning Combination

capacity. Concepts such as automated interlocks between the crumb rubber proportioning and blending and the use of 2,000 lbs (907 kg) super sacks for the crumb rubber were implemented.

While some sacrifices to mobility were made, the larger equipment that resulted from this effort served well as asphalt rubber in Arizona transitioned from experimental to routine use. Because quality and the lack of failures were so important to the continued use of the product, FNF sought out industry-knowledgeable individuals, particularly laboratory consultants that had experience with asphalt rubber. With the framework of a support structure in the Phoenix area due to the presence of the patent holder, FNF forged ahead as the first non-patent associated binder supplier.

Today a comprehensive support system through the Rubber Pavements Association facilitates any new entries into this industry. FNF’s experience with asphalt rubber, and the implementation of new equipment and methods, positioned it ideally to assist ADOT in its goal of building smoother roads.

5. Incentives

From its experience with partnering, ADOT knew it must stimulate the industry for smoother roads by creating a common goal with its contractors. Although penalties or disincentives had been used for years, approaching the problem only from the negative side did not release the innovative processes needed. By having only disincentives, minor defects in quality become accepted and tolerated as long as they don’t throw the project into penalty. Imagined risks, both by the owner and the contractor, can lead to unnecessarily higher bids. A divergence of interests between the owner and the contractor develops. There is no “incentive” to do better.

ADOT began its smoothness program by offering an incentive, a bonus, when a certain ride-score was achieved. [CAR 92] By emphasizing the positive, the incentive payment allowed the contractor to experiment and be rewarded when he was successful. There was money available for risk taking, and the private sector responded handsomely. New equipment and methods were developed to achieve smoothness and, just as importantly, contractors less committed to quality found they couldn’t compete. The bar for the entire industry was raised. As the bonus system matured contractors began speculating at bid time on future smoothness bonuses leading to lower bids. Eventually ADOT found that it was paying no more for smoother roads and that only contracting organizations fully committed to quality and smoothness were winning bids. In short the highest quality contractors succeeded through market competition and better, smoother roads were being built. FNF found itself emphasizing quality to its crews more and more each day.

FNF’s first ADOT project with smoothness incentives was constructed in 1994 on Interstate 10 near Tucson, Arizona. Seeking to get a longer, more spaced surface reading from its automated skis, which should help rideability, the company spent $18,000 in equipment modifications to construct a truss that spanned over the paver’s screed to reference the newly placed mat. The improvement in ride produced a ride-score that netted a $18,000 bonus. It was a breakeven proposition.
ADOT responded by introducing more available bonus in the specifications for future projects. FNF honed its techniques for producing smooth roads in response to the higher available bonuses.

6. Asphalt Rubber Practices Lead to Smoothness

Drawing from its experience in producing and placing asphalt rubber mixes, FNF realized there were many similarities to problem solving for laying smoother roads. Asphalt rubber mixes are more difficult to place due to the high viscosity binder. Having the mix at the right temperature, higher than a conventional mix, becomes a central theme. This leads experienced contractors to plan very effectively prior to firing up the hotplant. Heat management of the mix leads to considerations of matching plant production, trucking and laydown so that all facets of production achieve a complementary balance. Side issues of traffic control, mechanic availability for on-site breakdowns, and coordinated roto-milling all become elements in a successful asphalt rubber projects. The same issues are key to producing smoothness. As later projects were completed and the smoothness bonuses were calculated, FNF soon realized that the projects with the highest bonus, almost without exception, contained some mixes with asphalt rubber as the binder. The company began fine-tuning its techniques.

In analyzing where its successes and failures were regarding smoothness FNF concluded several things. Asphalt rubber mixes must be consistent, not just in mix properties, but in binder content and temperature to be smooth. Equilibrium and balance within the production and delivery system are words often heard. Haul routes and lengths, ambient temperatures, windy conditions and traffic delays all become heat management considerations. FNF concluded that trucking was much more important than many think. Good trailers with smooth sides are necessary. Build-up of material in the corners and “chunking” must be avoided. The time it takes properly clean out a truck is minimal compared to that cold material going through the paver and dragging behind, or worse under, the screed. Use of a proper release agent is important.

The paving spread is the most important part of achieving smoothness. FNF found using belly dump trucks and a pickup machine with an experienced dump man, traditional methods for paving highways in Arizona, served the goal of smoothness very well. Although a competitor in the state used a Shuttle Buggy in order to improve the ride-score, ADOT’s smoothest road to date is still with a dump man. Maintaining a consistent windrow of asphalt mix in front of the paver is important. It is imperative that the paver never stops. Keeping a smooth, even pace, the paver’s capacity to lay mix must be matched to the plant’s production and the trucking rate. Conventional wisdom in the industry is to dump loads as quickly as they arrive at the paver site. With asphalt rubber FNF had learned to keep a load or two always waiting in front of the paver for heat management reasons. This philosophy fit ideally into the efforts for achieving smoothness.
7. Innovations

FNF not only tried different techniques, but also different equipment. They became the leading testing contractor for Caterpillar Equipment. This partly was because of the great relationships established, but also because FNF’s year round paving schedule supplied the equipment company with continuous data.

New automatics and types of grade control were also tried. Sonar, and mat reference automatics were acceptable, but FNF found that common skis with the everyday automatics by Caterpillar or Blaw Knox worked well. Recognizing the importance of ski design and length, the company also mounted mat reference skis on both sides with an overall individual length of 40 feet (12.2 m). FNF mounted the controls close to or in front of the screed and concluded that it reacts best when it is closest to the screed.

Proper rolling, always an urgent concern in asphalt rubber mixes, is even more critical for smoothness. Temperature monitoring became critical as it became known that smoother roads and the accompanying rolling effort went hand in hand. FNF’s roller crews, with their asphalt rubber experience having honed their constant attention to detail, understood their part in having the final chance to provide a smooth road. Asphalt rubber also had a big affect on smoothness as its’ perceived ability to maintain temperature longer assisted in the compaction effort.

8. Smoother Roads Last Longer

Other entities also began to notice that there might be beneficial relationships with this “Smoothness Thing” [MCG 99]. The FHWA was aware of the great potential for longer lasting roads and was involved with the National Highway User Survey. Their results were a “focus on a quality roadway surface that would produce the greatest public satisfaction” [FHA 99]. This of course is the smoothness of the highway, listed as the number one wish of the public.

Next, the United States Department of Transportation commissioned racecar driver Richard Petty to appear in a video in conjunction with ADOTs’ smoothness program. This video was proactive and many years ahead of its time in recognizing the advantages of good rideability. It did however call attention to the relationship between ride bonuses, smoothness, quality contractors and the efforts involved. FNF’s techniques were prominently featured including a presentation on the video by one of its officers.

As FNF continued to perform more ADOT work than any other contractor, they also started generating more information as to rideability, bonuses, and how different crews and different equipment performed on these jobs.

At this time, much attention was given to how different structural sections on various specific projects performed. ADOT’s Road Rehabilitation Program included milling and filling a trench with Superpave type asphalt, an overlay with Superpave, and then an Asphalt-Rubber surface course. Sometimes the structural section would include an Asphalt Rubber overlay on the Superpave. Some designs
Asphalt Rubber and Smoothness

had conventional Asphaltic Concrete Friction Course as the driving surface. Many times multiple lifts of overlays were used. The realization that “leveling opportunities” greatly aided a smooth road was enhanced by using a final thin lift of Asphalt Rubber Asphaltic Concrete Friction Course. Much of the design information was based on empirical data from existing cracking, fatigue, or failures of the roadway surfaces.

After completion of each project, the different paving sections were measured for good rideability, and numerous contractors participated in the bidding process and project award through completion. Data gathered indicated one thing, the more structural sections that contained rubber, the better the overall rideability. The ultimate design for strength and longer life was 4” (10.16 cm) of Superpave in a trench (one lift) with an Asphaltic Concrete 2” (5.08 cm) overlay and finally an Asphalt Rubber Asphaltic Concrete Friction Course 3/4” (1.905 cm).

ADOT also at this time needed to try different mixes, binders and ideas. Research indicated success with other designs often mirroring the roads of Europe. These new products would help keep ADOT on the cutting edge of the newest technology. Test areas for ADOT included Asphalt Rubber, Stone Mastic, Fiber and different PG grades of oil. Again, different structural sections were designed, and diverse applications tried. Of the areas placed and tested, however, sections containing an Asphalt Rubber Asphaltic Concrete Friction Course, again, were smoother.

9. Summary

When asked why asphalt rubber mixes are smoother, the Paving Superintendents of FNF Construction supplied the following viewpoints. First, the in-house equipment utilized for the blending of the asphalt rubber into the binder product is controlled from the initial blends. The subsequent blends are consistent with regards to viscosity and ingredients. Binder temperatures are maintained equal, and proper cure times are important. Control and evenness are prominent.

Next, the hot plant produces the Asphalt Rubber Asphaltic Concrete at the same production rates hour after hour. Again proper temperatures are maintained and placement, rolling and finishing, as previously mentioned, receive additional care.

One could say that the above information might also apply to conventional mixes. Yet there are differences.

The original “gap graded” mix for the asphalt rubber has properties that need to be met for the addition of the rubber binder. [CAN 97] More care is taken in the crushing scenario to produce a consistent aggregate product and grading. The blending of the aggregates as far as design parameters is sometimes more challenging. Therefore more care must be taken in their production. The use of an asphalt rubber binder in a mix emphasises the care and consistency that must be present to be successful.

Because asphalt rubber is sometimes more difficult to work with, crews need to be at their best and this is understood from the beginning because of the type of mix.
that is being placed. Laydown machine techniques and placement are right from the start. Known processes and patterns are kept and remembered.

Finally, we know that this product performs better with cracking and checking. The asphalt rubber product has been observed to tend to iron itself out with traffic sometimes days later making a smoother road. The gap graded design and product is much like the difference between linoleum and a concrete floor. The surface of the road is more forgiving with the asphalt rubber mix.

The Federal Highway Administration Performance Plan for the President’s Fiscal Year 2001 Budget,” a companion piece to the FHWA FY 1998 Strategic Plan and the FY 2001 Budget Request, defines performance goals and the indicators used to measure progress to achieving long term strategic goals. [FHA 99] By linking these goals to the budget, objectives of the U.S. Department of Transportation can be measured and accomplished. One of their goals will be the implementation of a program to reward contractors who perform the best. This will be measured by how smooth of a pavement they can produce.

Additionally Asphalt Institute data on Life-Cycle Performance closely relates aging affects under environmental situations with not only the smoothness of the roads being monitored, but also the life span of the roads. [BOY 99] Asphalt Rubber improves and extends the serviceability of pavements that have alligator cracking and distressed areas with a good overlay and smooth application.

The enhanced durability of pavements due to smoothness has yet to be completely proven in the field since the early jobs have not reached their full design life. There will, however, be data available in the next 10 to 15 years that will most likely confirm this hypothesis.

In the initiation of the Rideability and Mays Meter/Profilometer studies by the FHWA, a single roadway has to stand as the “Smoothest Measured Road in the United States Interstate Highway System.” This road is located between Gila Bend and Yuma, Arizona on Interstate 8 and it is a product of an Asphalt Rubber Structural Section. This roadway was paved by FNF Construction. This is not a coincidence. Asphalt Rubber and Smoothness go hand in hand.
10. References


