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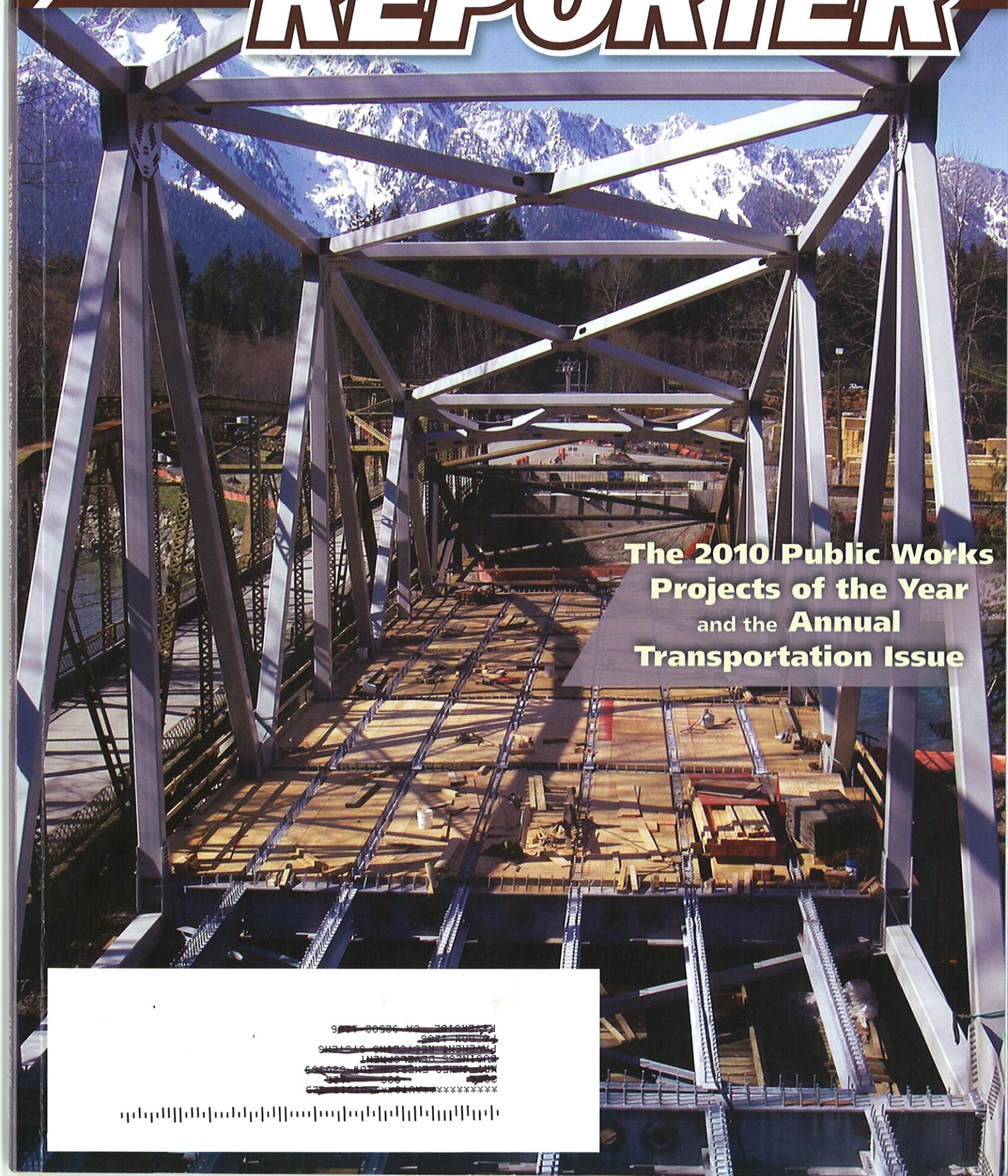

The 2010 Public Works Projects of the Year and the Annual Transportation Issue

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Lynnwood Olympic View Drive Road Improvement, Phases 1 & 2

Sustainable method that saved time, money and the environment

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After 10 years of planning and design, the City of Lynnwood, Washington, was ready to construct a two-phased road improvement project on Olympic View Drive located within the Cities of Lynnwood and Edmonds. What began as a typical road construction project had developed into a unique example of how the utilization of a sustainable method saved the City construction time and money while benefiting the environment.

The City of Lynnwood was looking for ways to save costs on this project in the short and long term. Prior to the beginning of construction, the entire construction team (including the City, designer, construction manager and contractor) investigated the full depth reclamation (FDR) method and determined it to be a viable option with numerous benefits.

This article explains, in more depth, the benefits and success the FDR method brought to the City of Lynnwood and how you can achieve the same results on your next transportation improvement project.

What is FDR?

Full depth reclamation (FDR) involves reconstructing asphalt pavement by recycling the existing roadway to create a new stabilized base. The process involves three steps:

- Pulverizing the existing asphalt, base materials and native soils
- Mixing it with cement and water
- Compacting to produce a strong and durable base for a new asphalt or concrete top surface

Since 1933, this method of combining common soils with cement has been tested and applied as a construction material suitable for paving roads. FDR has been experimented with other chemical and stabilization agents such as lime, fly ash, foam bitumen, and other cement-type additives. This article mainly discusses cement additives. Cement hardens faster than most additives and fulfills most project requirements of today's accelerated construction industry.

Western Washington's high moisture content reduces cement curing time with a little bit of drizzling providing a better condition to process FDR. Light moisture not only cures the mix better but also minimizes cement dust, thus keeping your project site neighbors happy.

Reclaimer processing FDR (photo: Harris & Associates)

Where is FDR not suitable?

FDR is appropriate for any pavement with suitable subsurface soils; therefore, it is critical to investigate the site to assure a suitable condition exists.

Many pavements have been in use exceeding their lifecycle to begin with. Many have been constructed years ago with minimum sub-base preparation. If native soil underlying the pavement has not been well prepared resulting in failure of the pavement section, an appropriate depth of the subsurface soils must be replaced with engineered fill prior to application of FDR. Asphalt pavement is a flexible material that easily reflects the movement of the underlying materials. Soils with high concentration of organic materials, high content of fine materials such as clay, and at or very close to surface underground water fluctuation are all conditions that no matter how good of a quality your FDR base is, it will deteriorate due to subsurface dramatic movements (upward and/or downward).

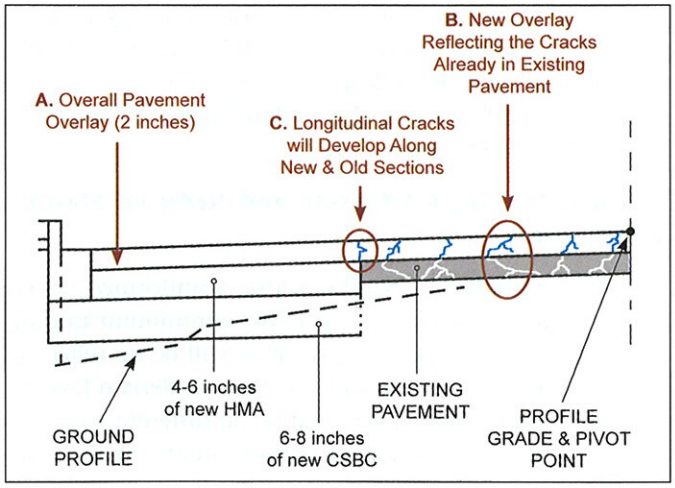
As the case for the City of Lynnwood, new roadway designs typically will include a geotechnical investigation during the preliminary design phase. Hence, no additional geotech-

nical investigation cost was required for FDR considerations. Olympic View Drive's geotechnical reports were available to review and explore the suitability of the material for FDR application.

Design trends

Many street widening projects today are designed to minimize the cost of replacement of the whole pavement structure. Consequently, the design teams leave the existing pavement in place and add new pavement in areas where the pavement is widened. Generally, a two-inch asphalt overlay is designed over the entire pavement (both old and new sections); *see "A" in road cross section below.*

Nevertheless, this design does not address the long-term maintenance cost due to reflective cracking. If the existing pavement section is in poor condition, which is the case for many old pavements, they already have developed cracks that will reflect through the new overlay, causing the new pavement to deteriorate quickly*); see "B" in road cross section below.* In addition, a two-inch overlay will experience longitudinal cracks along the entire pavement where new and old sections meet *(see "C" in road cross section below)* because the new overlay is supported on two different profiles (the old pavement and the newly built pavement section). These sections will move and settle differently, causing crack development along the joints.



Road cross section conventional method (image: Harris & Associates)

It is also encouraging to know that since new sections are designed with a thicker asphalt section (6-8 inches), applying FDR will reduce the asphalt to a thinner section. This by itself is a big cost savings.

Why FDR in Lynnwood?

Olympic View Drive was developed near a residential community surrounded by homes, schools, a park and a power substation with overall change in elevation across the site of 150 feet. 1.6 miles of road was reconstructed on this $9.8 million project to allow for:

- 14-foot-wide lanes to accommodate bicycle traffic
- 5-foot-wide sidewalks on both sides with ADA-compliant wheelchair ramps
- Enclosed drainage collection and conveyance system
- New stormwater detention/infiltration facility
- 15,600 feet of gravity/modular-block retaining walls
- 21,500 feet storm lines
- 11,400 tons of asphalt
- Improved illumination and crosswalks

The soils underlying the base course consisted of loose to medium dense sand with varying amounts of silt and fine gravel. Regional groundwater was encountered from 4-40 feet below surface. Loose sand was encountered in isolated and limited uncontrolled fill areas along the corridor. The project was designed without FDR considerations. For the purpose of FDR application, a review of the geotechnical reports found the native material highly suitable. The subsurface layer was stable with no major organic contents. In addition, the team determined that long-term subsurface settlement was minimal and would bear no future risk.

Pre-existing Condition of the Pavement Section. On Olympic View Drive, the existing pavement consisted of Hot Mix Asphalt (HMA) with varying thickness (2-7 inches) underlain by CSBC (3.5-10 inches) supported on native subgrade or fill material. Portions of the roadway were overlaid, in some locations several times. Thus, 12-inch FDR was considered for the project to assure localized thicker HMA layers are within the cross section being pulverized.

Lessons Learned: Design Documents. If you are thinking about applying FDR, consider including the following in the designer's scope of work (geotechnical subconsultant scope):

- Core the existing pavement at bore locations and document the thickness of the pavement and CSBC at each location
- Collect, identify and save the drilled material at the 12-inch top layer at these locations
- Ship samples to the owner for future laboratory use for FDR design

We learned that the benefit of collecting samples at the design stage is to:

- Minimize cost of re-sampling the top 12-inches
- Eliminate returning to an active roadway and core sampling the pavement
- Initiate FDR laboratory material testing ahead of the time to have answers when needed

On Olympic View Drive, the new design raised the grade between 6-12 inches along the corridor. This actually helped the project with the FDR process, since pulverizing the top layer results in surplus excavation due to fluff-factor. If the new design kept the road elevations exactly as they were originally, extra material would have been hauled off the site before the FDR process began. Our measurement on Olympic View Drive indicated that the fluff-factor on the combined material was approximately less than one-inch for 12-inches of FDR (~8.5%) after compaction efforts.

Lessons Learned: Specifications. It is recommended that a language be added to the specification to provide the owner an option to use the FDR method. For federally funded transportation projects this language can be added to the Special Provision section 1-04 (Changes) to indicate that the owner will entertain FDR. As a result, the owner is not obligated to compensate the contractor for the change.

Benefits of FDR

Benefit #1: Saves Money. In most LEED-certified building structures, sustainable design requires a higher investment upfront with eventual cost savings in the future. The advantage of FDR is that it saves money upfront in addition to saving maintenance costs in the long term. Typically, the cost of pavement construction utilizing FDR is 30 to 60 percent less than the traditional method.

In both phases of Lynnwood's project many bid items were drastically reduced or eliminated. The project team saved substantial costs on the following bid items:

- Removal of Pavement *(Eliminated)*
- Saw cutting *(Eliminated)*
- Roadway excavation/hauling *(Eliminated)*
- CSBC *(Minimized by using less than an inch of 5/8th minus for final grading)*
- Planing Bituminous pavement *(Eliminated)*
- HMA *(Reduced by 35% of the original quantity due to a thinner section)*
- Temporary Pavement *(Eliminated)*
- Flaggers and Spotters *(Reduced to days vs. weeks)*

Benefit #2: Saves Time. One of the main challenges of urban projects is controlling both vehicular and pedestrian traffic at all times. FDR performed faster than the conventional method. In Lynnwood, FDR was processed in each phase and involved slightly less than a mile of road with 14-foot lanes, one each way, and 5-foot sidewalks on both sides. Using the traditional method, more than a month of pavement and temporary pavement construction would have been required. Remarkably, FDR was completed in one week for each phase of the project. As a result, traffic disruptions to business and the community were minimized and temporary traffic control costs were reduced.

FDR may not be the preferred method for a contractor because it will reduce their bid amount and consequently reduce their profit; however, saving time was a major factor when negotiating the FDR method in Lynnwood with the general contractor. The contractor quickly realized the benefit that by completing the project sooner they would reduce their overhead costs.

FDR in WA State: Isn't it amazing that no matter when a road project starts, they usually always end up paving during the months of October-December? FDR will be another appealing method for contractors as well as owners, when wet weather becomes an issue for asphalt pavement, and we have plenty of that in Washington. During the first phase in Lynnwood we barely made it. FDR was processed three days before the December 2008 snow storm. Not being able to complete the FDR process in time, we had to leave the work unfinished (no pavement with soils exposed) and open the road to local traffic with large, unsafe potholes that could have created a liability for the City and the community. FDR held up very well during the month of the storm and we paved the road in January during three days of suitable weather.

Benefit #3: Longer Lifecycle and Reduced Maintenance Costs

Reflective Cracking – No doubt that a uniformly pulverized and cemented base will experience a minimum amount of distress. Constructed properly, there will be no reflective cracks that will transfer the distress from underlain layer to the new paved section. There will be no different road sections with different settlement or movement behavior that would cause stress.

Something to note is that cementation of FDR soils should be designed with careful considerations. Experience has concluded that best results are achieved by controlling compressive strength of the soil-cement between 300-400 psi as determined by ASTM C 42 Method. Over-cementing of the soils does not add value to the base; on the contrary, it will increase the possibility of base stress resulting in cracks. If the FDR base develops major cracks, those cracks will reflect into the asphalt layer causing the pavement to fail within the stressed areas.

Wetting/Freezing/Thawing Cycle – Durability of the road base subjected to wetting/drying and freezing/thawing cycles is a critical challenge in wet climates where deeply penetrating freeze-thaw patterns can cause damage to the base and the pavement. These conditions exist in several areas across eastern Washington counties. In these areas with severe cold weather, water movement within pavement layers, freeze and thaw, and heavy traffic have resulted in heaving and rutting on many roads. Many public agencies have found FDR an effective construction method to eliminate heaving and make their roads operable in cold-weather conditions.

Aerial photo of Olympic View Drive, Phase 1, at completion (photo: Harris & Associates)

Benefit #4: Reduces Landfill Disposal. On Olympic View Drive, we recycled the old asphalt and CSBC eliminating hauling of approximately 25,000 cubic yards of old material to landfills. Additionally, if old asphalt and base materials are not recycled, they must be disposed of or stockpiled, increasing transportation costs and occupying valuable landfill space. In some states, old asphalt can no longer be transferred to landfills. Environmental laws are becoming stricter causing higher landfill costs.

Benefit #5: Reduces Exhaustion of Valuable Natural Resources. We reduced consumption of approximately 8,000 cubic yards of CSBC material and 4,000 tons of HMA. As a result, we reduced extraction of natural resources for aggregate and oil materials. There is a shortage of good quality aggregate in most states. They sometimes come from distant quarries at great expense.

Benefit #6: Saves Energy, Reduces Air Pollution. We reduced 4,000 tons of HMA consumption due to a thinner section. Consequently, oil consumption and air pollution were minimized from manufacturing and hauling in less asphalt material.

Benefit #7: Traffic Control. The FDR process can be performed under traffic. With low-volume traffic on Olympic View Drive we allowed traffic to flow on one side of the road while construction continued on the other side. Also, traffic was allowed on the finished lane about four hours after the process was completed. For high traffic volumes a surface treatment could be applied to act as a curing layer and allow traffic to flow until the roadway is ready for final asphalt pavement. In addition, truck traffic for hauling asphalt and CSBS and disposing excavated materials was minimized, therefore helping manage local traffic more effectively.

In the words of one satisfied public agency representative, Jeff Elekes, P.E., City of Lynnwood Deputy Public Works Director, explains that this method contributed to "project savings of several hundred thousand dollars for each project phase...the contractor was able to accelerate his schedule by some three to four weeks and still make a profit...and the existing pavement was recycled in place, thus saving a tremendous amount in hauling costs."

In essence, our economy is shifting the focus to cost savings, efficiency and innovation in order to build infrastructure for our communities that demonstrates higher quality, lower cost and sustainability. FDR is one such way to ameliorate our aging transportation infrastructure.

Sam Yaghmaie chairs the APWA Washington State Chapter's CM Committee, is a member of APWA's National Sustainable Transportation Subcommittee, and has served as president of CMAA (Washington Chapter) for two years. He will give a presentation at APWA's upcoming Congress in Boston entitled "Sustainability in Road Construction" that takes place on Tuesday, August 17, at 10:00 a.m. He can be reached at (425) 453-0999 or syaghmaie@harris-assoc.com.