Take the green approach; why replace it when you can restore it?

Use of infrared technologies in the repair of manholes, catch basins and utility bells

The importance of the innocuous-looking, much-maligned manholes and catch-basins encountered in every urban and sub-urban street-setting cannot be understated. However, Drivers of all types of wheeled vehicles frequently complain about the bumpy ride they provide, or the damage they cause to their vehicles

So why do they fail?

A properly-elevated, well constructed manhole located in a position where contact with vehicle wheels is limited to *normal* vehicle-wheel rolling loads, can theoretically last the life of the asphalt pavement. Designers attempt to keep manholes off the vehicle-wheel line and even more so where heavy acceleration and braking takes place, but this is often a challenge. In this construction phase, the height of the manhole frame, the distribution and compaction of asphalt is carefully calculated, controlled and executed to ensure that smoothness and level of the asphalt around the rim, and the integrity of the surrounding mat are within specification! But in the real world, even this "ideal" manhole installation is subjected to the unexpected!! Urban traffic-growth and resulting stop-start congestion result in thousands of tensile/compressive cycles of the man-hole frame, which in turn transfers it to the asphalt in contact with it on both the leading and trailing edges. As the asphalt binder ages (oxidizes) and shrinks due to loss of volatiles from the top down, its elastic properties and flexibility gradually deteriorate and a gap between the frame and asphalt is created. This process may take several years but it is cumulative and progressive, and eventually horizontal displacements become large enough to allow significant water-flow down the outside of the frame and barrel rise, and with sufficient movement the flange at the bottom of the manhole frame is no longer able to maintain a seal with the top of the barrel rim. The result is water infiltration, stripping of the binder off the aggregate at the pavement level, frost-heave between base and sub-base and further down, the fines keeping the barrel secure, are flushed away. At this point, stress-cracks radiating outwards from the frame cause crumbling of the peripheral asphalt and larger chunks are ejected by wheel traffic

The urban reality is such that frequent utility-cuts, drainage upgrades, changes in communication technologies, chemical and fuel leaks, fires, accidents and other events lead to pavement deterioration which necessitates overlays as the most cost-effective remedy. However, the incorrect level of the manhole-cover, relative to the pavement surface, is in itself very harmful, since vehicle-wheel impact loading on the frame of the manhole cover is extremely high. In the case of overlays, it is the trailing edge of the manhole depression which is subjected to these impact loads and this impact is transferred to the surrounding pavement rather than to the manhole frame, and these compressive loads are radiated outwards and cause little harm since the asphalt is still flexible and pliable. In the case of a milled surface, with the frame now protruding, the impacts are extremely high and increase linearly with vehicle weight and exponentially with speed! The next order of business is leveling the manholes, catch basins/drains, utility water bells and other utility boxes, that are subject to damages and roadway deterioration around them.

We at Smartfix, after repairing and restoring thousands of Manholes, catch-basins, utility covers in a multitude of counties, both private properties and municipalities, have observed that many of the repairs we have performed have been to those already previously repaired by the "cut-out and replace" method of repair. Whatever the reason for repair, the standard fix inevitably result in a large rectangular cut-out of new asphalt.

It is at this point that the true value of a restoration using infrared technology manifests itself by eliminating those very factors introduced during the rehabilitation process!

"The cold-joint" a new "4 sided fault line" for water to penetrate and the thaw-freeze process to eventually cause collateral damages and unravel the repair. Let us review the standard methodologies to rehabilitate a manhole. An asphalt cutting saw is used to create a clean cut such that a rectangular excavation surrounding the manhole can be made, usually through multiple asphalts lifts right through to the base. New fill is brought in, leveled and compacted, and these methods are the factors which shorten the life of the repair:

These are inter alia:

- Lack of compaction at the corners of the cuts where the compactor cannot properly compact the new asphalt leading to raveling and material loss
- Lack of proper compaction around the rim of the manhole frame is also a factor in the longevity of the repair
- The cuts in the asphalt where the saw-wheel penetrates beyond the edges of the cut-out resulting in stress-risers in the surrounding mat and water entry into the repaired area
- Parallel micro-stress cracks resulting from compaction of spilled-over asphalt onto the hard shoulders surrounding the cut-out is a concern, especially when the mat has already lost some flexibility
- Creation of a peripheral vertical seam where the new asphalt meets the old, usually relying on a coating of tack-oil to ensure a bond between old and new. This process will create an ongoing maintenance of "crack fill products" to try and keep the water out of the crack. This new joint typically adds approximately 40 feet of joints requiring crack fill upkeep and does very little in preventing water penetration into the cut out crack.
- There are also physical differences in the properties of the old and new pavement composition, due to age, rheology, gradation, compaction etc, which may result in harmful shear stress at the joint upon application of wheel-loading, and although infrared application cannot obviously eliminate this factor, it goes a long way towards mitigating these stresses since there is no longer a physical joint. Infrared repairs heat at least 6" – 12" inches around the surrounding repair, that thermo-bonds the old and new, to provide an unbroken, homogenous mat which does not have stress riser.

Smartfix's specialized compaction technique around the rim of the frame successfully eliminates the first of the "failure-factors "along with the "cold joint failure factor" the rest of the factors are effectively eliminated, resulting in an equal life-cycle with the surrounding mat.

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Frequently voiced concerns regarding infrared restorations.

The argument against the use of infrared in restoring asphalt pavements which we hear most often are as follows.

- *We could have repaired a pothole in half the time it took Smartfix to do it with infrared!*

That is absolutely correct when compared with "throw and go" or "tack and pack" and in the case of the larger municipalities, the pothole-repair process of infrared repair may not be as quick and cost effective as "throw and go" or "tack and pack" yet it can be done effectively and permanently to match the lifespan of the mat. But in the municipal milieu, it is just not cost-effective. However, infrared is also much quicker and more cost effective than a "cut-out and fill" process used around manholes, catch basins and water bells..

- *The asphalt is damaged by heating or re-heating it with infrared.*

Correct if the operators do not know what they are doing, or if the exposure to IR is too long. It is also true when cooking a steak on a barbecue. Attention and experience are key!

Infrared heat of the right temperature (frequency and wavelength), the correct heat density and the correct exposure has negligible effect on the physical properties of the asphalt. Core tests performed on a range of infrared-repaired asphalt samples at a longitudinal joint, as well as binder-tests confirm conclusively that there is little to no loss of performance grade between infra-redded and non infra-redded samples. Ductility and tensile strength remain unaffected, and air-voids and compaction demonstrated an improvement between 2 and 4%! Here are some of the 11 but here are the technical reasons:

- Infrared heating is a *surface* phenomenon and energy from infrared heat is converted to sensible heat at the *surface* of the pavement only. Surface temperatures rise and then heat is carried downwards through the mat by *conduction* only, mostly by the aggregate which has a thermal transfer coefficient several times higher than the binder.

- Asphalt pavement sustains heat-damage when the binder is overheated and is compromised due to loss of volatiles. On older pavement, the binder has long since been oxidized (as evidenced by the lighter gray shade of the asphalt) and the only volatiles left to evaporate are below the surface.

- When infrared heat is applied, the pavement is left undisturbed and the volatiles below do not have sufficient vapour-pressure to break through the bonder layers and it is only when the asphalt is scarified, that some loss of volatiles occurs from exposed surfaces, but this loss is negligible since the boiling point of most commercial industry binders is upwards of 450°F (232°C) and the correct application of IR heat, only raises the temperature to 350°F (176°C) and raking is possible.

- On freshly-laid asphalt the volatiles at the surface are indeed evaporated, but their loss does not affect the strength of the matt since the aggregate portion is below the surface and remains unaffected.

- *"The quality of the asphalt needs to be very* specific *to make effective restorations ".*

Again, the steak on the barbecue analogy can be applied and quality in equals quality out!! Smartfix uses hot-mix only from batch-plants complying with a city or regions specification in order to ensure that the quality of the final product is up to standard. We thus do not have any control over the mix composition, aggregate/binder ratio, gradation etc, but we do know that our technology does not harm the mix and actually enhances the quality of the finished product.
The application of infra-red heating technology in helping to maintain and protect urban infrastructure, only show-cases *one* of its real advantages. When applied to longitudinal joint-heating of highways and roads to extend their life-cycles, its true value on a *national* basis, may be realized!

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