Use of infrared 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. Drivers of all types of wheeled vehicles frequently complain about the bumpy ride they provide, or the damage they cause to their vehicles, and drivers of two-wheeled vehicles dislike and try to avoid, the potential dangerous slippery surfaces they have in the wet. Many would love to see them gone altogether or relocated to a less-travelled location because of this but running them under the roads is simply the most efficient and cost-effective way to route our multiple services. It is only when sewage backs up, flooding occurs, or when communication, water or power-cuts take place that manholes suddenly climb into prominence with Mr. Everyday Citizen!!!
In truth, they protect and help maintain that very infrastructure which takes care of our health, well-being, movement of goods and people, communication and safety. They are the unsung heroes of our cities and their efficient up-keep deserves a high level of care.

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 an unreachable dream! In this construction phase, the height of the manhole frame, the distribution and compaction 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 pavement develops. 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. At this point, 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 resultant stripping of the binder off the aggregate at the pavement level, frost-heave between base and sub-base and further down, the loss of fines result in radial stress-cracks and disintegration/ejection of the asphalt on the frame periphery.

But this type of age-related failure is the exception, not the norm!! *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 and this is by far the most common cause of manhole asphalt remediation!* 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! Thankfully this type

of loading is usually of short duration otherwise the very expensive riser and the connecting piping would be irreparably damaged in short order! The next order of business is leveling the manhole

We at Smartfix, after repairing and restoring thousands of Manholes, catch-basins, utility covers (communication and power bells) in a multitude of counties and municipalities, have observed that most of the repairs we have performed have been to those already in a cut-out due to previous repairs or level adjustments.

Whether the reasons for the rehabilitation of the manhole were necessitated by level changes, asphalt-aging or temperature, whatever the reason, the fix inevitably results are a large rectangular cut-out with a fill 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!

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 are the factors which shorten the life of the repair:

These are inter alia:

- Lack of compaction at the corners of the cut where the compactor rides the two edges, leading to raveling and material loss
- Lack of compaction around the rim of the manhole frame
- The cuts in the asphalt where the saw-wheel penetrated beyond the edges of the cut resulting in stress-risers in the surrounding mat and water entry
- Parallel micro-stress cracks resulting from compaction of spilled-over asphalt onto the hard shoulders surrounding the cut 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.
- 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 12" of the surround to provide an unbroken, homogenous mat)

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

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 Smarfix to do it with infrared!*

  That is absolutely correct when compared with "throw and go" or even "cut and fill" but pothole-repair is the wrong application for using infrared. It can be done effectively and permanently to match the lifespan of the mat, but in the municipal mileau, it is just not cost-effective.

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

  Correct if the operator does not know what he is doing, or if the exposure to IR is too long. This 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 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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