# E&M Engineers and Surveyors, PC

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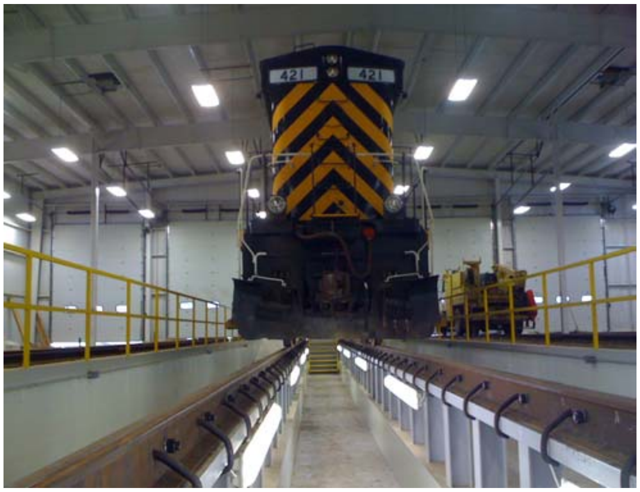
## Locomotive Maintenance

by: Roy Pedersen, P.E.

E & M Engineers and Surveyors recently provided structural design for foundations and rail support structures for a new locomotive maintenance facility in Allegany, NY. The owner is the Western New York and Pennsylvania Railroad, LLC (WNYP) and the contractor was Kessel Construction, Inc. of Bradford, PA.

The structure is a 100' wide by 200' long pre-engineered metal building with 5 large overhead doors at each end. It will service the 18 locomotives that cover the 330-mile territory of the WNYP in Western New York and Pennsylvania.

There are currently 4 sets of tracks going through the building, one of which goes over the inspection pit pictured here. The service pit is 16'-8" wide by 3'-0" deep, with a deeper section in the center allowing workers to work under the engine. The structure is designed to safely support the 200 ton locomotives.



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## The American Civil Engineers Handbook

By: Alan R. Vanderpoel, P.E.

The bible written for civil engineers, The American Civil Engineers Handbook, is about to celebrate its 100th birthday. This handbook was assembled by Thaddeus Merriman and Thomas Wiggin, along with a whole host of associate editors. The handbook (at least the thirteenth edition that I obtained not quite 100 years ago) is 2,263 pages long and contains everything that the professional engineer would need in the early 1900's to carry out his work.

I actually used this as a reference manual when I started my career as a civil engineer, but I must admit that it was pretty dusty when I picked it up recently. A quick look through the book shows that some things have not changed, while others are light years ahead of 1910. For instance, there are chapters on foundations, structures, water supply and dams that are still relevant to today's requirements. There is a long chapter on surveying that has the basics of land surveys, including highway layout. There is a chapter on storm water runoff, and sizing of culverts and bridge openings. There is a chapter on highway engineering that includes the formulas still used to lay out vertical and horizontal curves.

But there are three chapters with the tables of square roots, logarithms, sines and cosines and almost every other formula that you could think of.

Computers replaced these 327 pages. There are two chapters on railroads, including the needs of a steam powered locomotive. Steam engineering, and electric engineering each have a chapter devoted to these early necessities. And the chapter on sewage disposal relies on the closest river as the primary means of treatment.

Times have changed. The chapters that are missing are probably more interesting than the chapters that were included. There is no mention of how to obtain an Earth Disturbance Permit, or a Storm Water Management Permit. There are no chapters on GPS surveying, or CAD drafting, or the interface between these two fields. In fact, interface probably wasn't a word back then.

But even though times have changed, engineering still retains the same process. Planning, design, construction and maintenance remain the keys today the same as they were 100 years ago. Good engineering produces good results.

## Winter Roof Problems

by Jeffrey C. Bahret, P.E.

We often get calls as a consultant to investigate and design corrective solutions to winter roof problems on both commercial and residential buildings. Although individual cases look different, and often result in different types of damage, all situations have two things in common: (1) They involve an ice-dam that happens because melting snow pools behind the dam of ice barrier at the roof's edge and leaks into the structure and (2) The ice dams and the damage that results from them is avoidable.

Three things are required for an ice dam to form: snow, heat to melt the snow and cold to refreeze the melted snow into solid ice. Ice dams develop as snow on the upper part of the roof melts. Water runs down the roof slope under the blanket of snow and refreezes into a band of ice at the roof's edge creating a "dam". Additional snow-melt pools against the dam and eventually leaks into the building through the roof or roof trim.

The reason ice-dams form along the roof's lower edge, usually above the overhang, is straightforward. The upper roof surface (toward the ridgeline) is at a temperature that is above freezing. And the lower part of the roof surface (along the eaves) is below freezing. The upper roof surface is located directly above the living space. Heat lost from the house warms this section of the roof, melting snow in this area. During periods of sub-freezing temperature the lower regions of the roof deck remain at sub-freezing ambient temperatures. Roof overhangs are not warmed by indoor heat-loss.

The damage caused by ice dams can be controlled in 2 ways: (1) Maintain the entire roof surface at ambient outdoor temperatures or (2) Build a roof so that it can't leak into sensitive building materials if an ice dam forms. Cold roofs make a lot of sense. Here you let the cold outdoor air work for you. Keep the entire roof as cold as the outdoor air and you solve the ice-dam problem. Look at the roof of an unheated shed or garage. Ice dams don't form on these structures because there is no uneven melting and freezing.

For new construction it's easy. Design the structure to include plenty of ceiling insulation, a continuous air barrier separating the occupied space from the underside of the roof, and an effective roof ventilation system. Insulation retards the conductive flow of heat to the roof surface. An air barrier retards the flow of heated air to the underside of the roof.

A good roof-ventilation system helps keep the roof sheathing cold. In an existing structure this approach may be more difficult to follow. Often we are stuck with less than desirable compromise solutions. The following presents all the issues that will guide our strategy for a workable solution

Houses in the northern United States should be equipped with ceiling insulation of at least R-38 (about 12 inches of fiberglass or cellulose). The insulation should be continuous and consistently deep. The most notable problem area is located above the exterior wall. Raised-heel trusses or roof-framing details that allow for R-38 above the exterior wall should be used in new construction. In existing structures, where the space between the wall's top plate and underside of the roof sheathing is restricted, install high R/inch insulating foam (R-6/inch).

A soffit-to-ridge ventilation system is the most effective ventilation scheme you can use to cool roof sheathing. Power vents, turbines, roof vents and gable louvers just aren't as good. Soffit and ridge vents should run continuously along the length of the house. A baffled ridge vent is best because it will exhaust attic air regardless of wind direction. The exhaust pressure created by the ridge vent sucks cold make-up air into the attic through the soffit vents. A 2-inch space or "air-chute" should be provided between the top of the insulation and the underside of the roof sheathing in all applications. Be sure to install insulation baffles above the exterior wall to protect the insulation from the air that blows in through the soffit vents.

Insulation retards conductive heat loss, but a special effort must be made to block the flow of warm indoor air (convection) into the attic or roof area. Small holes allow significant volumes of warm indoor air to pass into attic spaces. In new construction avoid making penetrations through the ceiling whenever possible. But when you can't avoid making penetrations or when you need to air-tighten existing homes use urethane spray-foam (in a can), caulking, packed cellulose, or weather-stripping to seal all ceiling leaks like wire penetrations, plumbing penetrations, ceiling light fixtures, attic hatches, chimneys or bathroom exhaust fans.

Electric heat tapes work the best in northern facing roof valleys. Keeping in mind that water will take the path of least resistance, the heat tape will provide this easy release path for melting ice/snow. When the temperatures start to rise in the springtime, without the conveyance channel made by the heat tape, the hydraulic pressure from the water under the ice sheet will force the liquid under the shingles and into the structure.

Whatever plan is decided to be the most cost-effective to follow, it is always better to focus on the cause. Ice dams are created by the heat lost from a structure. Developing a strategy that is centered around this fact makes for the best solution. Ventilate, insulate well and block as many air leaks as practical. Cures for existing structures are often elusive and expensive. In some cases you have to treat the symptom for a workable solution. The payback is damage prevented.

## Steel Bridge Coatings

by: Christopher M. Ernst, P.E.

I read an interesting article in the November 2009 issue of *Modern Steel Construction* and I would like to share the overview of the article with you. Within the article, Mr. Eric Kline who is a certified coatings expert, discussed the changes that occurred to steel bridge coatings about 1965 and the results that have been seen since those changes were made. Prior to 1965 coatings were generally oil or alkyd-based and contained pigments using lead and/or chromium compounds as the corrosion inhibitors. In addition, they were often applied directly to steel covered with shiny, slick mill scale that been subjected to only power tool cleaning. These coatings were expected to last about 8 to 10 years before requiring some level of maintenance, which normally was completed by adding another coat on top of the failing layer. As a result, there were so many coating layers on some bridges that apart from other forces, the sheer weight of the paint would overcome the adhesion of the coating layers to one another and/or to the smooth mill-scale-covered steel beneath. Subsequently, the coatings would simply fall off, sometimes in sheets. Coatings with an overall thickness of ¼-inch or more have been encountered.

Bridge owners are still dealing with these lead-based paints that were placed prior to 1965. A recent survey of 20 state departments of transportation (DOTs) regarding bridge painting practices revealed that in these states, only about half of the bridges originally painted with lead-based paint have been repainted. Repainting in this context refers to complete removal and replacement of all old coating. The removal replacement expense in many areas is around $12 per sq. ft. of steel surface area, including access, lead removal, containment, worker protection, disposal, repainting, etc.

In about 1965, many DOTs began specifying the use of blast cleaning to a near white condition in order to completely remove the mill scale. Zinc coatings were turned to due to the fact that when it is combined with steel in the presence of moisture and oxygen (air) – a corrosive environment – zinc will be consumed first, and the steel will be protected from corrosion. This consumption of the zinc will continue until the available zinc is depleted.

Basically, zinc can be applied to the steel in three ways. Galvanizing is the process in which the bare piece of steel is dipped in molten zinc. It is limited by the size of the "kettle" in which the article is immersed. Metalizing requires melting wire containing zinc and spraying the molten metal onto the steel surface, with a stream of air. Both galvanizing and metalizing are excellent means of protecting steel from corrosion. However, many steel members and components are best protected by the use of zinc-rich paint.

The zinc-rich paint is different from galvanizing in that the paint consists of binding materials and zinc whereas galvanizing is 100% zinc. A plus factor in terms of service life for zinc-rich coatings is that they are often paired with additional coating layers (top coats). These additional layers protect the zinc by limiting the amount of moisture and oxygen in direct contact with the zinc. The extensive and impressive 40-plus-year field performance history of zinc-rich coatings suggests strongly that steel which has been properly coated with a zinc coating and which has additional coating layers can provide permanent or nearly permanent protection for the steel beneath. The current "gold standard" for bridge coating entails the use of a three-coat system consisting of an inorganic zinc-rich primer, an epoxy mid-coat and a urethane top coat. The costs (in 2009 U.S. dollars) for this system are as follows:

<u>Lifetime Cost Per Sq. Ft. (Three-Coat System)</u>

| | |
|---|---|
| Year 1 | $1.50 for the initial blast cleaning surface preparation and prime coating in the shop during fabrication. |
| Year 1 | $2 for the application of the second/third coating layers at the construction site after steel erection. |
| Year 30 | $1 for the first touch-up/overcoating |
| Year 45-55 | $1 for the second touch-up/ overcoating |

In closing, the author stated that effective means of corrosion protection via corrosion preventive protective coatings have proved themselves in the field for more than 44 years. Progress is steadily being made toward the development of even better, more durable, safer, and more cost-effective coatings, ensuring that there is always a solution in steel.

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