FORENSIC DYNAMICS INC.
CONSULTING FORENSIC & BIOMECHANICAL ENGINEERS

OUR FILE: SB10

April 4th, 2006

Denmar Brines Ltd.
15124 Longwoods Road
Bothwell, ON

Attention: Kevin Meredith

Dear Sir:

RE: Comparative Friction Testing of NaCl, Salt Brine, $CaCl_2$ and $MgCl_2$ DLA Anti-Icers

As requested, we have now completed the friction testing of these anti-icing agents on an asphalt test surface. This testing was undertaken to investigate if the application of a Natural Salt Brine DLA to a dry asphalt roadway, reduced the friction on the roadway more than the application of NaCl, $CaCl_2$, or $MgCl_2$ DLA.

For this testing you provided samples of Denmar Brines' inhibited and un-inhibited Lo-CAL 50 and Hi-CAL 50 Natural Salt Brines. Comparison test where performed with uninhibited samples of 23% NaCl, 32% $CaCl_2$, and 30% $MgCl_2$.

The first round of friction tests compared the inhibited Natural Salt Brines to NaCl and $CaCl_2$. For this testing, each DLA was applied at a rate of 60 liters per lane kilometer to the test surface. The environmental chamber, in which the testing is done, was sealed and the air and surface temperature was gradually lowered from about 15 to -10E Celsius. The relative humidity in the chamber averaged approximately 55% during each test. Friction tests were performed at 2 ½ minute intervals to monitor each DLA's effect on the friction on the asphalt test surface.

The enclosed graphs, for reference, show the friction on the asphalt test surface when dry, wet, and when covered in ice. The asphalt surface has an average friction of 1.08 ± 0.05 when dry and 0.92 ± 0.05 when wetted with water only. The friction on ice varies with temperature, hence, an average ice friction value of 0.15 has been shown.

As you will appreciate from the graph titled "Comparison Friction vs. Surface Temperature (Average RH ~55%)", the Natural Salt Brines and $CaCl_2$ DLA displayed very similar properties. At a surface temperature of 15EC all three produced a friction of just over 0.8. Just above 4EC all three produced a minimum friction. The 32% $CaCl_2$ solution and the Hi-CAL 50 product reached a minimum friction of 0.65. The Lo-CAL 50 product's minimum friction was slightly greater at 0.7.

Below 4EC the friction for the three solutions steadily increased. The Lo-CAL 50 and Hi-CAL 50 both achieved a friction similar to water on asphalt at about -2EC, and produced and maintained friction values above 1.0, (ie. similar to the friction on the dry asphalt test track), at below -4EC. Throughout the testing the asphalt test surface remained visibly darkened by all three solutions, indicating that the chemicals had remained on the test surface.

The NaCl DLA friction test results were quite different from the Natural Salt Brines and $CaCl_2$. NaCl produced a friction of 0.89 at 15EC surface temperature. At 11EC the friction reached a minimum of 0.86. By the time the surface temperature had decreased to 4EC, the friction had returned to that of the dry test track. The test track was dry at this point, and only small amounts of white, solid NaCl remained. The friction remained at this level until the surface temperature dropped below 0EC, when the friction slowly began to decrease. This decrease continued, gradually, until the test was halted at a surface temperature of -6EC.

This first set of friction tests revealed that, within the tested surface temperature range, at relative humidity levels of about 55%, there is no significant difference in friction between the inhibited Natural Salt Brines and $CaCl_2$ DLA. All three had the same friction at the start of the test, and exhibited a drop in friction at about 4EC. The Hi-CAL 50 and the $CaCl_2$ DLA, at this temperature caused the same drop in friction, to about 0.65. The Lo-CAL 50 only reduced the friction to 0.7, likely due to its lower concentration of $CaCl_2$. This lower concentration also allowed the Lo-CAL 50 to achieve a maximum friction equal to that of the dry asphalt test track at -5EC. Comparatively, the $CaCl_2$ DLA, was only able to achieve a maximum friction just slightly greater than that found with only water on the test track, and lower than both of the Natural Salt Brines.

The NaCl DLA, unlike the other DLAs tested, dried out on the test track. Plotting the NaCl's friction versus time, showed that within 20 minutes of application the solution had dehydrated, leaving only a white solid NaCl residue on the test track. Solid NaCl is not an effective anti-icing agent. NaCl needs to be in solution to maximize its snow and ice melting capacity. Even more importantly, once dry, NaCl loses its ability to adhere to the road, and as a result, would be blown of the road by passing traffic, soon after having dried out. Conversely, the Natural Salt Brines and the $CaCl_2$ DLA, remained in solution and hence would not lose their retention on the road.

The second round of friction tests compared the un-inhibited Natural Salt Brines to NaCl, $CaCl_{2,}$ and $MgCl_2$. For this testing, each DLA was again applied at a rate of 60 liters per lane kilometer to the test surface. The environmental chamber, in which the testing is done, was sealed and the air and surface temperature was gradually lowered from about 5 to -10E Celsius. The relative humidity in the chamber was maintained at 70% during each test. Friction tests were again performed at 2 ½ minute intervals to monitor each DLA's effect on the friction on the asphalt test surface.

As you will appreciate from the graph titled "Comparison Friction vs. Surface Temperature (RH 70%)", the Natural Salt Brines and $CaCl_2$ DLA again displayed very similar properties. Upon initial application the friction produced by Lo-CAl 50, $CaCl_{2,}$ and NaCl was around 0.9. Hi-CAL 50 started at a friction of 0.85. Please note that the Hi-CAL 50 test was started at about 3EC, and at this temperature Lo-CAL 50 and $CaCl_2$ also had a friction between 0.8 and 0.85. The Natural Salt Brines and $CaCl_2$ produced virtually identical friction values for the remainder of the test. Between -4 and -5EC the friction produced by these three solutions maxed out at 0.85 to 0.9. In other words, just marginally lower than the friction with water on the test track. By the time the surface temperature reached -11EC, the friction of these three solutions appeared stabilized at about 0.85.

The $MgCl_2$ DLA, on initial application, produced a much lower friction of 0.73. As the surface temperature dropped below 4EC, the friction had reduced to 0.7, where it stayed until the surface temperature decreased to 0EC. Below freezing the friction gradually increased to a maximum of 0.75 by the end of the test.

The second NaCl DLA friction test results were identical to the first test results. This can be seen most clearly in the attached graph titled “23% NaCl Comparison Friction vs. Time.” Again, within 20 minutes the solution had evaporated, leaving only a solid NaCl residue on the test track.

A third NaCl DLA test was performed. This test was started at -3EC. Relative humidity was again maintained at 70%. The initial friction was lower, at 0.85, than in the two previous tests. The solution again appeared to dehydrate, reaching a maximum friction just over 35 minutes after application. However, the maximum friction achieved was lower, at 1.0 compared to the previous tests’ 1.08. A gradual decrease in friction was again observed after this maximum friction was achieved. The friction values to -9EC surface temperature, paralleled the previous tests’ values, however they were shifted slightly lower. This test was continued for a longer time, allowing the test surface to achieve a temperature of -11EC. Between -9EC and -11EC, the rate the friction was decreasing at increased markedly.

This second series of friction tests again showed that there is no difference between the Natural Salt Brines and $CaCl_2$ DLA. $MgCl_2$ DLA produced friction values markedly lower than any of the other products tested.

NaCl DLA, at both initial application temperatures above 0EC, rapidly dehydrated within 20 minutes at relative humidity at or below 70%. Although this returned the asphalt test track to friction levels equal to dry, as noted before, NaCl in its solid form is not an effective anti-icer and is likely to be blown of the road by traffic very soon after drying out. Applied at below freezing surface temperatures and 70% relative humidity, NaCl still appeared to dry out partially. The rapid decrease seen in the friction below -9EC, was likely caused by water from the air condensing and starting to freeze on the test track. In other words, as expected, at this low a temperature NaCl is no longer an effective anti-icer.

Based on the testing performed to date, the following conclusions may be drawn:

- The friction produced on a roadway by application of Natural Salt Brines, such as Denmar Brines Lo-CAL 50 and Hi-CAL 50, does not lower the friction more than the application of a $CaCl_2$ DLA, and produces a higher friction than the application of a $MgCl_2$ DLA.

- At relative humidity levels of 70%, the application of any of the tested anti-icers, except NaCl, reduced the friction on the test track by no more than 13% below the friction with only water on the track.

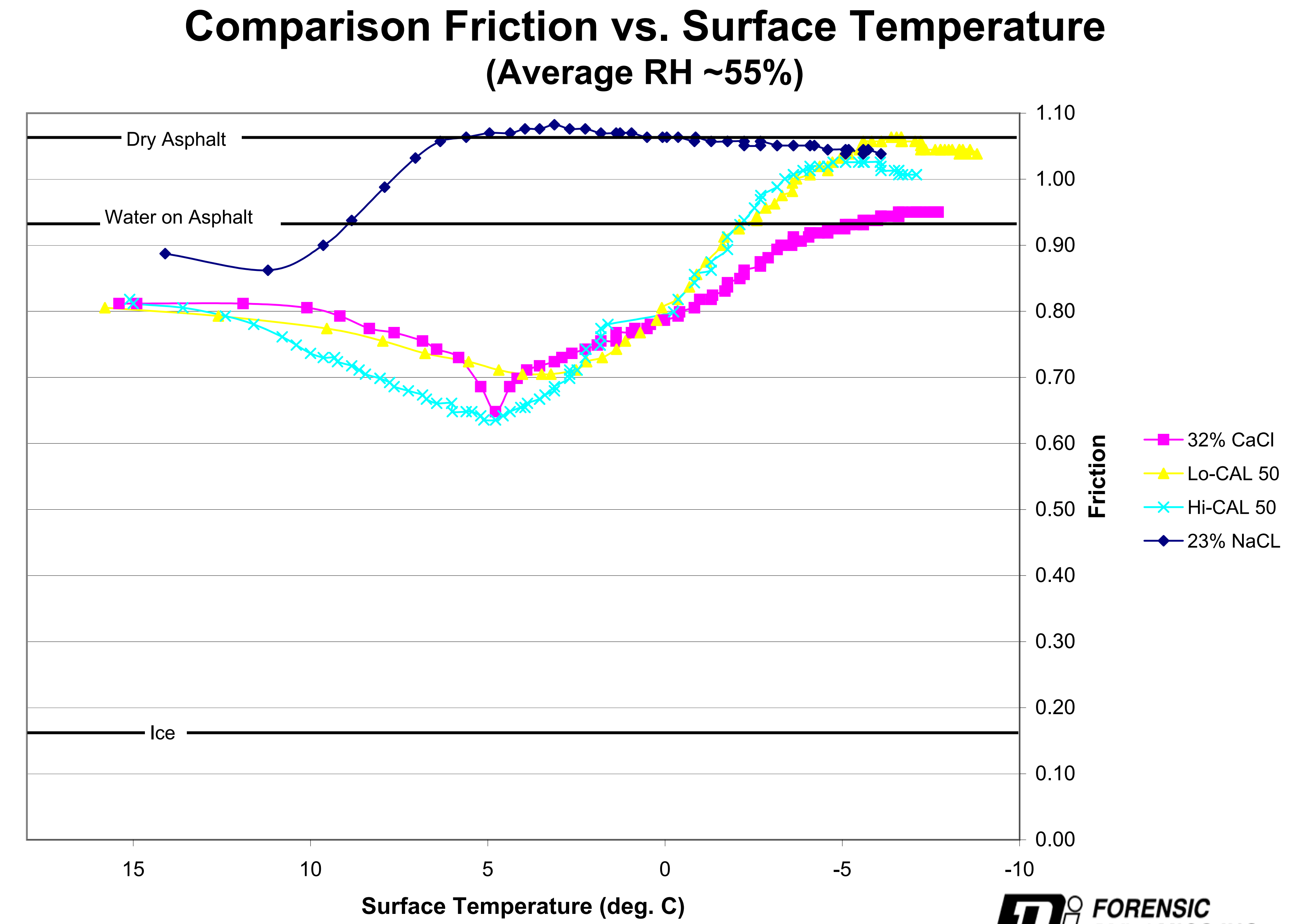
- NaCl DLA evaporates rapidly after application to a dry roadway at relative humidity levels of 70% and below, leaving only solid NaCl on the roadway. Solid NaCl is not an effective anti-icer and is likely to be rapidly blown of the roadway by traffic.

We trust the above is satisfactory for your needs at this time. Please contact the undersigned should you require clarification on the results. We trust we were of service and look forward to serving your needs in the future.

Yours very truly,
FORENSIC DYNAMICS INC.

GERALD D. SDOUTZ, P. Eng.
Project Engineer

GDS:gs
Enc.



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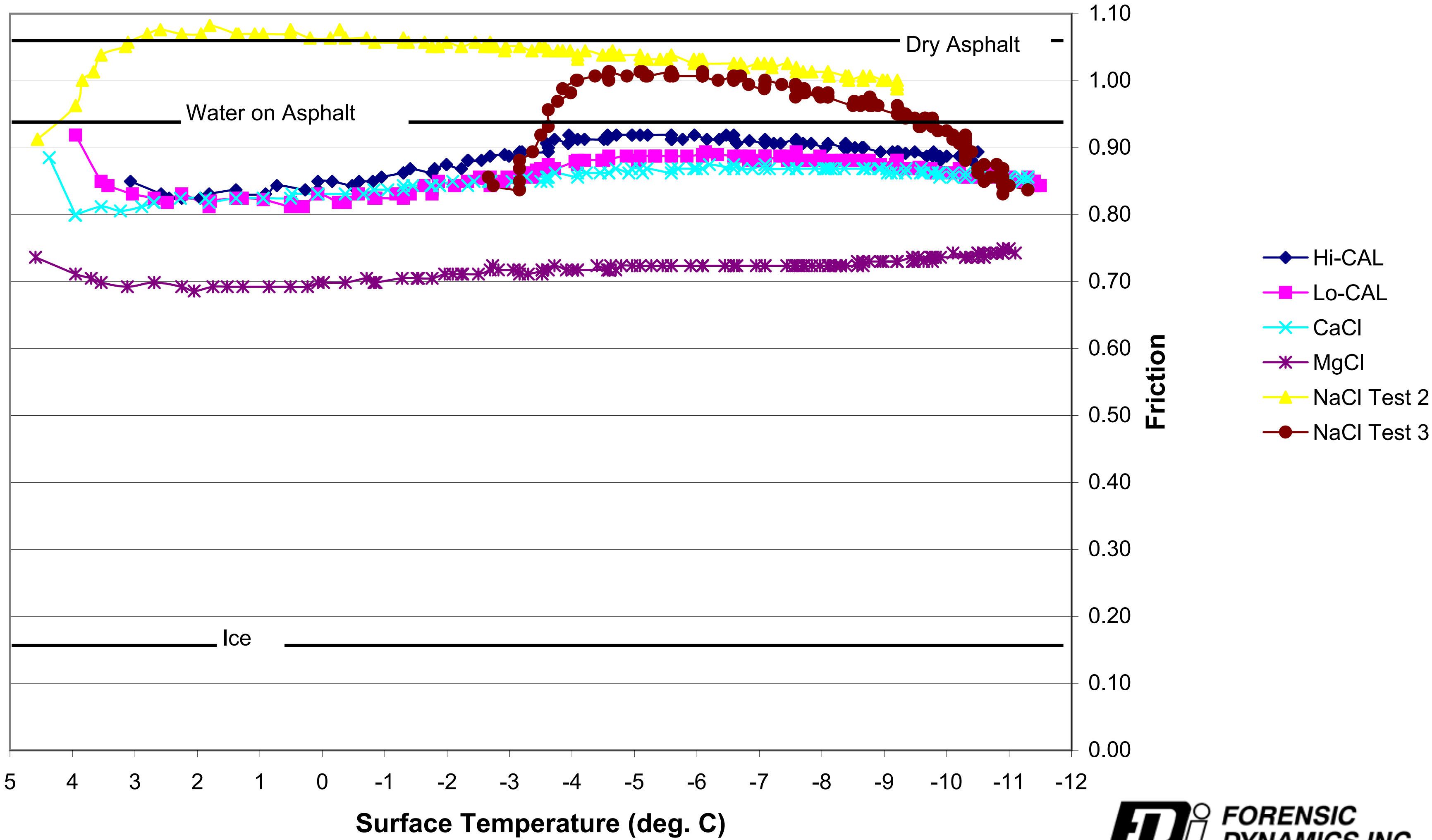
Comparison Friction v. Surface Temperature
(RH 70%)



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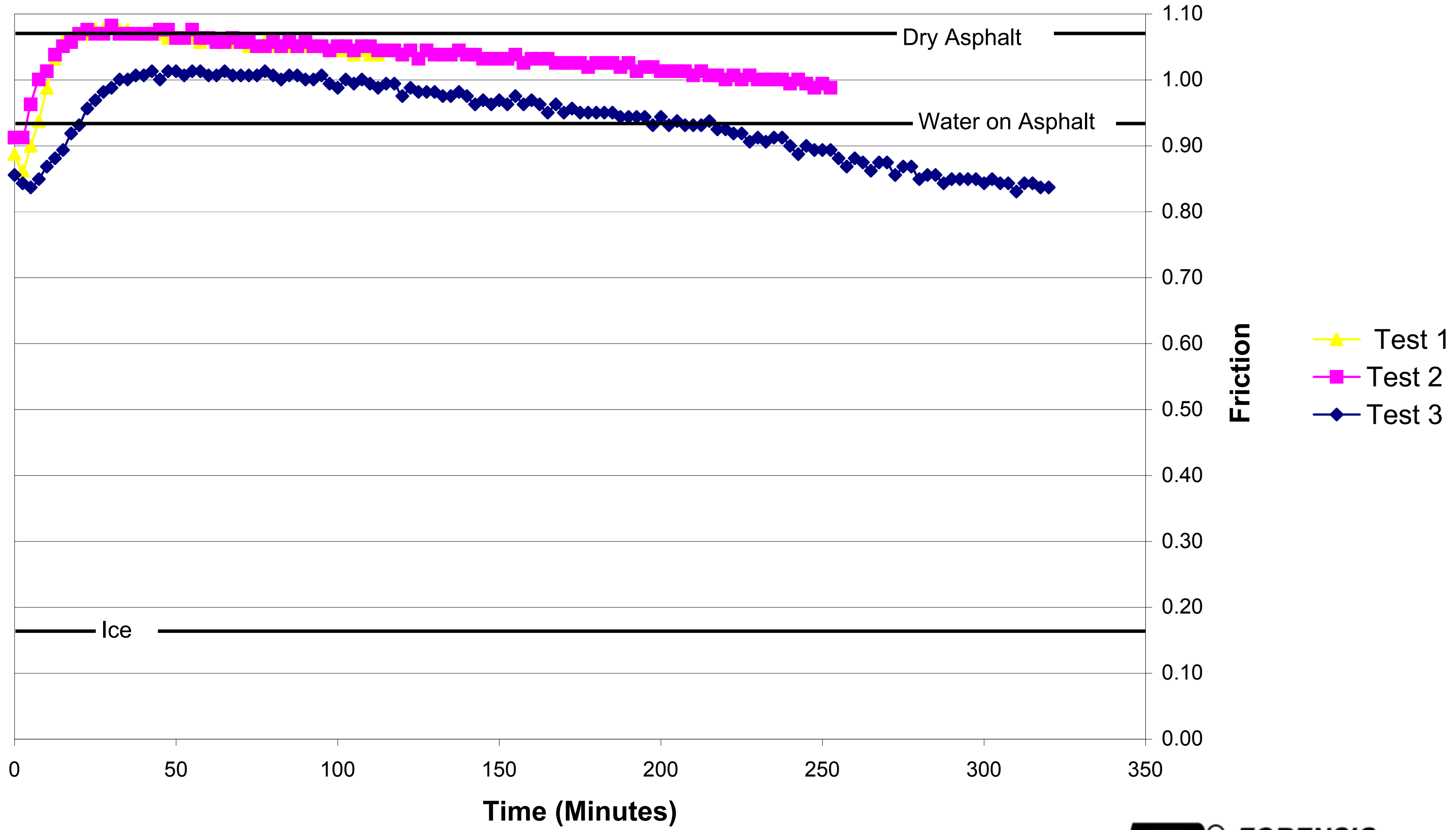
23% NaCl Comparison Friction vs. Time



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