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**MRE REPORT #R10-01-003**

## **Puncture per ASTM F2412-05**

**Prepared for**

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Testing and Report by:  
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A total of 29 Penetration tests per ASTM F2412-05 section 11 were performed at room temperature on materials supplied by King Family Kingetics.

**Raw Material Information:**

- 5 Samples were production shoes from a variety of manufacturers.
- 2 Samples were composite inserts from Kingetics
- 1 Sample was a flat piece of galvanized steel (a Simpson Strong Tie): 18 gauge galvanized steel, 0.047 inches thick.

**Sample Preparation:**

- The samples were acclimated to the local temperature (72°F) and 40% relative humidity for 10 days prior to testing.
- The tops of the shoes were sawn off in order to facilitate testing on the production shoe samples.
- The foam inserts in the following shoes were removed prior to testing: Nike Shox, Belleville, Boxer Israel and Danner Combat Hiker.

**Testing:**

- The samples were tested in the order indicated in the chart below (starting at Cross point 1 and ending at Simpson Strong Tie point 3).
- The test points on each sample were indicated on the sole of each shoe or sample by King Family Kingetics. Each sample had either 3 or 4 test points.
- For all samples, test point 1 is closest to the toes, test point 4 is at the heel.
- Per section 11.1.3, a puncture is defined as the visual protrusion of the point of the test pin through the sample. The sample was inspected during actual testing to determine protrusion.
- The test fixture geometry was as per section 11.2.2.
- The ASTM does not define from which side of the sample the test pin should begin the puncture. Therefore, for purposes of this test, the test pin is driven into the sole of the shoe or sample, upwards toward the interior of the shoe or sample in order to simulate actual usage.
- The test pin travel rate was 0.393 inches per minute as per the ASTM.
- The values reported below are the force at which the test pin punctures the sample. In most tests, the maximum load recorded during test pin penetration is greater than the load indicated in the chart. In most cases, the load drops when the test pin tip nears the exit surface.

**Test Results:**

Sample Identity	Test Point 1 (load, lb)	Test Point 2 (load, lb)	Test Point 3 (load, lb)	Test Point 4 (load, lb)	Average (load, lb)
Crocs	29.8	37.7	NA	22.2	29.9
Nike Shox	39.3	33.7	NA	83.8	52.3
Boxer Israel	70.0	69.5	102.4	80.7	80.7
Danner Combat Hiker	247.4	209.8	195.7	145.7	199.7
Belleville	138.0	151.1	228.5	143.0	165.2
Cradle 5-Kingetics	96.8	710.2	802.6	877.2	621.7
Cradle 8/Kevlar - Kingetics	171.2	720.9	846.0	742.0	620.0
Simpson Strong Tie	403.7	414.8	411.1	NA	409.9

