Earth Tech Engineering, Inc.

June 24, 2024

Re: Impact Analysis of Bollard Model TIB-67-SA
ASTM F2656 C40 P1 Test Parameters

To whom it may concern:

As the professional engineer of record for the Model TIB-67-SA Traffic Impact Bollard that was crash tested to ASTM F2656 C40 P1 parameters, I have completed additional analysis of the impact energy and stopping capabilities for this bollard. The subject bollard system was impacted by a passenger car weighing 2432 lbs. at 42.6 mph delivering 147,400 ft-lbs. of kinetic energy upon impact. A P1 penetration distance was achieved where the vehicle experienced about 12" of frontal crushing during the impact, meeting or exceeding the S30 penetration requirement.

When comparing the Bollard Model TIB-67-SA to ASTM F3016 S30 testing parameters for low impact bollards, the Bollard Model TIB-67-SA provides equivalent stopping capability and penetration distance as follows:

1. The Bollard Model TIB-67-SA was impacted at 147,400 ft-lbs. of kinetic energy during the crash test, which is significantly higher than the minimum F3016 S30 impact energy of 123,600 ft-lbs. The minimum required stopping capability under ASTM F3016 S30 is 123,600 ft-lbs. based on vehicle weight of 5,000 lbs. (with 110 lbs. of allowable variance) and impact velocity of 30 mph (with 2.5 mph of allowable variance). Bollard Model TIB-67-SA exceeds the minimum stopping capability required under the F3016 S30 bollard test standard.
2. The Bollard Model TIB-67-SA's penetration distance as tested meets the ASTM F3016 S30 P1 penetration standard. Under ASTM F3016, a "surrogate vehicle" is used, and dynamic penetration is measured after crushing of an internal media occurs. A P1 vehicle penetration rating under ASTM F3016 S30 testing parameter requires no more than 12" of dynamic penetration from the leading edge of the bollard, where the ASTM F3016 S30 dynamic penetration is measured after the surrogate test vehicle's internal media crushes during impact. The Bollard Model TIB-67-SA was impacted with an actual vehicle where the front engine realistically crushed upon impact.

In conclusion, Model TIB-67-SA Traffic Impact Bollard tested to ASTM F2656 C40 P1 parameters meets the stopping capability and allowable penetration distance under the F3016 S30 P1 bollard test standards.

Michael Lamore is a registered professional engineer and subject matter expert (SME) regarding engineering, design, and testing of robust physical barrier systems. He has more than 25 years of experience in engineering and design of crash rated barriers and has completed more than 30 ASTM 3rd party crash tests. Mr. Lamore has completed extensive engineering and analyses of various types of impacts on crash rated barrier systems including foundations, structural materials, connections, weld types, energy dissipation, load paths, crushing, and associated analyses.

Sincerely,

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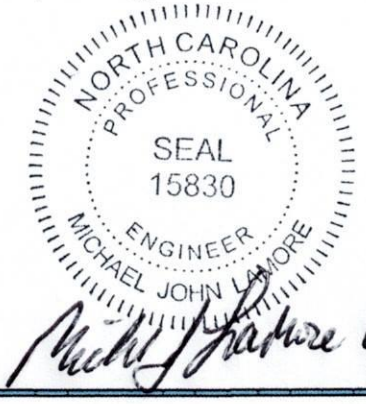

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