Designation: F3455/F3455M – 22

Standard Practice for Establishing the Minimum- and Maximum-Width Configurations for Crash Testing of Exceptionally Long Variable-Width Vehicle Barriers[1]

This standard is issued under the fixed designation F3455/F3455M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice provides a procedure for applying Test Method F2656/F2656M test criteria to an exceptionally long (that is, 300 ft [91 m] or greater) variable-width vehicle barrier as defined by Test Method F2656/F2656M.

1.2 This practice provides a procedure to establish a maximum-width configuration that is equivalent to an infinitely long barrier for a variable-width barrier as defined by Test Method F2656/F2656M.

1.3 This practice applies only to variable-width barriers that are dependent on both a structurally repetitive interior system that could be exceptionally long and terminated with strengthened end terminals.

1.4 This practice applies only when it is impractical or impossible to install the maximum-width test article of a variable-width barrier because the test facility site constraints limit the practical length of the test article.

1.5 This practice does not apply when its use is employed solely with the intent of reducing the test article installation cost when it is practical to test the maximum-width installation length.

1.6 This practice does not apply to continuous or other types of vehicle barriers.

1.7 This practice shall be used with Test Method F2656/F2656M to establish a condition designation and penetration rating for the complete variable-width barrier. Further, the complete variable-width barrier shall receive a single penetration rating that is determined as the maximum penetration rating for both the minimum- and maximum-width configurations tested, and is taken to be the final penetration rating. The penetration rating is not based on engineering calculation or judgment.

1.8 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.9 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.10 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F2656/F2656M Test Method for Crash Testing of Vehicle Security Barriers

3. Terminology

3.1 *Definitions:*

3.1.1 *barrier, n*—gate, bollard, wedges, drop arms, walls, wire ropes, net, planter, other structure, or topographical feature (that is, berms, rocks, or trenches) that provides protection against a vehicle trying to gain access overtly or inadvertently to a compound or facility.

3.1.2 *condition designation, n*—relates vehicle type and vehicle velocity to the kinetic energy for which testing is conducted.

3.1.3 *continuous barrier, n*—any barrier that relies on a continuous foundation or a continuous structural element to resist penetration by vehicles.

[1] This practice is under the jurisdiction of ASTM Committee F12 on Security Systems and Equipment and is the direct responsibility of Subcommittee F12.10 on Systems Products and Services.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.1.4 *penetration rating, n*—rating achieved by a barrier based on maximum dynamic penetration distance for a given condition designation.

3.1.5 *rated-ASTM barrier, n*—vehicle security barrier tested in accordance with this practice and Test Method F2656/F2656M by an accredited facility that achieves a given condition designation and penetration rating based on the distance travelled after impact.

3.1.6 *variable width barrier, n*—perimeter security devices such as gates, nets, wedges, and modular units that will likely be deployed with different functional widths, as defined by Test Method F2656/F2656M.

3.1.6.1 *exceptionally long variable-width barrier, n*—a variable-width barrier whose maximum-width could be 300 ft or greater and which consists of a structurally repetitive interior system that is terminated with strengthened end terminals; these barriers include cable fences or post-and-beam type systems.

4. Summary of Practice

4.1 The procedure specified in this practice applies to variable-width barriers that are dependent on both a structurally repetitive interior system and terminated with strengthened end terminals, as described herein. The procedures presented herein establish the maximum-width configuration that is equivalent to an effective, infinitely long barrier.

4.2 The minimum-width configuration is established in accordance with procedures presented in Test Method F2656/F2656M.

4.3 The maximum-width configuration for the variable-width barrier is established using instrumented end terminals and the required number of interior repeating systems so that zero shear, torsion, and moment and negligible axial load are transferred to the extreme load-carrying elements in the interior system.

4.4 Physical connections or mechanisms are used to ensure zero shear, torsion, and moment are transferred between the interior system's extreme load-carrying elements and the instrumented end terminals. In addition, each extreme load-carrying element is instrumented using load cells, strain gages, or other appropriate methods for the purpose of measuring axial load during the crash test. These data are analyzed to verify the axial load transmitted through each extreme element is negligible.

4.5 If the axial load is negligible for each extreme load-carrying element, it will be shown that the performance of the interior repeating system is not altered as the length of the system exceeds the maximum width tested.

4.6 This practice shall be used with Test Method F2656/F2656M to establish a condition designation and penetration rating for the minimum- and maximum-width configurations of the variable-width barrier, where the results of the maximum-width configuration are deemed to apply to a barrier of exceptionally long length.

4.7 The complete variable-width vehicle barrier shall then become a rated-ASTM barrier with a condition designation and penetration rating. The penetration rating does not require engineering calculations, judgment, etc. Rather, the complete variable-width vehicle barrier is defined using the largest penetration rating (that is, if the maximum-width configuration achieves a P2 Penetration Rating and the minimum-width configuration achieves a P1 Penetration Rating, the complete system is rated as P2).

5. Significance and Use

5.1 Test Method F2656/F2656M states that variable-width barriers shall be tested in minimum- and maximum-width configurations. Interpolations between maximum and minimums are allowed if there are no structural modifications made to the barrier (that is, all structural components, including spacing of support members and connections, are similar between the two barriers tested at minimum and maximum widths). Extrapolation outside of the tested minimum- and maximum-width configurations is not allowed.

5.2 However, there is a class of barriers such as some nets and fences that rely on a structurally repetitive interior system and strengthened end terminals or anchorages that are not explicitly treated under Test Method F2656/F2656M. There are situations where the interior system of the barrier could be exceptionally long and it is impractical or impossible to test the maximum-width configuration due to test facility site constraints, as an example.

5.3 When a variable-width barrier is dependent on a structurally repetitive interior system that could be exceptionally long and terminated with strengthened end terminals, this practice shall be used to establish the maximum-width configuration that is equivalent to an infinitely long barrier.

5.4 This practice shall be used with Test Method F2656/F2656M to establish a condition designation and penetration rating for the complete variable-width barrier. Knowing the condition designation and penetration rating provides the ability to select an appropriate barrier for site-specific conditions around a facility.

5.5 Use of this practice assumes:

5.5.1 Except for the instrumented end terminations, the structurally repetitive interior system is constructed and installed in a manner that represents the proposed actual service installation;

5.5.2 Except for the instrumented end terminations, the structurally repetitive interior system conforms to supplier specifications and drawings;

5.5.3 The actual service installation of the structurally repetitive interior system shall be terminated using the strengthened end terminals used for the minimum-width configuration test; and

5.5.4 The instrumented end terminations used for the maximum-width configuration shall provide axial load resistance only.

6. Procedure

6.1 The minimum-width configuration for the variable-width barrier shall be established using two end terminals and using none or as many interior repeating systems as desired.

This as-tested length defines the minimum installation length for a crash-rated system in conformance with Test Method F2656/F2656M.

6.2 The maximum-width configuration for the variable-width barrier shall be established using two instrumented near-rigid end anchors and the required number of interior repeating systems so that axial load transferred to the instrumented end anchors through the load-carrying elements are negligible, as defined herein.

6.3 All load-carrying elements at the end anchor shall be terminated in a manner where only axial tension or compression is permitted, that is, this instrumented connection shall not allow for moment, shear, or torsion to develop between the load-carrying elements and the end anchor.

NOTE 1—The primary purpose of this type of connection is to prevent the transfer of moment, shear, and torsion between the load-carrying elements and end terminations. This can be achieved mechanically with the use of pinned connections, clevises, spherical joints, links, cables, etc. This type of connection will not necessarily be representative of the proposed actual service installation and should not be considered part of the structurally repetitive interior system.

6.4 Each individual load-carrying element shall be instrumented at the end anchor for the purpose of measuring axial load during the crash test. This load can be measured using load cells, strain gages, or other appropriate methods depending on the application.

6.5 Using the minimum and maximum-width configurations defined above, Test Method F2656/F2656M testing shall be conducted as prescribed.

6.6 To consider the axial load negligible at the end anchor, the measured axial load in any one load-carrying element cannot exceed the smaller of:

6.6.1 One percent (1 %) of the ultimate static axial load capacity of the load-carrying element attached to the end anchor through the load cell, strain gage, or other device, or

6.6.2 500 lb [2224 N].

6.7 All raw data measured shall be sampled at a minimum of 1000 Hz and filtered using a CFC Class 180 filter and then a moving window average over 50-ms applied.

6.8 The calculated deflection of the end anchor shall be less than 0.250 in. [6 mm] when the maximum of the sum of the dynamic load determined in 6.7 from all structural elements are applied to the end anchor at the centroid of the load carrying elements.

6.9 The end anchor shall be adequate in size to behave linearly elastic only.

7. Report

7.1 The test report shall be prepared according to the criteria established in Test Method F2656/F2656M, except that the minimum- and maximum-width tests shall be combined into a single report. The test report shall clearly indicate the minimum and maximum widths tested. Photographs (including front, side, back, and overhead views) which show the entirety of both tested articles shall be included with the test report.

7.2 For the maximum-width configuration, the report shall describe the as-built instrumented end terminals, the as-built strengthened end terminals used for the minimum-width configuration, and structurally repetitive interior system, including tested width, photographs, detailed engineering drawings with dimensions and material specifications, of all components of the barrier, including, but not limited to foundation details, rebar sizing and spacing, concrete properties, and instrumentation devices used.

7.3 A reference for this practice shall be provided for the method used to test the maximum-width configuration and why it meets the criteria described in this practice (that is, the load is negligible at the end terminals).

7.4 The report shall clearly state that the complete variable-width barrier is only a rated-ASTM barrier if the service installation of the structurally repetitive interior system is terminated using the end terminations used for the minimum-width configuration.

8. Keywords

8.1 anti-ram barriers; anti-terrorist barriers; continuous barriers; net barriers; perimeter barriers; security barriers; variable width barriers; vehicle crash test

APPENDIX

(Nonmandatory Information)

X1. EXAMPLES OF INSTRUMENTED END TERMINALS AND AXIAL-ONLY CONNECTIONS

X1.1 See Fig. X1.1 for an example of an instrumented end terminal for the maximum-width configuration of a variable-width wire rope barrier. The structurally repeating interior system with wire rope load-carrying elements is terminated to a near-rigid end anchor. Load is measured in each load-carrying element using a load cell that is placed in-line with the wire rope and connected to the end anchor. An axial-only connection is enforced with the use of bow shackles and spherical rod eyes to connect the load cell to the anchor and each wire rope.

X1.2 See Fig. X1.2 for an example of an axial-only connection that attaches a W-section load-carrying element to a load cell using bow shackles and spherical rod eyes. For testing, the load cell would be terminated to a near-rigid anchor like that shown in Fig. X1.1.