

Equivalence of ASTM F355-C and Triax/G Test Methods

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ASTM subcommittee F08.63 on Playground Surfacing is responsible for the F-1292 Standard Specification for Impact Attenuation of Surface Systems Under and Around Playground Equipment. An alternative method of impact testing is currently under consideration by that group. The Triax/G or “Triaxial” method and the current standard are based on similar principles. However, the Triaxial method uses a different headform that is not guided as it falls. To compensate for any rotation of the headform during the drop, the Triaxial headform has a spherical surface and incorporates three accelerometers mounted orthogonally. The important differences between the two-methods are listed in Table 1. The importance of the Triaxial method is that it is portable, and capable of testing surfaces *in situ*.

TABLE A1-1: Important differences between the F355-C and the Triaxial methods

		F 355	Triax
Headform	Type	ANSI C	non-standard
	Mass	5.0 kg	4.6 kg
	Shape	Compound Curves	Hemisphere
Drop	Type	Guided	Free-fall
	Velocity measurement	Direct	Indirect
Accelerometry		Uniaxial	Triaxial
Portability		Limited	Portable

As part of it’s evaluation of he proposed new method, ASTM Subcommittee F08.63 has conducted an Interlaboratory Study (“ILS”) of both the existing standard method (“Uniaxial”) and the Triaxial method. By comparing the results of the same test method applied to the same materials or samples in different laboratories, an ILS makes it possible to determine the repeatability and reproducibility of a test method. In collaboration with an F08.63 task group, the author of this report has performed an independent statistical evaluation of the ILS data.

The general conclusion to be drawn statistical analyses of the ILS data is that both the Uniaxial and Triaxial test methods are “noisy”, in the sense that their results are somewhat variable. HIC measurements are less reliable than *g*-max measurements. On average, however, the two tests give similar results.

- The interlaboratory study results show that the two tests have similar repeatability and reproducibility. The repeatability results are slightly better for the Uniaxial tests and significantly so in the case of *g*-max. Reproducibility results were almost identical for the two tests, but the reproducibility confidence intervals were high for both tests; ± 25% for *g*-max and ± 50% for HIC.

- Correlation analysis shows that there is a strong association between the results obtained with the two methods, with correlation coefficients of 0.98 for *g*-max and 0.95 for HIC.
- Regression analysis shows that the form of the association between the two sets of test results is linear, and that the relationship is almost one-to-one.; Over a large number of tests, the average scores for the two methods will be within 1% or 2 % of one another. The “noise” in both tests methods is such that this correspondence is less reliable for individual test results. The 95% confidence intervals are quite large, reflecting the poor repeatability and reproducibility results.
- Three way analysis of variance found significant differences between surfaces (as expected), and significant differences between laboratories (undesirable but not unexpected) but no significant differences between the two test methods.

The results of these analyses show little evidence for preferring one test method to the other. Despite small methodological differences between the Uniaxial and Triaxial tests, the average values and variability of the results they produce are similar. Both tests have variability but if enough samples are taken to average out the “noise”, they can be expected to give the same results. For practical purposes, therefore, the two test methods are equivalent.

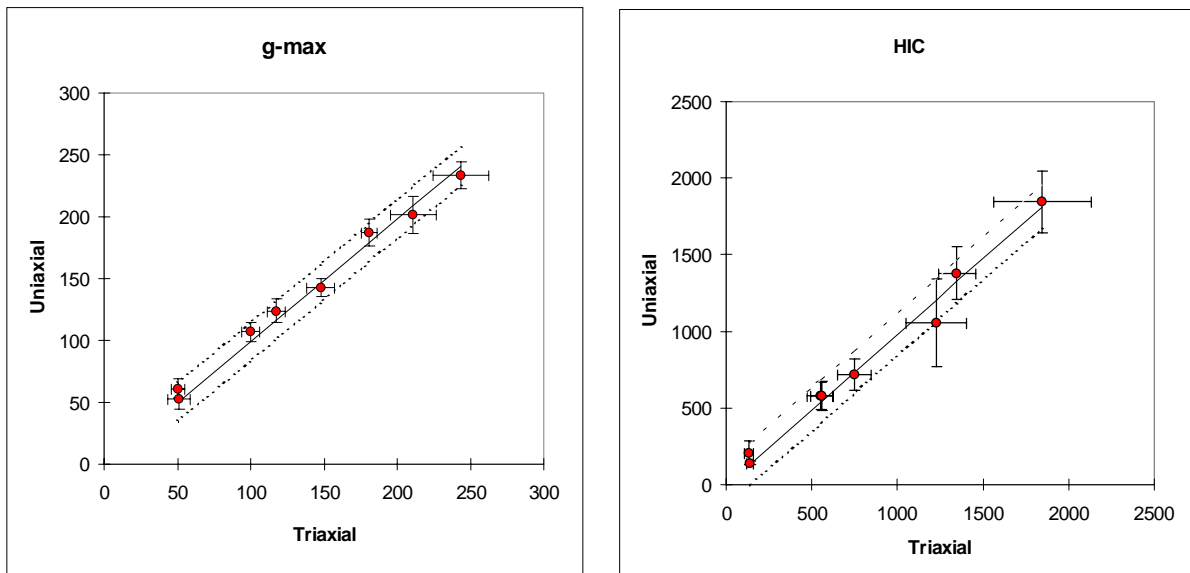


Figure A1-1: Regression of *g*-max and HIC scores from Uniaxial and Triaxial methods
Each point is the mean of values recorded on the same surface in 7 different laboratories. Vertical and horizontal bars attached to each point represent ± 1 standard deviation. Solid lines are regression lines. R^2 is the coefficient of determination. Dashed lines represent the 95% confidence interval of the regression.