Experimental Measurement of TNT Equivalency for Contact Charges

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Intro

The ability to compare explosives is fundamental. Numerous methods are used and while simple conversion factors are often used, the use of TNT Equivalency (TNTe) is not a simple subject as explosives exhibit very different equivalencies depending on whether the pressure or impulse are being compared. Using a Ballistic Pendulum rather than a traditional Ballistic Mortar allows the impulse from charges to be measured and by comparing with a reference explosive (TNT) allows a TNTe to be obtained quickly and accurately.

Methods

Unlike the ballistic mortar, the ballistic pendulum does not have a firing chamber for containing the explosive and there is no projectile to be ejected. Charges are directly fixed to the anvil on the pendulum and the gas products allowed to vent directly into the atmosphere while imparting impulse into the pendulum, causing it to swing.

Tests were carried out with charges ranging from 10g to 70g for a range of explosives which were fixed directly to small sacrificial anvils designed to transmit the force into the pendulum mass while preventing damage to the mass.

Results

A TNTe (Impulse) for PE4 of 4.05 was obtained and for a dynamite 1.44. It is likely that the baseline TNT charges may not have fully detonated due to the small charge size, meaning that the factors are likely to be slightly high, the huge difference between PE4 and dynamite was surprising.

Discussion

Further investigation found that among the limited data in the literature there were some tests conducted in the US in the 1970s and 80s which also found that under certain conditions TNTe factors of over 4 were obtained for impulse indicating that the results obtained were accurate. A 2-stage propulsion theory (Backofen) in which an initial brisant-phase would play a significant role with contact charges may explain the high figure for high brisance explosives (PE4) compared with those with lower brisance such as dynamite. The difficulty found with initiating small TNT charges begs the question of whether it would be better to change the reference explosive to something like Pentolite.

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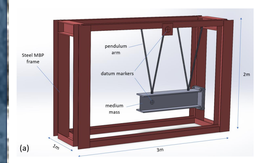
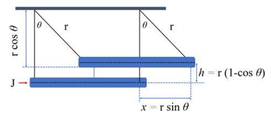
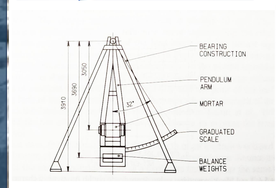
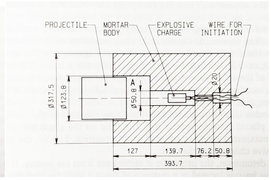
Extra Figures & Tables

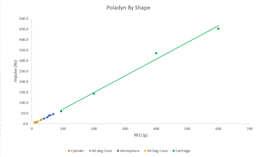
$$J = m\sqrt{2gr\,(1-\cos\theta)}$$

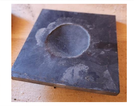


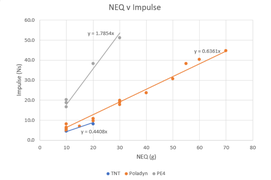




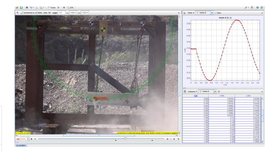


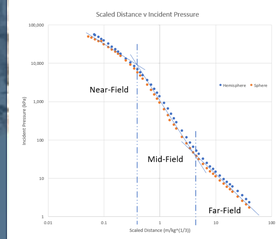


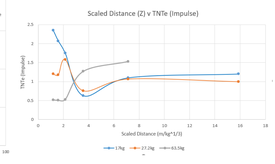




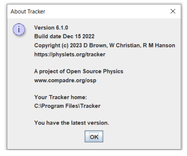
Explosive	NEQ g	Impluse Ns	TNTe
TNT	22.00	9.70	1.00
Poladyn	-	13.99	1.44
PE4	-	39.28	4.05







Explosive	Sand Crush test	Ballistic Mortar	Trauzl	Plate Dent	Pressure	Impulse	Range	Source
C4					1.37		NA	Maserjian & Fisher (1951) *
C4	0.557	1.3		1.15			NA	Cooper & Kurowski (1996)
C4						1.19		US DOD (2002) **
C4					1.8	4.7	Near-Field	McIntyre (1981)
C4					1.0	2.3	Far-Field	McIntyre (1981)
PE4		1.3			1.35	1.3	Far-Field	Wharton, Formby & Merrifield (2000)
RDX	0.602	1.5	1.57	1.35				Cooper & Kurowski (1996)
PETN	0.627	1.45	1.73	1.29				Cooper & Kurowski (1996)
Driftex NG Dynamite		0.71			0.55	0.5	Far-Field	Wharton, Formby & Merrifield (2000)



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