

MULTIPLE HIT PERFORMANCE OF 7.62 MM HARDENED STEEL AND 30 MM APFSDS PROJECTILES IN BRICK AND REINFORCED CONCRETE WALLS

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This study presents terminal ballistic data on the multiple hit performance of kinetic energy projectiles against brick and reinforced concrete wall materials. We use 7.62 mm ammunition with hardened steel penetrator and 30 mm APFSDS ammunition with tungsten long rod penetrator. The firings are performed in two different distances to the target. The impact pattern is governed by the given projectile dispersion and not by a limit for the minimum distance between two impacts. The impact velocity is measured by radar. For control of the residual velocity behind the target high speed cameras are applied. Starting from the geometrical damage caused by single hits first ideas are developed for modelling the multiple hit performance.

INTENTION AND EQUIPMENT

This study presents terminal ballistic data on the multiple hit performance of kinetic energy projectiles against brick and reinforced concrete wall materials. We don't base our research on the impact pattern governed by a limit for the minimum distance between two impacts according to standardized material test methods, but on the multi hit pattern governed by the given projectile dispersion. The data presented here are part of a comprehensive program to model the multiple hit performance in walls. To start with, we determine the typical geometric data of the impact damage of single hits as designated in FIGURE 1.

The targets are consisting of one or more layers, which are bound together. The brick wall layers have a thickness of 240 mm (FIG 2) and the layers of reinforced concrete a thickness of 200 mm (FIG 3).

We use 7.62 mm ammunition with hardened steel core and with tungsten carbide core shot from standard test barrels. Further we also apply 30 mm APFSDS ammunition with tungsten long rod penetrator shot from the Bushmaster II Mk44 gun of the SPz 2000. The terminal ballistic investigation is performed in the ballistic ranges of armasuisse in Thun in two different distances of 50 m and 200 m to the

target. The impact velocity is measured by radar. To analyse the residual velocity behind the target high speed cameras will be applied.

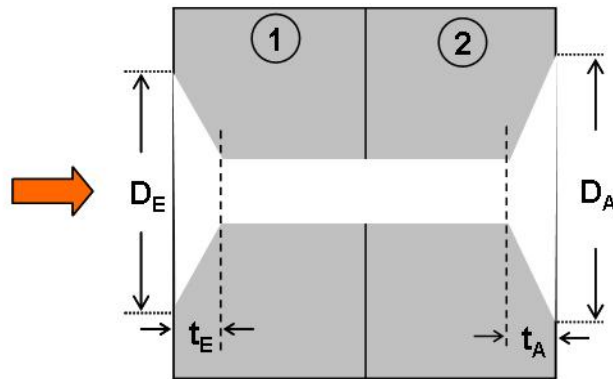


Figure 1. Typical geometrical crater data measured on the targets after impact



Figure 2. 240 mm thick brick wall target

Figure 3. 200 mm thick reinforced concrete wall target

RESULTS

The results obtained are presented in FIG 4-7. So far the following experimental series have been executed

Single shot performance

Brick wall target

- 7.62 mm tungsten carbide core, distance 50 m and 200 m

Reinforced concrete wall target

- 7.62 mm hardened steel core, distance 50 m and 200 m
- 7.62 mm tungsten carbide core, distance 50 m
- 30 mm APFSDS tungsten core, distance 50 m and 200 m

Multi hit performance

Brick wall target

- 7.62 mm tungsten carbide core, distance 50 m and 200 m

Reinforced concrete wall target

- 30 mm APFSDS tungsten core, distance 50 m and 200 m

In brick walls two regions of complete different perforation resistance are observed. One is the brick material the other one the joint material, usually mortar or plaster called, in between the bricks. Whereas the first region is able to stop 7.62 mm TC cores in less than 120 mm, the latter lets pass the projectile easily through the whole wall (>240 mm). This certainly is very much coupled to the non-homogeneous character of such construction joints.

Experiments with 30 mm APFSDS against brick wall layers were omitted since the tremendous penetration performance in reinforced concrete renders obvious that simple brick walls would never be taken into account as protection against this type of ammunition.

Multi hit experiments were restricted to 7.62 mm tungsten core against brick wall and 30 mm APFSDS against reinforced concrete wall. This is mainly due to the need for targets with reduced thickness for further small caliber experiments. Using the 7.62 mm TC projectile, the brick wall is perforated after 8 shots in 50 m distance and after 27 shots in 200 m distance. The 30 mm APFSDS projectile is perforating the reinforced concrete wall after 3 shots in 50 m distance and in 4 shots in 200 m distance (FIG 7).

FURTHER STEPS

The collected data presented here as well as those from succeeding experiments will be used to suggest a multi hit model for typical building wall materials such as the materials investigated so far. To accomplish this goal further data will be analyzed such as the residual projectile velocity after the targets, which has not yet been completed. Further experiments will certainly complete the missing performance of hardened steel core projectiles and include additional construction materials.

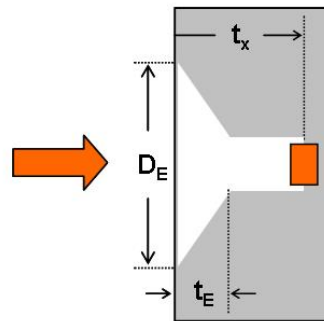
ACKNOWLEDGEMENTS

This investigation is part of the science and technology protection research program of armasuisse. All tests are carried out with the support of the testing and metrology department in Thun. Our thanks especially go to T. Rothacher and his team.

REFERENCES

- [1] Referenz: D. Hoffmann, 2004. BAD beim Beschuss, von Gebäudezielen, IBH-report

Single shot on 200 mm thick reinforced concrete plate



Hardened steel core:
Residual projectile parts
at crater ground prevent
exact measurement of t_x

a) Hardened steel core

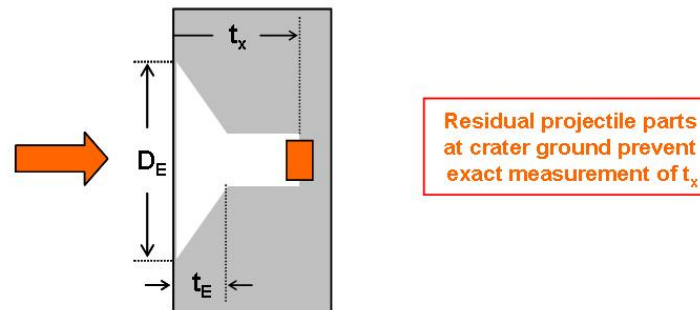
Shot #	Distance x (m)	D_E (mm)	t_E (mm)	t_x (mm)	v_i (m/s)	Notes
1	200	60-65	20	47	734	Rear undamaged
2	200	30-35	20	39	735	
3	200	90-97	20	36	739	
4	50	100	27	43	841	Near existing crater
5	50	110-130	25	55	835	Rear undamaged
6	50	12	2.7	5.2	835	

b) TC core

Shot #	Distance x (m)	D_E (mm)	t_E (mm)	t_x (mm)	v_i (m/s)	Notes
1	50	100	25	62	902	Rear undamaged
2	50	80	23	82	903	
3	50	80-90	20	80	902	

Figure 4. Single shot performance of 7.62 mm hardened steel core and tungsten carbide core in reinforced concrete in 50 and 200 m (only steel core) distance

Single shot on 240 mm thick brick wall

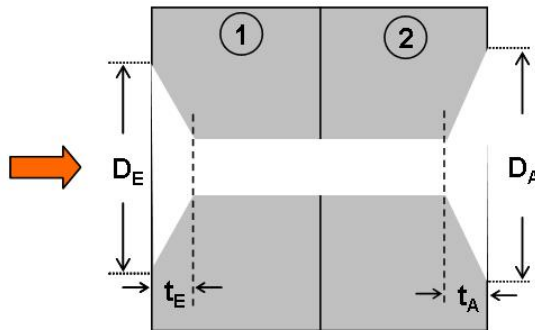


b) TC-Kern

Shot #	Distance x (m)	D_E (mm)	t_E (mm)	t_x (mm)	v_1 (m/s)	Notes
1	50	27-34	14	>240	897	Perforation
2	50	60-65	17	102	900	
3	50	60	21	110	900	

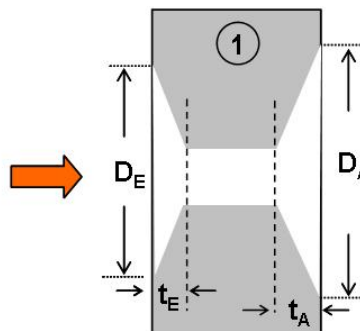
Figure 5. Single shot performance of 7.62 mm tungsten carbide core in brick wall in 50 m distance

a) Single shot on two 200 mm thick reinforced concrete plates



$D_E(\text{mm})$	$t_E(\text{mm})$	$D_A(\text{mm})$	$t_A(\text{mm})$	$v_i(\text{m/s})$	Notes
220-290	45	390-400	50	1351	Crater passes near fortification

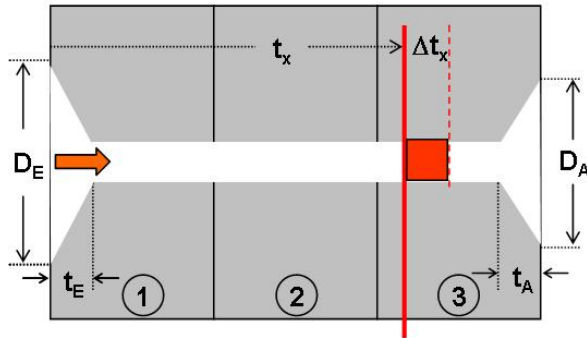
b) Single shot on 200 mm thick reinforced concrete plate



$D_E(\text{mm})$	$t_E(\text{mm})$	$D_A(\text{mm})$	$t_A(\text{mm})$	$v_i(\text{m/s})$	Notes
210-230	40	240-300	45	1351	Shot through reinforcement near crossing

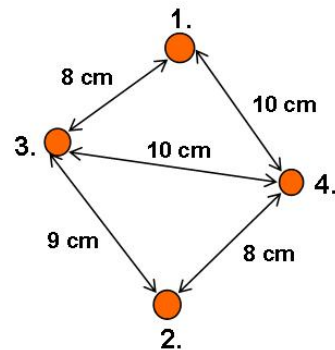
Figure 6. Single shot performance of 30 mm APFSDS tungsten core in reinforced concrete in 200 m distance

4 shots on three 200 mm thick reinforced concrete plates



Note: Residual penetrator parts prevent exact measurement of penetration depth t_x

Hit pattern on front side



Shot #	D_E (mm)	t_E (mm)	t_x (mm)	v_l (m/s)	Note
1	220-240	40	46	1346	fine crack on rear of 3. plate, gap between 2. und 3. plate
2	280-350	40	47	1344	extended crack formation
3	280-370	40	47	1348	Rear side of 3. plate almost unchanged
4	280-370	50	Perforation	1346	Rear side crater D_A (mm): 260 - 470, t_A (mm): 80

At 50 m distance perforation with 3. shot.
 D_A (mm): 500 – 540, t_A (mm): 80, v_l (m/s): 1368

Figure 7. Multi hit performance of 30 mm APFSDS tungsten core in reinforced concrete in 50 m and 200 m distance