Development of a 7.62 mm Armor Piercing (AP) Projectile Using a Lean Design For Six Sigma (LDFSS) Process

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Development of a 7.62 mm AP projectile using a LDFSS process

- OBJECTIVE
- APPROACH
- CONCEPTS
- RESULTS
- CONCLUSION
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OBJECTIVE

– To study a number of 7.62 mm AP projectile concepts with performances superior to those obtained with the 7.62 mm Improved Penetration (IP – 1038) cartridge.

– Criteria for the new design
  – penetration > 19 mm RHA at 100 m at 0°
  – penetration > 6 mm RHA at 550 m at 0°
  – Same propellant charge and cartridge case as 7.62 mm C21 (Canadian equivalent to US 7.62mm M80)
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APPROACH

– BRAINSTORMING
  – Several meetings to establish a set of criteria
  – 12 concepts were proposed:
    – Different materials
    – Several geometries
    – Various penetrator and slug combinations
  – Used Pugh method to select concepts that satisfy the criteria
  – $V_{50}$ trials for three of the selected concepts
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CONCEPTS

– Three most promising concepts selected:

- M80 – T1
- Open Jacket – Tungsten Carbide (WC)
- Two Parts – Tungsten Carbide (WC)

– Two more concepts added to understand influence of materials on penetration:

- M80 – T15
- Open Jacket – T1
## Summary of concepts characteristics

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<tbody>
<tr>
<td><strong>Total Weight (g)</strong></td>
<td>8.40</td>
<td>8.44</td>
<td>8.40</td>
<td>9.21</td>
<td>9.04</td>
<td>8.46</td>
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<tr>
<td><strong>Penetrator Weight (g)</strong></td>
<td>4.91</td>
<td>5.01</td>
<td>4.95</td>
<td>6.31</td>
<td>5.67</td>
<td>1.25</td>
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<tr>
<td><strong>Slug Weight (g)</strong></td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>3.85</td>
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<tr>
<td><strong>Total Length (mm)</strong></td>
<td>30.84</td>
<td>29.31</td>
<td>29.87</td>
<td>25.48</td>
<td>29.82</td>
<td>29.29</td>
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<tr>
<td><strong>Hardness of Penetrator (RC)</strong></td>
<td>57</td>
<td>60</td>
<td>67</td>
<td>71</td>
<td>60</td>
<td>71</td>
</tr>
<tr>
<td><strong>Velocity at 24 m (m/s)</strong></td>
<td>857</td>
<td>865</td>
<td>865</td>
<td>864</td>
<td>868</td>
<td>867</td>
</tr>
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- Setup for penetration trial
  - Three different thickness (10 mm, 14 mm and 19 mm) of RHA steel plates
  - Hardness of the steel plate was 300 HB
  - Standard $V_{50}$ trial setup
  - Impact velocity was measured at 38 m
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RESULTS

- High speed camera pictures of projectiles in flight

Two Parts – WC
- 10 mm steel plate
- Impact Velocity : 804 m/s

Open Jacket - WC
- 14 mm steel plate
- Impact Velocity : 688 m/s

Open Jacket - WC
- 19 mm steel plate
- Impact Velocity : 828 m/s
RESULTS

- $V_{50}$ measured for six rounds that penetrated and six rounds that did not penetrate the steel plates, within a velocity range of 40 m/s.
- The Reference projectile was the in-house developed, 7.62 mm IP-1038.
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RESULTS

Range vs plate thickness

- M80 – T1, M80 – T15 and OJ - WC are superior to the reference concept (IP - 1038)
- OJ – T1 shows same performance as the reference concept
- Two Parts – WC is inferior to the reference concept
- OJ – WC performs the best among all concepts
  - Only concept that satisfies the two criteria
    - Penetration > 19 mm at 100 m and > 6 mm at 550 m.
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- Second iteration
  - Concept Open Jacket – WC with a more sharper nose (Influence of the geometry)
  - Two Parts – WC
    - Press fit linkage between the penetrator and the slug (Linkage of the penetrator)
    - Increased weight of the penetrator
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- Results of second iteration
  - Open Jacket – WC and Open Jacket – WC #1 show similar results
    - Penetrator geometry has little influence on penetration
  - Press fit linkage has an influence on penetration (Two Parts – WC and Two Parts – WC #1)
  - Penetrator weight significantly influences penetration (Two Parts – WC and Two Parts – WC #2)
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RESULTS

- Used Quality Function Deployment (QFD) to prioritize concepts
- Higher QFD weight
  - Concepts Open Jacket – WC and Open Jacket – WC #1 were able to satisfy the penetration criteria
  - Concept Two Parts – WC #2 was able to penetrate a 14 mm steel plate at > 100 m
  - Concepts IP-1038, M80 – T1 and M80 – T15
    - Inexpensive to produce
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Conclusions

- The types of materials significantly influence penetration
  - Tungsten carbide gives good result (71 HRc).
  - The Hardness plays an important role on the penetration process. However, other mechanical proprieties may also have an influence since T1(60 HRc) and T15(67 HRc) have the same performance
- The weight of the penetrator has a major effect on the performance of the projectile
- The solidification of the linkage (Press fit) shows a better performance since the slug is able to transfer its momentum to the penetrator
- The geometry of the penetrator has little influence
Further Information

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