

Article36

Damage to the built environment from the use of explosive weapons

It is a distinctive feature of explosive weapons that they, by contrast with firearms, can cause very severe damage to the built environment.

For some types of explosive weapons, the capacity to damage or destroy buildings is an important aspect of their perceived military utility. However, when used in a built environment, explosive weapons with wide area effects ('heavy explosive weapons') create elevated humanitarian risks.

This is due to:

- × the potential for explosive force to cause the collapse of a building hit with a heavy explosive weapon;
- × the potential of heavy explosive weapons to damage buildings other than the one directly hit, sometimes over a wide area:
 - collapsing structures can cause damage to neighbouring buildings;
 - the propagation of the blast wave can damage buildings in the wider surroundings; and/or
 - multiple explosive weapons launched at an area or inaccurate delivery of an explosive weapon can hit buildings within an area that are not the intended targets;
- × the concentration of public service infrastructure in towns and cities, which presents an elevated risk of damage to healthcare, water and sanitation, shelter, power and education facilities – damage and destruction of which greatly exacerbates the impact of conflict.

In Syria, for example, explosive weapons have caused immense devastation over the last two years. Entire neighbourhoods have been levelled to the ground by shelling and bombardment with mortars and artillery shells; rockets; air-dropped bombs; and powerful improvised explosive devices (IEDs). The use of heavy explosive weapons in villages, towns and cities has been a major cause of humanitarian suffering in that conflict.



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How explosive weapons affect buildings and structures

Explosive weapons affect structures and other objects in the vicinity of a detonation mainly through blast pressure, impact damage and heat.¹ The scope and type of damage from an explosive weapon depends on a variety of factors, including the energy output of the detonation, the location of the detonation relative to the affected structure (distance), the incident angle, and the affected structures' characteristics.² In terms of their impact on buildings:

Blast from the detonation of an explosive weapon can destroy or severely damage portions of a building's external and internal structural framework. It can bend beams and pipes, damage columns, push exterior walls inward, shear off parts of the building, push floors up, push the roof up, and blow out windows.³

Impact damage results from weapon fragments and debris such as shards of window glass, bricks, soil being mobilised by the blast. These materials can penetrate walls, break windows and even cause structural damage.

Heat from the explosion can affect the properties of building materials. This can cause materials to lose flexibility, which may contribute to progressive collapse. Heat from the explosion can also ignite fires.

Explosive weapons in the built environment

The use of heavy explosive weapons can affect the built environment over a wide area. Some explosive weapons are very powerful and have a wide blast or fragmentation radius. When they are used against a building, they can cause severe damage to structural elements of the building, resulting in partial or total collapse of the structure.⁴ In a populated area, where buildings tend to be occupied by civilians, even if they may also contain military assets or personnel, use of very powerful explosive weapons bears a high risk of civilian harm.

The effects of heavy explosive weapons are often not limited to a single structure. The collapse of a building can severely damage neighbouring structures.

“the family returned to their home to find that it had been flattened to the ground by rubble from a neighbouring apartment building that had been directly hit by an Israeli military strike.”⁵

In a densely built-up area, the blast wave can be reflected and amplified by structures and the hard surface of the ground around the detonation site.⁶ Especially dense urban streetscapes do not permit the blast energy to radiate spherically away from the detonation. Tall buildings and narrow streets can concentrate and significantly enhance blast pressure in some places, channeling the blast through ‘urban canyons’. As a result, blast damage can be more extensive over much wider areas than if the same explosive weapon had been detonated in an open space.⁷ Due to the complex interaction of the blast wave with reflecting surfaces, the extent and severity of blast damage to the built environment can be very difficult to accurately predict.⁸

Built environments often contain a density of different types of structures – with commercial and residential buildings alongside schools, hospitals and other civic institutions. Servicing these structures are the networks of water, sanitation, power, communications and transport infrastructure critical to the local population. Where heavy explosive weapons are used in such environments, even in attacks directed at legitimate military targets, there is an elevated risk of such structures being damaged, resulting in subsequent harm to the civilian population.

The humanitarian impact of damage to the built environment

It is often challenging from existing data sources to disaggregate the specific impact of explosive weapons from the wider humanitarian situation in times of war. However, it is apparent that due to their capacity to severely degrade the built environment, the use of heavy explosive weapons in populated areas tends to have wide-ranging and long-lasting negative effects on shelter, communal infrastructure, water and sanitation, health, education, public services and economic activity – with grave consequences for the civilian population:

Shelter and shared spaces of living

Damage caused by explosive weapons to homes can leave people without shelter. After being hit with an explosive weapon houses and apartment blocks can collapse. But even the loss of non-structural building sub-systems (piping, ventilation, light, etc.) can make a building uninhabitable. Hanging rubble or structural damage can make its use unsafe.

Loss of shelter increases the population’s vulnerability to natural hazards and violence, including further attacks with explosive weapons, and is a cause of forced population displacement. The destruction of shared spaces (such as communal infrastructure, playgrounds or places of worship) can negatively impact social cohesion, affect group identities and erode social support networks critical to the economic survival and psychosocial well-being of the civilian population.

Water and sanitation

Damage to water purification stations, drinking water reservoirs, wells, pumping stations, and drinking water distribution networks can lead to a deterioration of water and sanitation infrastructure, giving rise to health and hygiene problems.⁹

Clogging of the sewers by debris from the impact of bombing can disrupt the functioning of the waste water system and lead to overflow. Disruption of wastewater treatment can lead to the pollution of the natural environment and agricultural land, and pose a risk of drinking water and food contamination.¹⁰

Health care

Damage to health care facilities, medical vehicles, or the destruction of medical supplies can result in inadequate provision of health care to the civilian population. A study by the ICRC identified the use of explosive weapons during active hostilities that intentionally or unintentionally strike medical facilities as a key threat to health care in situations of armed conflict.¹¹

Scarcity of health care resources can have far-reaching effects on public health. The scarcer the available health care resources the more likely it is that only emergency care is given, with detrimental impacts on the chronically ill, and on those requiring long-term care, and rehabilitation.

Education

Explosive violence can contribute to the disruption of schooling, which can negatively affect the future prospects of large numbers of children and young adults.¹² The use of explosive weapons can damage educational facilities like schools or universities, and destroy libraries, or school busses. Shortages in educational resources can lead to a decline in school attendance and performance. In addition to the transmission of knowledge, education offers the promise of greater social cohesion, and provides students with the tools to leave the cycle of violence and conflict.¹³ Prolonged time out of school, and incomplete schooling, can translate into a loss of opportunities for young people.

Loss of livelihoods, displacement and economic crisis

The use of explosive weapons can damage economic assets, commercial premises, and kill livestock in peri-urban areas, which can be an important cause of loss of livelihoods, unemployment and financial destitution.¹⁴

Use of explosive weapons in populated areas has been identified as a major driver of forced population displacements,¹⁵ whether due to the immediate threat of death, injury and psychological trauma, or the destruction of the built environment. Repeated use of explosive weapons in populated areas can lead to people being displaced several times over the course of a conflict. Due to the material destruction of homes, sources of livelihood and public infrastructure, people may not be able to return. The use of explosive weapons will leave explosive remnants and may leave or release toxic remnants that can be a threat to health and an additional cause of protracted displacement.

“In terms of infrastructure, major parts of Syria have effectively been bombed back to Ottoman times.”¹⁶

At the same time, the use of explosive weapons in populated areas threatens the safety of humanitarian workers and hinders the delivery of humanitarian aid.¹⁷ Explosive weapons can damage or destroy humanitarian infrastructure, including aid supplies, warehouses, and trucks.¹⁸

In economic terms, destruction of the built environment constitutes a large-scale loss of capital, and especially wide-spread and repeated use of explosive weapons can be an important driver of economic impoverishment.¹⁹

Public infrastructure

Damage to transport, energy or communications infrastructure is likely to amplify the detrimental effects of damage to the built environment in other sectors.

Damage to certain components of this type of networked infrastructure, can disrupt the delivery of public services critical to the survival of the civilian population. Damage to roads or bridges, for example, can inhibit timely evacuation of the wounded and hinder the provision of assistance, thereby contributing to additional casualties. Disruption of the electricity supply can seriously affect the provision of health care and economic activity.

Damage to public governance infrastructure, such as buildings of the administration, parliament, justice system, and civil society infrastructure can weaken the institutional capacity of the state and civil society to cope with the effects of explosive violence.

Conclusion

Through damage to the built environment, explosive violence in populated areas can have wide-ranging and long-lasting negative effects on the well-being and survival of the civilian population. Particularly heavy explosive weapons (those which affect a wide area with blast and fragmentation) are likely to cause severe levels of harm. For this reason Article 36 and other members of the International Network on Explosive Weapons (INEW) have called for an end to the use in populated areas of explosive weapons with wide area effects.

Attacks on public infrastructure

Under international humanitarian law (IHL) governing the conduct of hostilities in times of armed conflict, attacks must be limited strictly to military objectives. Civilians and civilian objects must not be made the object of attack, and civilians enjoy general protection against the effects of military operations. Structures that are *a priori* civilian objects may become legitimate military objectives, however, if they make an effective contribution to military action ‘by their nature, location, purpose or use’ and if their total or partial destruction in the circumstances ruling at the time, offers a definite military advantage.

Transport, energy or communications infrastructure is at particular risk of becoming a military objective. Over the past decades, recognition has grown that likely or foreseeable long-term repercussions (‘reverberating effects’, and possible also ‘cumulative effects’) of attacks on such objects on the civilian population have to be taken into account when evaluating the legality and acceptability of an attack. In spite of this, considerable disagreement and uncertainty surround these assessments, and certain practices raise doubts about whether sufficient efforts are being undertaken to limit the indirect effects of attacks on the civilian population.

For further information see www.inew.org

For further examples of the impact of explosive weapons on infrastructure and the built environment, see Action on Armed Violence (AOAV), 100 Incidents of Humanitarian Harm: Explosive Weapons in Populated Areas 2009-2010, www.aov.org.uk

END NOTES

¹ The effects of blast on buildings differ in important respects from the forces exerted by natural hazards. Blast loading is more intense, more localized, of much shorter duration, and non-oscillatory (as opposed to earthquakes). Therefore, some blast protection measures are not compatible with seismic protection, and seismic, wind and fire protections incorporated in conventionally designed civilian buildings do not necessarily help to protect them against blast pressure. For example, floors are not constructed to bear pressure from below, such as may be exerted by the detonation of a car bomb at ground level. National Research Council, Protecting Buildings from Bomb Damage, p.58, <http://bit.ly/17IPFCx>.

² The combined effects of blast, fragment penetration and heat on structures are complex, but experiments have shown that the combination of effects tends to amplify the damage. For a discussion, see, J. Leppänen, Dynamic Behaviour of Concrete Structures subjected to Blast and Fragment Impacts, 2002, <http://bit.ly/1flvHZp>.

³ For more information, see e.g. U.S. Department of Homeland Security, Reference Manual to Mitigate Potential Terrorist Attacks Against Buildings, Doc. FEMA-426/BIPS-06/October 2011 (Edition 2), 2011, section 3.1.2, <http://1.usa.gov/16Tqc2i>.

⁴ FEMA-426, section 3.3.2.

⁵ UN OCHA oPt, Locked in: The Humanitarian Impact of Two Years of Blockade on the Gaza Strip, 2009, <http://bit.ly/tPHUK>.

⁶ FEMA-426, section 3.1.1.

⁷ FEMA-426, section 3.1.5.

8 The 'Urban Blast Tool' of the U.S. Department of Homeland Security (<http://www.dhs.gov/urban-blast-tool-ubt-opening-thunder-closing-whimper>) illustrates the immense challenges involved in and the sophisticated analytical methods required to accurately model the propagation of the blast wave of an explosive weapon in an uneven urban streetscape.

9 Disruption of irrigation systems can negatively impact agricultural activities or fresh water pisciculture. 'The fish farm produced and packed trout, which were grown in six 5 x 15 m ponds fed by water from the adjacent river. Much of the infrastructure, including drainage channels and a number of the concrete ponds, was extensively damaged in the bombing of the site. One of the ponds had a substantial impact crater, and all of the fish in it had died, presumably from the shock waves of explosions'. UNEP, Lebanon Post-Conflict Environmental Assessment, 2007, p.86, <http://bit.ly/bpa03i>.

10 Israeli attacks caused widespread destruction of the Gaza water and sanitation infrastructure. Eleven wells were partially or totally destroyed, four water reservoirs, 20 km of pipes, and sewage networks and pumping stations in four locations were damaged. At the household level, more than 5,000 roof water-storage tanks, 2,200 solar heaters, 500 water connections and numerous electrical pumps were destroyed. Approximately 70% of the population suffered from shortages in drinking water. UNDP, One Year After Report: Gaza Early Recovery and Reconstruction Needs Assessment, 2010, p.41, <http://bit.ly/bPYgZR>.

11 ICRC, Health Care in Danger: a Sixteen-Country Study, 2011, <http://bit.ly/pBn9AL>.

12 Denial of education in armed conflicts has many causes, aside from attacks on schools. See on this issue, UNESCO, Education under Attack, 2010, <http://bit.ly/142leCn>.

13 Save the Children, Attacks on Education, 2013, p.8, <http://bit.ly/142lnpt>.

14 'Prior to the conflict, the site housed a farm that bred cattle and small livestock, but it was completely destroyed during the aerial bombardment, reportedly killing some 175 cows and 430 sheep. At the time of UNEP's visit, the site was covered in rotting animal carcasses, and there were numerous smouldering piles where carcasses were being burnt'. UNEP, Lebanon Post-Conflict Environmental Assessment, 2007, p.83, <http://bit.ly/bpa03i>.

15 S. Bagshaw, 'Driving displacement: explosive weapons in populated areas', Forced Migration Review, 41, December 2012, <http://bit.ly/V7CdRd>.

16 'Syria's civil war leaves its cities, economy and cultural heritage in shambles', Fox News (Associated Press, 9 October 2012), <http://fxn.ws/SMJ7ro>.

17 C. Wille and L. Fast, 'Humanitarian staff security in armed conflict: policy implications resulting from changes in the operating environment for humanitarian agencies', Policy Brief, Insecurity Insight, 2013, p.6, <http://bit.ly/14bEKVc>.

18 'Preliminary assessments by UNRWA staff indicate that 53 UNRWA installations have been damaged as a result of the recent conflict. This includes 36 school compounds, seven health centres, distribution centres and sanitation offices, warehouses, offices of the Microfinance Department and the Gaza Field Office compound and neighbouring Gaza Training Centre. Damages range from minor damage to windows, boundary walls and finishing to more serious structural damages.' UNRWA, Quick-Response Plan to Restore Critical Services to Refugees in Gaza, January – September 2009, <http://bit.ly/187eUXg>.

19 See on this, UNRWA, The Syrian Catastrophe: Socioeconomic Monitoring Report, June 2013, p.8, <http://bit.ly/17ISsvz>.