Suggestion of improvised shelter design

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Abstract: An aim of this submission is to refer to possible provision of improvised shelters, mainly from the point of view of appropriate construction materials use, for protection from CBRN harmful effects. The shelter design is diagrammed in AutoCad software. For easier comprehension, the construction conversions are visualised in both 2D.

Key-Words: Improvised shelter, Population protection, Designing, AutoCAD

1 Present sheltering solution

The article is a response to current events in other countries, e.g. in Japan, mainly with respect to radiation leaks. Such events make us think about the already approved Concept of Population Protection by the year 2013 until the year 2020, that brought new problems for population protection by means of sheltering, mainly limitations of maintenance, construction and conversions of permanent shelters. The new Concept supposes to utilize mainly improvised shelters (IS) to protect from CBRN weapon impacts. However, background data for design and preparation of the IS are insufficient or missing. Data digitisation and interconnection with other fields would improve readiness and management of competent bodies.

2 Co-operation with the City of Zlin

We are trying to partly resolve the problem of inadequate preparation of the shelters in co-operation with the City of Zlin administration (especially creating a standard for evaluation and design of IS and a suitable information system for population protection by sheltering planning and management).[3]

2.1 The Standard

The standard is a basic element for IS designs. It includes all information necessary for construction conversions designs, calculation of required values and planning of the sheltering. The suggested improvised shelter design will stem from the information in the standard. [3]

3 Basic data for improvised shelter design

In order to design and suggest needed conversions to protect from CBRN effects it is necessary to complete information on particular shelters, incl. room dimensions, construction and other (e.g. surrounding environment, height of walling and anchorage, location, number of floors, etc.).

3.1 IS characteristics for calculation of Ko

In order to calculate protective features it is necessary to know the improvised shelter characteristics of 4 types. Those characteristics are important to calculate a protection coefficient of the building Ko. [2]

3.1.1 Types of IS characteristics

We have to decide whether it is a:

- Ground-floor or partly set-in object with a superstructure;
- Shelter located in the central wing of a building;
- Set-in shelter with a superstructure;
- Set-in shelter without a superstructure.

Protective properties of IS against radioactive radiation are expressed by the protective coefficient of the building Ko. The calculation of Ko was solved in 1978 by the military prescript MO CO-6-1 “Adjustment, projecting and construction of radiological shelters”. [1]

3.1.2 Protective coefficient of the building Ko

Specifies how many times the radiation is lower inside the shelter than in the one meter height above exposed ground providing that the radioactive fall is staggered on horizontal surfaces, where the radioactive fall on vertical surfaces is not considered.[2]

3.2 Structure and dimensions of the building

For the determination of Ko, it is necessary to know these initial data about peripheral shell constructions and measurements of rooms:

- Surface density of outside and inner walls and floors;
- Area of window and other vents in outside walls, and the height of their placement above the floor cloth (the sill height);
- Measurements of the room (length, width, height);
- Depth of the floor embedded below the ground level;
- Width of undeveloped areas or streets adjacent to the shelter. [2]

4 A proposition of a model shelter

A projecting describes a model ground-floor shelter or partly set-in object with a superstructure.

4.1 An assessment of measures

The basic attributes of a model shelter:
Length of a room **15m;**
Width of a room **10m;**
Height of a room **3m;**
Length of external peripheral walls **40m;**
Number and area of windows **6m;**
Distance between lower edge of a window and floor (height of a window-sill) **1,5m;**
Surface density of peripheral wall (0,6m – manually compressed simple concrete)
$\rho = H*x = 2200*0,6 = 1320 kgm^{-2}$;
Subterranean embedment **1,5m;**
A residence is a standalone complex of some detached dwelling and service buildings of an agricultural farm.

Further formula is used for the calculation of the protective coefficient of the building Ko of the shelter without modification for the set type of IS:

$$Ko = 0,65 * K_1 * K_{st} / (1 - V_2) * (K_z * K_{st} + 1) * K_m$$

Equation 1: Protective coefficient Ko formula with values [2]

Legend:
K_1 = coefficient of the outside wall influence, according to the graph;
K_{st} = coefficient of the radiation attenuation by outside wall, read off and based on the surface density table;
K_z = coefficient of the radiation penetration into the room by vents, determined depending on sill height;
K_m = coefficient of lowering the exposure speed in buildings by screening effects of adjacent building structures, read off
V_z = coefficient dependent on depth of the building, determined from the table;
V_2 = provided by the table.

All of the formulas, graphs and tables used for the calculation of the protective coefficient of buildings Ko are mentioned in the proposed standard. [2]

4.2 Description of the protective coefficient of the building Ko calculation without modifications

$$Ko = 0,65 * 0,37 * 7800 / (1 - 0,27) * (0,0018 * 7800 + 1) * 1 = 54$$

Equation 2: Protective coefficient Ko formula with values

The resultant value of the protective coefficient of the building Ko without modifications is 54 (a non-dimensional value), which shows us that the effect of the radiation inside the shelter without modifications is 54 times lower than the outdoor radiation. The resultant protective coefficient is to be multiplied by the coefficient 0.8 for the reasons of possible contamination of surroundings above the shelter by the radioactive fall.

$$Ko = 0,8 * 54 = 43$$

Equation 3: Final result of Ko without modifications (approximated)

The finite number of the protective coefficient of the building Ko is 43. The protection against radiation is 43 times lower inside IS than the outside radiation. By the reason of increasing protection inside IS, it is necessary to make modifications ensuring the increase of protection of the building coefficient Ko. The formula for calculation of the protective coefficient with modifications is the same one as that without modifications.

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4.3 IS projection in 2D representation without modifications

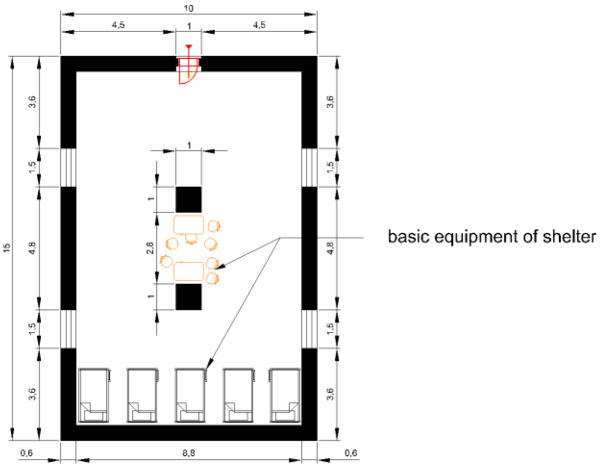

Figure 1: View of IS without modifications

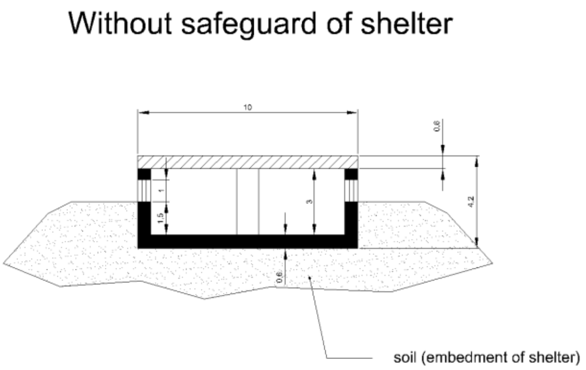

Figure 2: Side view of IS without modifications

4.4 Description of the protective coefficient of the building Ko calculation with modifications

The modifications consist mainly in the prevention of the radiation penetration to IS by window vents, which have the width of the walling in the model shelter 0.6 m, and in filling the shelter up to the ceiling height by building materials. These modifications change the protective coefficient formula so that the value of K_z x K_{st} is 0, because the room is calculated except window vents. The final protective coefficient of the building Ko without window vents is 2570, which means that the inner radiation inside IS is 2570 times lower than the radiation outside of the shelter if the established procedure for the protection of the shelter is followed.

$$Ko = 0{,}65 * 0{,}37 * 7800 / (1 - 0{,}27) * 1 = 2570$$

Equation 4: Protective coefficient Ko formula with modified values.

4.5 IS adjustments proposal in 2D representation

As can be seen in figures, the most modifications are done with window vents, which were filled by the walling made from plain concrete and wood. Further, all window vents were covered by soil in a specified width. The soil coverage can be done by various methods as hinted in the figure 3 and 4. The representation by the AutoCAD software enables easier understanding of modifications and displays used material clearly.

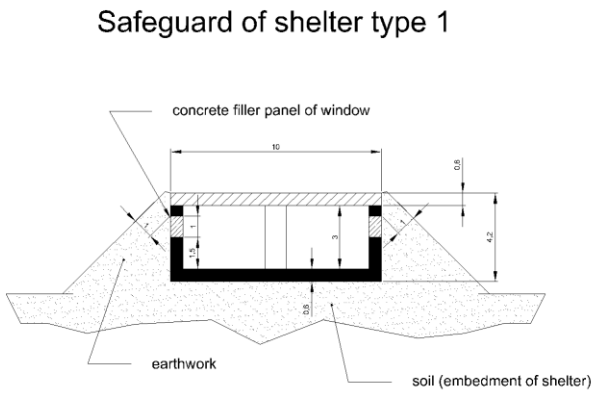

Figure 3: Side view of IS with modifications type 1

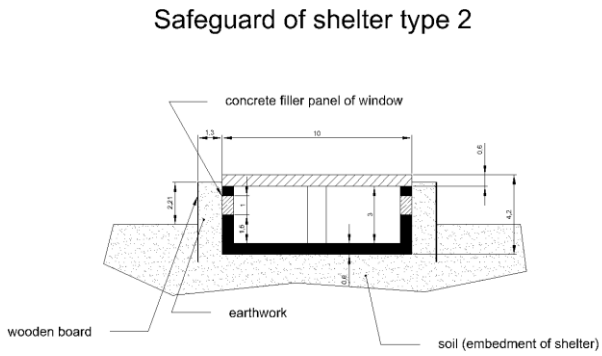

Figure 4: Side view of IS with modifications type 2

5 Conclusion

The increase of the protective coefficient of buildings Ko with lowering of the radiation penetration into IS can be ensured by those proposed materials. The main reason for those

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modifications is the provision of protection and health protection of people concealed inside the shelter.

This proposed variation of the protection inside IS is a necessity for the protection against radiation and CBRN weapons effects. The final version of the standard will deal with the ventilation, chimneys and intra-shelter props projecting.

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