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Military Technical College
Kobry El-Kobbah,
Cairo, Egypt

8th International Conference on Civil and Architecture Engineering
ICCAE-8-2010

Reduction the thermal signature of embedded construction

By

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Abstract:

The theme of camouflage and concealment of the most important topics in terms of military strategy, military and field work have brought the importance of the fact that this science has a significant impact on the conduct of hostilities and the scale of profit and loss on the subject of military balance between States.

The ongoing modernization of weapons and ammunition, rocket hacks for different types of buried construction and intended for laser and thermally always need to build fortifications more complex and very expensive to achieve the necessary protection against such weapons. This in turn led to an elaborate disguise of a modern and fit with the risks of this construction, and checks the necessary protection of all means of visual, radar and thermal.

But the doors used in these construction is one of the heat signatures also air ventilations required for the equipment in this construction are clear thermal targets.

In this paper we will use foam covered with a thin layer of concrete as on outer shelter the door. also we will use as second choice the polyvinyl chloride(pvc)material is the form of flakes cells forming a circle shape.

The thermal reduction for both these two designs will be experently measured on a model in the form of shelter submerged and equipment with a thermal source represent The used equipments in the construction.

Keywords:

Reduction the thermal signature; of embedded construction

*, Syrian Armed Forces.
**, Egyptian Armed Forces
***, Egyptian Armed Forces
**** Arab Academy for science, Technology Maritime Transport.

1. Introduction:

Will address this subject from the practical side, and by building a miniature model real construct fortification in the form of shelter submerged and equipped with the necessary equipment for the testing process, as shown in Figure (1).

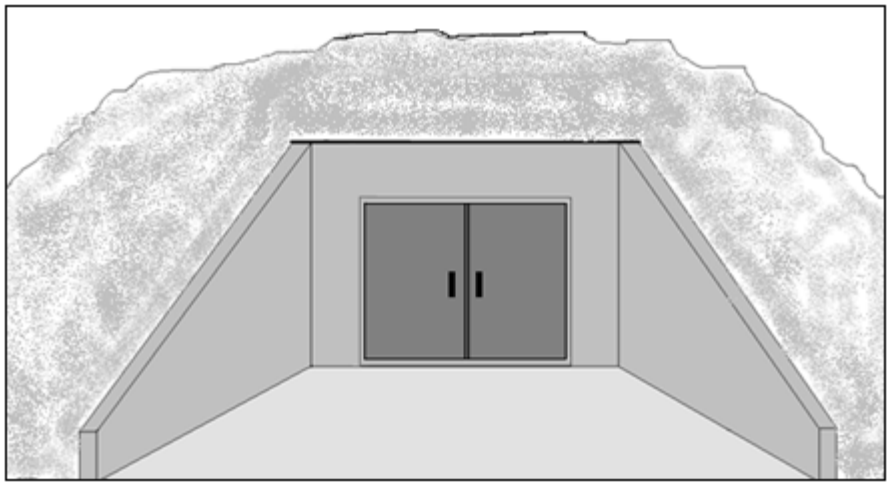


Figure (**1) -** Front view of the buried construction.

The surveillance capabilities of armed forces around the world have increased considerably in recent years. The threat to military objectives is multi-spectral and only camouflage, concealment and deception (CCD) can provide a sufficient level of protection in the appropriate electromagnetic spectral bands. Over the last few years, advances in sensor technology have led to the development of systems with enhanced electromagnetic spectral coverage and performance at competitive costs. From a military standpoint, these advanced technologies make it harder to go undetected on the battlefield. Developing new camouflage material with multi-spectral signature-reduction capabilities is an effective way to increase the chances of survival on the modern battlefield**.**

Composite materials are often more practical in use for different military applications. These materials provide interesting results especially through their good strength properties, corrosion resistance and low specific weight. These materials have various structures. [1].

-In 1995 Pieter A Jacobs has developed the methods to determine the ability of a camouflage material to follow temperature changes in the background. Temperatures measurements of camouflage techniques and background elements have performed under a variety of meteorological conditions.

Measurements of representative weather-and background conditions are needed to determine those situations, where the camouflage material effectively reduces the target signature.

Camouflage effectiveness is expressed in the percentage of time for which the apparent temperature contrast between the camouflage materials and a background element is 1 c ,2 c or 5 c.[2]

Hexels, Gerd et al. 09/20/2001 made a new studies in a camouflage shelter that has a collapsible self-supporting sub frame, which is assembled from a lattice of poles, which are coupled in an articulated manner at their ends and form scissor-like pairs. The poles are rotatably connected at their intersections. The camouflage shelter has a camouflage net arranged loosely over outer bearing points of the sub frame and consisting of a polyester mesh with a perforated structure, incorporated metal fibers and a coating which contains absorbent pigments.[3]

Various types of polymer-based binders (such as polyurethanes, vinyl polymers, silicone polymers, epoxy resins, polyethylene, chlorinated polyolefine) were characterized in order to find one with good transmission properties. Typically, in the case of polymers, the absorption in the 3-5 μm region is low as compared to the 8-12 μm region. [4]

2. **Emissivity and highly reflective pigments:**

The reflectance (ρ) and emissivity (ε) are important parameters. The emissivity is defined as the ratio of the radiance from a surface sample (L_s) at a given temperature T and wavelength λ, to that of a blackbody radiator (L_{BB}) at the same temperature and wavelength. Thus, ε is expressed as .

$$\varepsilon(\lambda,T)=\frac{L_{\varepsilon}(\lambda,T)}{L_{BB}(\lambda,T)}\ .$$

Figure (2) shows emissivity for a green paint different concentrations of Al flakes (7.5, 10, 15) and 20 %, in that order producing high to low emissivity).[5]

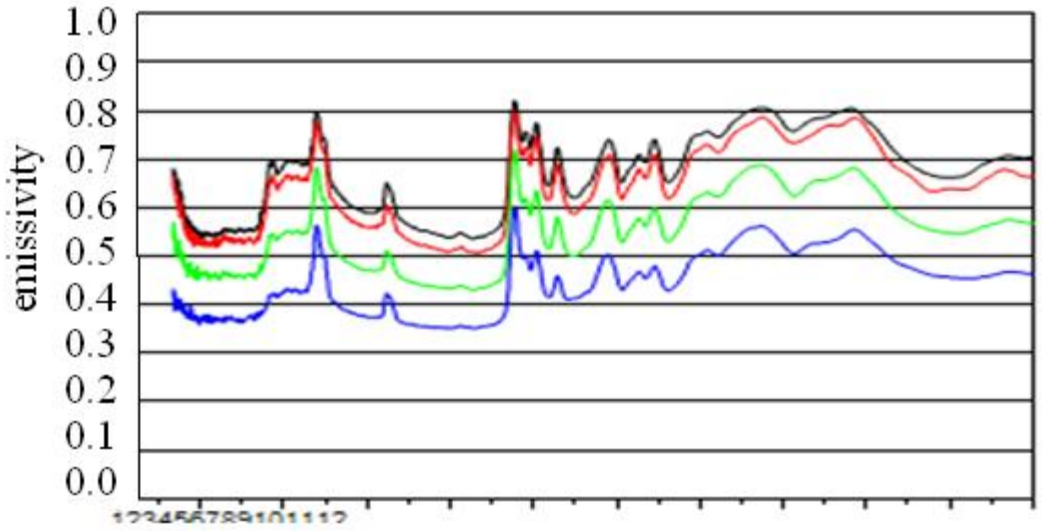


Figure (2)

3. Experimental work:

In order to study this case of real construction we will go through three steps:

Step(1) - build a model for this construction with this dimension (400 × 750 × 350) cm ,in the steps for building this model are showing in Figure (3).




Figure (3)

Step (2)-to choice the suitable place for this model to build and suitable soil (Green land or sand)for visual camouflage. As shown Figure (4).

And installation of concrete blocks for the formation of the required construction.

Step (3) –to choice a suitable heat source representing the used equipment in the roll construction to be comparable to the dimension of the model.

After **-Befor-**

Figure (4)

4. Testing process:

In this experiment we will operate a heat source inside the model and measuring the temperature inside and outside the model. The experiment will include two cases:

4-1.Case (1):

This case contains:
- Thermal camera (VisIR **640-P** Handheld Infrared Camera),as shown in Figure (5).
- Materials used to camouflage the door with a mixer layer of foam and concrete. as shown in Figure (6).
-Metal gate-source heat (heater) within the established,
-External temperature (34℃).

-Internal temperature (45℃).

-The time is photography (12:00) daytime.

Figure (5) VisIR Handheld Infrared Camera

The **VisIR 640-P** with high resolution detector and 1.3M pixel colour camera, integral LED illuminator/flash, laser pointer and voice recording, make Predictive Maintenance surveys more efficient and cost-effective.

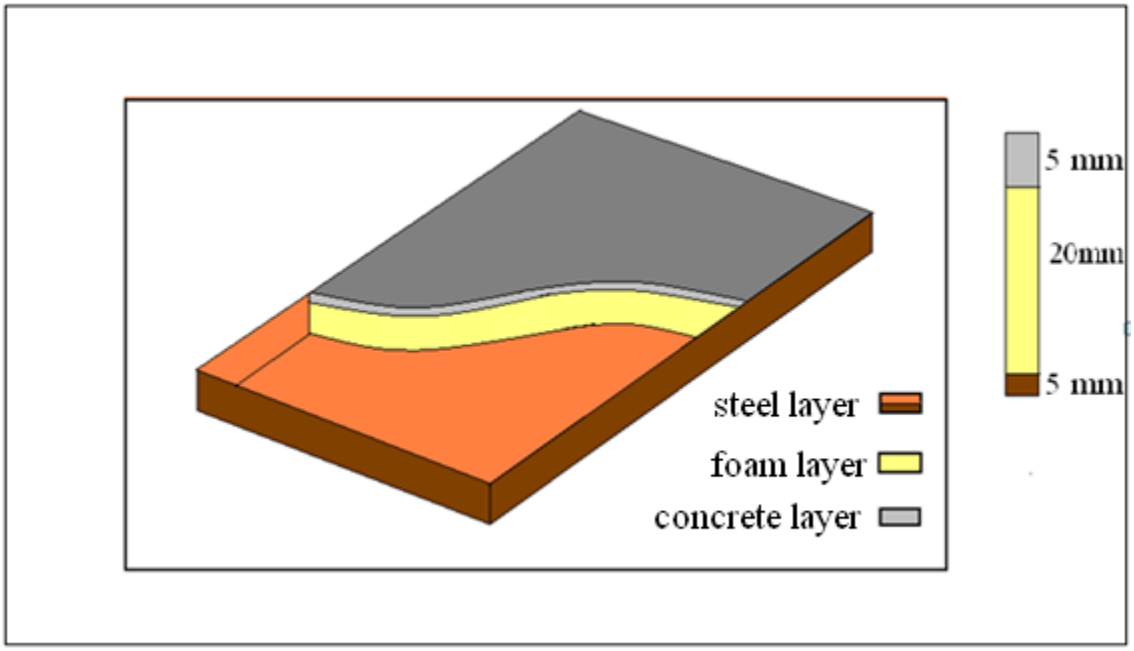


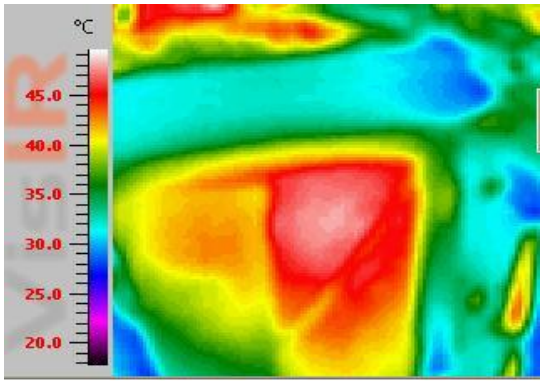
Figure (6) components of the door

Figure (7) shows the thermal signature of the model door without a protective layer, and here appear red zone indicates the temperature within the limits (45 degrees Celsius), giving it this form.

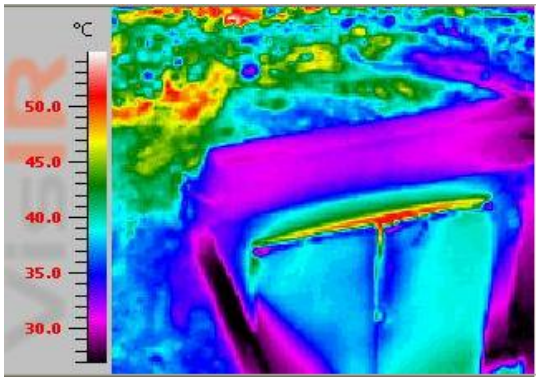
While Figure (8) shows the thermal signature of the door after using the protective layer in this case, which has reduced the temperature to within 38 degrees Celsius?

Graph in Figure (9) shows the reading results depending on (program visual basic 6) that takes into account the strength of the red color, which indicates the highest thermal signature on the area of the image.
The graph shows the level is followed by the decrease in temperature resulting from the use of seclusion.

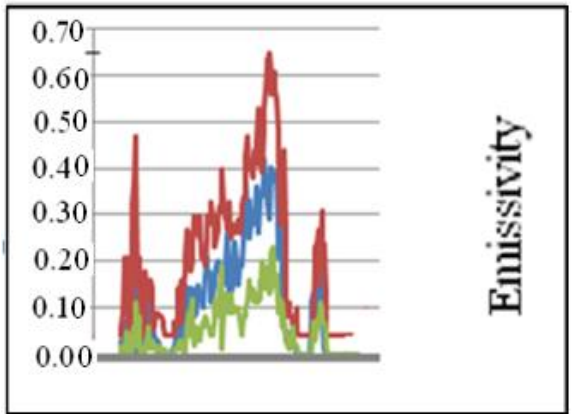
This graph shows the reduction in the thermal signature after using the protection layer in case (1).



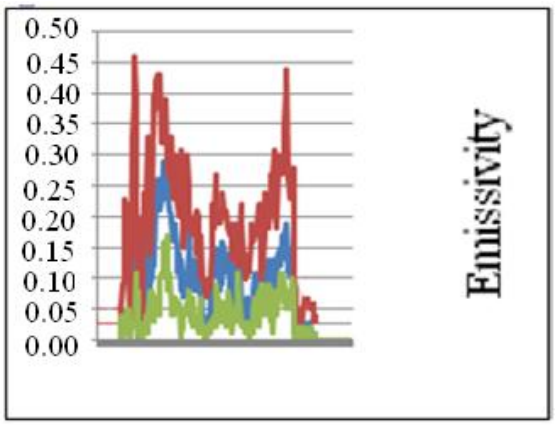
Figure(7)



figure(8)



A



B

Degree	45°C	4O°C	35°C
A	0.65	0.40	0.22
B	0.46	0.29	0.17
Percentage	29%	27%	22%

Figure (9)

4-2. Case (2):

This case contains:
-Thermal camera (VisIR **640-P** Handheld Infrared Camera) Figure (5).
-Materials used to camouflage the door consist a layer of (PVC) with honeycomb form a details section of the layer is shown in Figure (10)

-External temperature (34°C).
-internal temperature(45°C).
-day time (12:00).

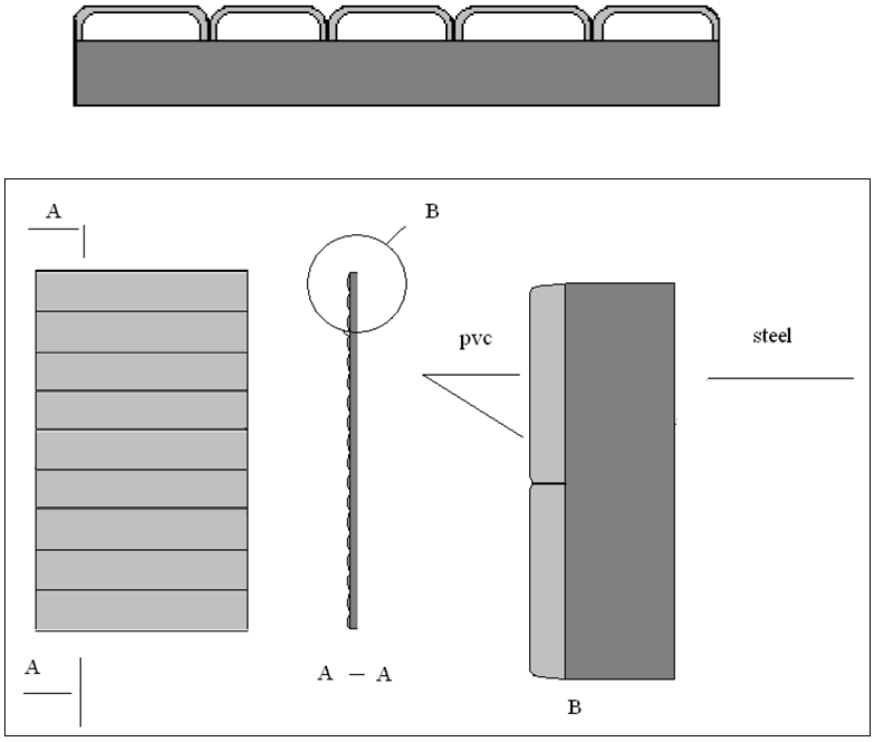


Figure (10)

Figure (11) shows the thermal signature of the model door without a protective layer, and here appear red zone indicates the temperature within the limits (46 degrees Celsius), giving it this form.

While Figure (12) shows the thermal signature of the door after using the protective layer in, which has reduced the temperature to within (35) degrees Celsius.

Graph in Figure (13) shows the reading results depending on(program VB- 6) that takes into account the strength of the red color, which indicates the highest thermal signature on the area of the image.

This graph shows the reduction in the thermal signature after using the protection layer in case (2).

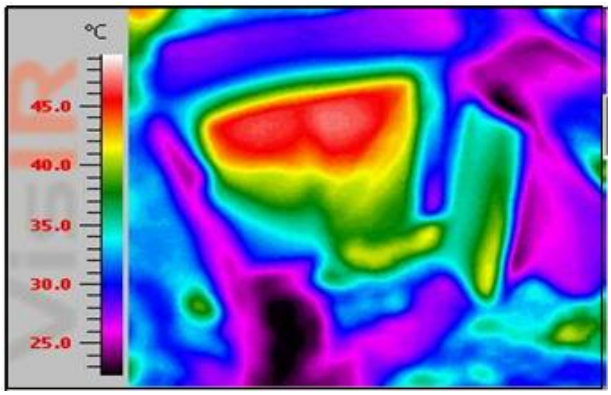


Figure (11)

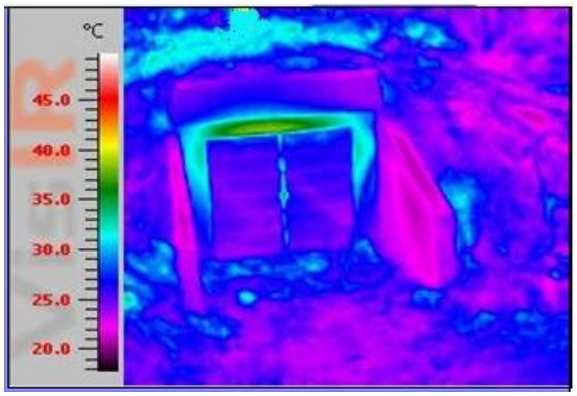
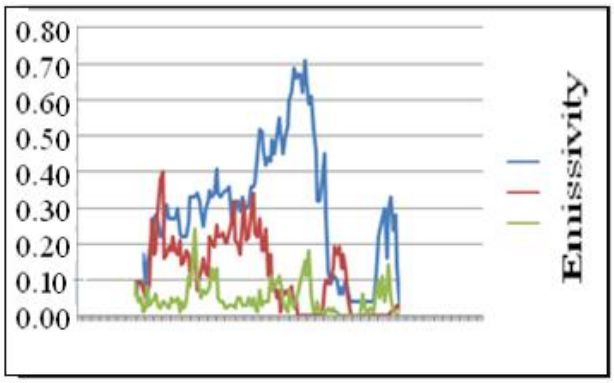
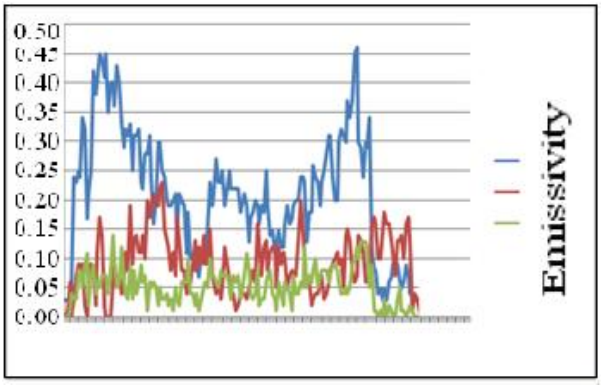


Figure (12)



A



B

Figure (13)

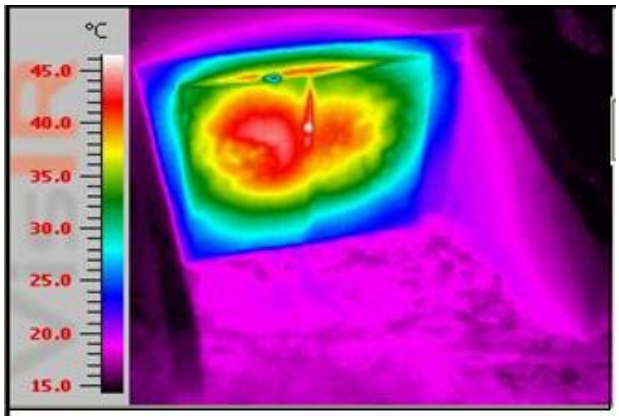
Degree	45°C	40°C	35°C
A	0.71	0.40	0.24
B	0.46	0.23	0.14
Percentage	35%	42%	41%

We note that the amount of the reduction in the thermal signature with (PVC) gave better results and noting that this article fit with the external temperature of the medium.

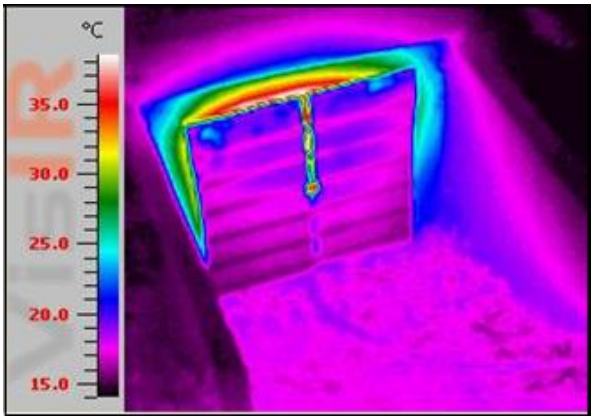
Figure (14) shows the thermal signature of the model door without protection layer during the night (time 20:00 pm)and the external temperature (19°C).
We note here appearing red zone indicates the temperature (45 degrees Celsius).

Figure(15) shows the thermal signature of the door after using the protective layer in which has reduced the temperature to within (23) degrees Celsius.

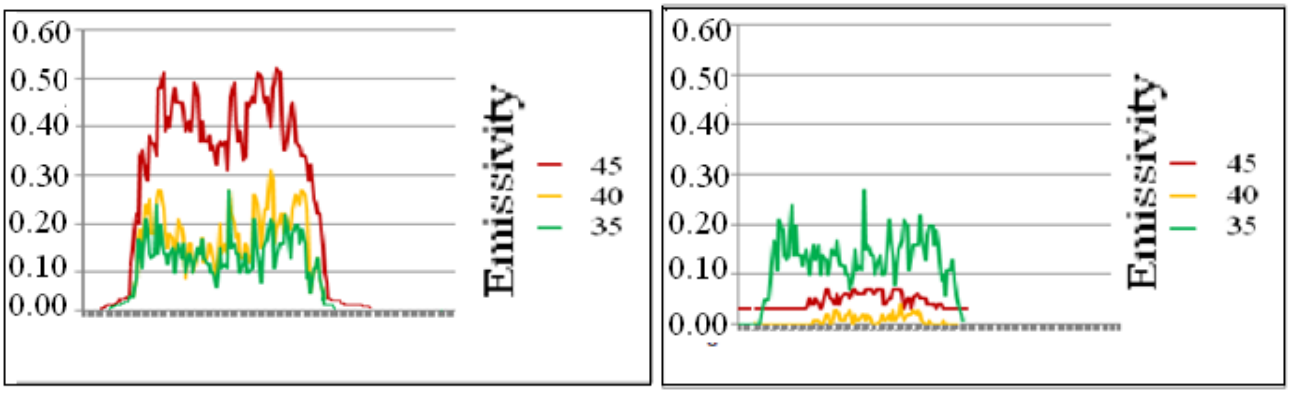
Graph (16) shows the reduction in the thermal signature after using the protection layer in this case.



Figure(14)



Figure(15)



Figure(16)

Degree	45°C	40°C	35°C
A	0.51	0.31	0.28
B	0.07	0.05	0.28
Percentage	86%	83%	o.o%

5. Conclusions:

In this paper we studied a method for visual and thermal reduction to real construction by building a model representing this real construction , two different cases were studie in the first case we used protection layers, consist of a foam covered with a thin layer of concrete as an outer shell to the door of the constructer case.
In the second case we used a protection layer consist of a (PVC) material in the form of cells forming circle shape.
From the thermal measurement results we note that there is a good visual and thermal signature reduction in both cases.
We notice that the reduction in the thermal signature at night using the protection layer while in case 2 has better results than at daylight measurement which indicates that the layer is more efficient due to the big difference between the temperature inside and outside model which indicates that the layre prevent the inside temperature completely.

But in case one with using foam has week point when it needs protection layer from conclusion which leads to use the concert layer and this means excessive weight and hand cost.
So we find that protection layer in case to more suitable to its lightweight for the real construction and its practical use and also due to its excellent results at night which exceeds 80% reduction of the thermal signature.

7. References:

[1]. W. Swiderski "Estimation of a Mortar Bore Temperature by a Thermography Method" Infrared Physics Technology.

[2]. P. A. Jacops Experimental evaluation of thermal camouflage effectiveness, proceedings of the SPIE, 2469, pp.462-472, 1995.

[3].Camouflage shelter having a collapsible self-supporting subframe
United States Patent Application .

[4]. H.S. Lee, Ö. Staaf, and H. Ghaemi, *IR properties of some binders for the coatings industry*, FOA-R--00-01576-615--SE (2000).

[5]. by T. Hallberg – 2005 Defence Forces Technical Research Centre, on the Development of low-emissive camouflage paint