Aspects regarding the use of Sustainable Energy for Building a Passive House

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Abstract: - The paper presents a solution to introduce sustainable efficient energy concept for passive office building with the use of neopor insulated concrete forms – ICF. We want to show that it is possible to build houses with many advantages by introducing in building projects a new concept of passive house standard. Houses that are built by this very simple solution have obtained an environmentally friendly impact and an energy efficient result. In the current context of climate change, a revolution is required in the field of design and construction. Among the energy efficiency standards currently existing in the EU, we chose the "Passive Building" standard to apply it to the specific conditions of Romania, the Arges area. An extremely interesting experience in which we applied the concept in a holistic manner, speculating on every small advantage obtained from the site conditions, relief, orientation to the cardinal points, existing constructions and vegetation. Creativity and innovation played an extremely important role in obtaining a result of maximum energy efficiency, which also made possible the certification of the building by the Passivhaus Institute "Dr. W. Feist" Darmstadt Germany. The building meets the standards of ecological construction with a low level of pollution, and which fully uses energy from renewable sources

Key-Words: -efficient building, sustainable energy, passive concept, simple solution
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1 Introduction

1.1 Passive House concept

Passive House' is a design standard that achieves thermal comfort with minimal heating and cooling by using insulation, airtightness, appropriate window and door design, ventilation systems with heat recovery, and elimination of thermal bridges.

Originally developed in Germany in the 1990s, Passive House principles are now being used throughout the world.

Passive House standards are performance-based: they set performance targets to be met but do not dictate specific materials or products.

The definition of a Certified Passive House is:"a building, for which thermal comfort (ISO 7730) can be achieved solely by post-heating or post-cooling of the fresh air mass, which is required to achieve sufficient indoor air quality conditions, without the need for additional recirculation of air"

As air is a poor carrier of heat energy, the heating and cooling energy requirements of the building must be very low because there is not sufficient air flow to deliver large amounts of heating or cooling energy.

A Passive House is appropriately insulated, airtight, has quality windows and reliable ventilation systems with heat recovery. A certified Passive House undergoes a quality assurance process that ensures that it is built as designed and meets the comfort standards required by the Passive House standard.

The first home constructed to test the Passive House concept was completed in Darmstadt, Germany in 1991 by Dr Wolfgang Feist and Dr Bo Adamson. It has been continuously occupied by Dr. Feist and his family ever since and data monitoring and testing show that the building still performs as predicted after nearly 30 years. Dr Feist established the Passive House Institute (PHI) in 1996 as an independent research institute.

1.2 The passive house standard and certification

The Passive House standard defines globally consistent performance metrics for buildings. The PHI administers a certification scheme that allows a building to be called a Certified Passive House. To obtain certification, a building must meet the following criteria:

- Thermal comfort must be achieved during winter (20°C minimum) as well as in summer (this can be adjusted in extreme climates), with no more than 10% of the hours in a given year over 25°C.
- Heating demand 15kWh/m^2/yr or heating load 10W/m^2.
- Cooling demand 15kWh/m^2/yr (in humid climates this allowance increases to allow for dehumidification) or cooling load 10W/m^2 (if installed)
- Humidity must not exceed 12g/kg for more than 20% of the year (~60%RH at 25°C).
- Airtightness must be 0.6ACH50 or lower and be verified on site.
- Overall energy use (Primary energy renewable must not exceed 60kwh/m^2/yr. When calculating overall energy use, Passive House includes whole-of-building energy; this includes heating and cooling, hot water, lighting, fixed appliances and an allowance for consumer electronics.

A Passive House is designed to maintain a comfortable indoor air temperature, which is defined as being between 20°C and 25°C. There is also a requirement for all internal surfaces to remain warm enough to prevent radiant asymmetry (differences between air temperatures and surface temperatures) and avoid risk of mould and condensation.

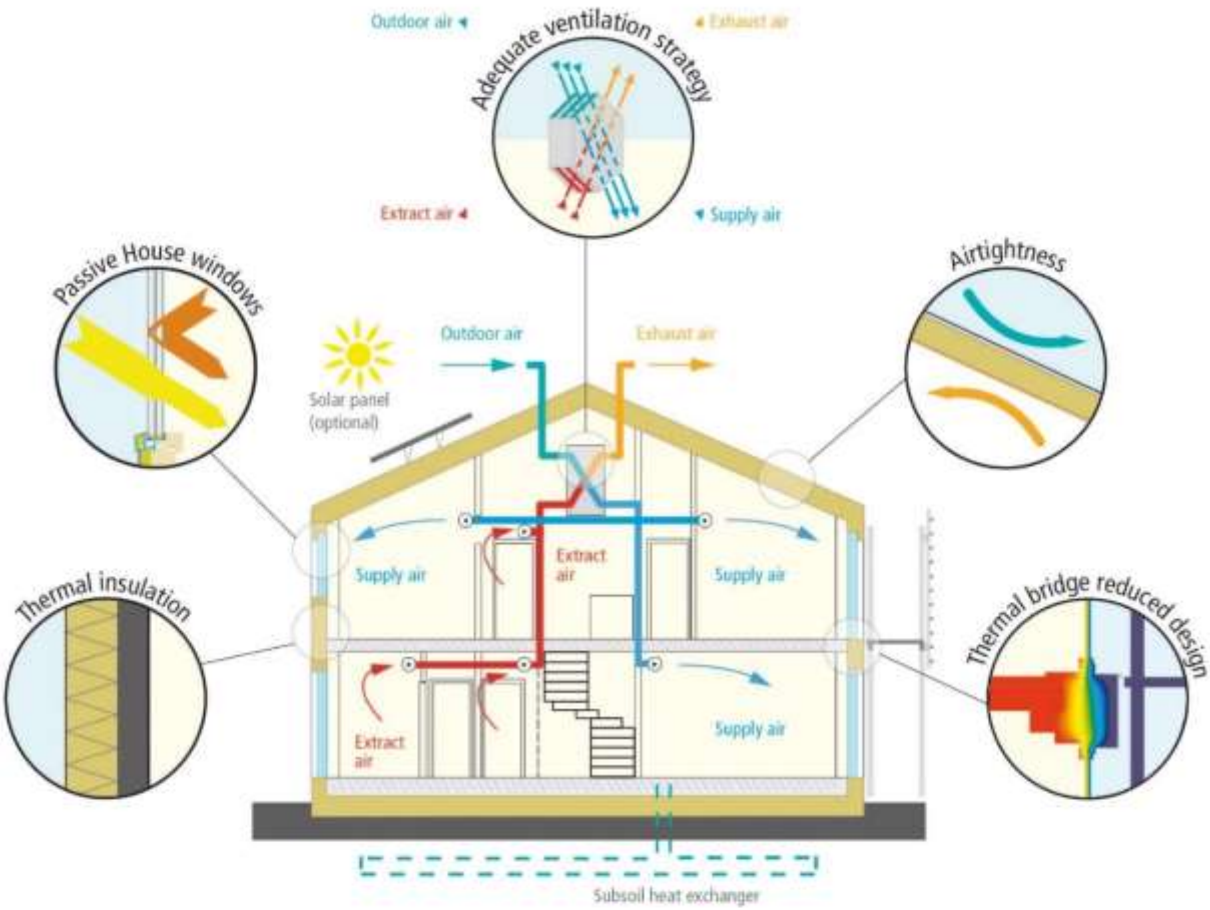

Fig. 1: Scheme of a passive house

1.3 Thermal insulation

Appropriate levels of insulation are required to control heat loss and gain. Insulation is a material that resists or blocks the flow of heat energy. Insulation is used to stop heat inside the home from escaping in winter, and to stop heat outside the home from entering in summer.

The best type and location of insulation will depend on local climate, and whether the insulation is mainly needed to keep heat out or in, or both. Insulation acts as a barrier to heat flow and is essential for keeping your home warm in winter and cool in summer. A well-insulated and well-designed home provides year-round comfort, cutting cooling and heating bills, and reducing greenhouse gas emissions.

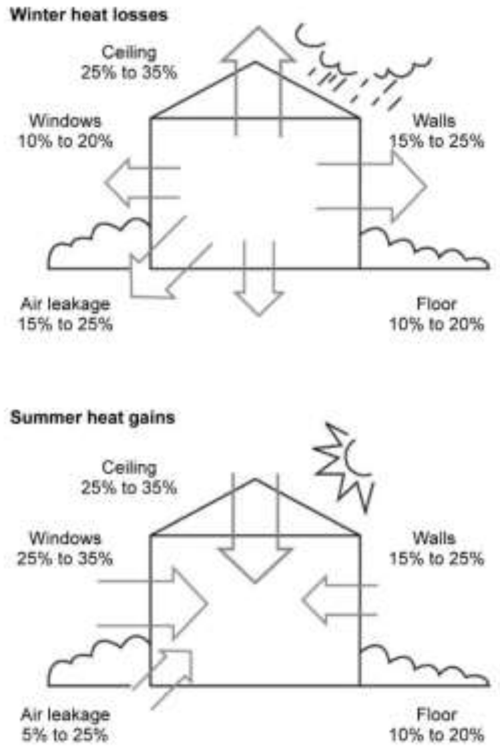

Fig. 2: Typical heat losses and gains without insulation in a temperate climate

How well an insulation product resists heat flow is know as its R value. The higher the R value, the higher the level of insulation. 'Total R value' describe the total resistance to heat flow provided by a roof and ceiling assembly, a wall or a floor. Each of the material components has its own heat resistance (R value), and the total R value is calculated by adding the R value of each component, including the insulation.

Total R values are the best indicator of performance because they show how insulation performs within the building envelope. Total R values are used when calculating energy ratings to measure thermal efficiency.

Total R values for roofs, ceilings and floors that use reflective insulation are expressed as up and down values, depending on the direction of heat flows through the product:

- 'Up' R values describe resistance to heat flow in an upwards direction (sometimes known as 'winter' R values).
- 'Down' R values describe resistance to heat flow in a downwards direction (sometimes known as 'summer' R values).

Both up and down R values should be considered when installing roof, ceiling and floor insulation.

Total R values for walls are expressed as a single figure, without 'up' and 'down' distinctions.

Many factors can reduce the total R value, including thermal bridging, compression of bulk insulation, dust settling on reflective insulation and the lack of a suitable air gap for reflective surfaces. Careful installation according to specifications is needed to ensure your insulation performs as it should.

Insulation products come in 2 main categories — bulk and reflective — which are sometimes combined into a composite material.

1.3.1 Bulk insulation

Bulk insulation uses pockets of trapped air within its structure to resist the transfer of conducted and convected heat. Its thermal resistance is essentially the same regardless of the direction of heat flow through it.

Bulk insulation products come with one R value for a given thickness, and include materials such as:

- glass wool, batts and rolls (often made from recycled materials)
- wool, batts and loose fill
- cellulose fibre loose fill (often made from recycled paper fibres)
- polyester, batts and rolls (often made from recycled materials)
- polystyrene, expanded (EPS) or extruded (XPS), as rigid boards
- polyisocyanurate (PIR) as rigid boards
- polyurethane (PUR) as rigid boards.

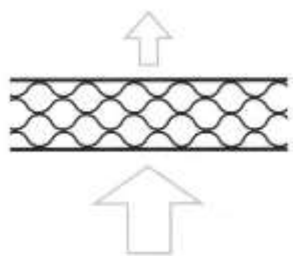

Fig. 3: Bulk insulation traps air in still layers

1.3.2 Reflective insulation

Reflective insulation mainly resists radiant heat flow because of its high reflectivity and low emissivity (ability to re-radiate heat). Its insulation ability relies on the presence of an air layer of at least 25mm next to the shiny surface. The thermal resistance of reflective insulation varies with the direction of heat flow through it.

Reflective insulation is usually shiny aluminium foil laminated onto paper or plastic and is available as sheets (sarking), concertina-type batts and multi-cell batts. These products are known as reflective foil laminates (RFL).

Because any foil insulation is electrically conductive, the risk of contact with electrical cables and equipment must be considered with all installations, and measures to eliminate the risk should be followed. Refer to Installing insulation on this page.

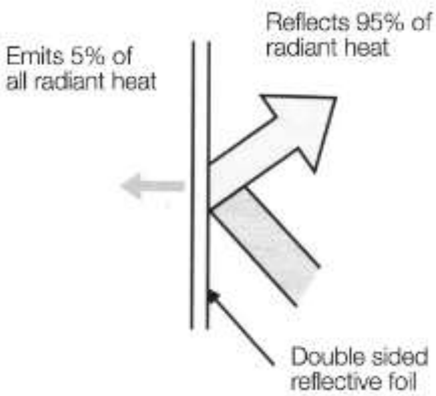

Fig. 4: Reflective insulation and heat flow

1.3.3 Composite insulation

Composite insulation combines bulk and reflective insulation. Examples include foil-faced boards, reflective foil-faced blankets and foil-backed batts. The orientation of the foil needs careful consideration to ensure it is most effective and does not add to condensation risk. Be aware that reflective foil insulation should be on the warm side of any building system. Generally, in cooler climates, this means placing the foil on the inner side of the bulk insulation (foil facing inwards), with an air gap betweenthe foil and the ceiling material (for example plasterboard). In hot humid climates in air-conditioned buildings, the opposite is a better solution (foil facing outwards).

1.4 Orientation

Orientation is how a building is positioned in relation to the sun's paths in different seasons, as well as to prevailing wind patterns. In passive design, it is also about how living and sleeping areas are designed and positioned, either to take advantage of the sun and wind, or be protected from their effects.

To achieve good orientation, the most important factors to consider are:

- the climate of house's region
- true north and sun angles for the site or building
- optimum building design for the climate zone
- the effects of climate change

Ideally, we should choose a site or home with good orientation for the climate in house's region, and build or renovate to maximise the site's potential for passive heating and passive cooling. North-facing walls and windows receive more solar radiation in winter than in summer because the sun is lower in the sky. East- and west-facing walls and windows receive more sun in summer in the early morning and late afternoon when the sun is lower in the sky.

In most climates, passive heating can be achieved relatively easily by locating living areas and windows on north-facing walls to let in low-angle winter sun and using horizontal shading devices to exclude high-angle summer sun. The best orientation for living areas is solar north; however, orientations of up to 15° west of north and 25° east of north still allow good passive sun access.

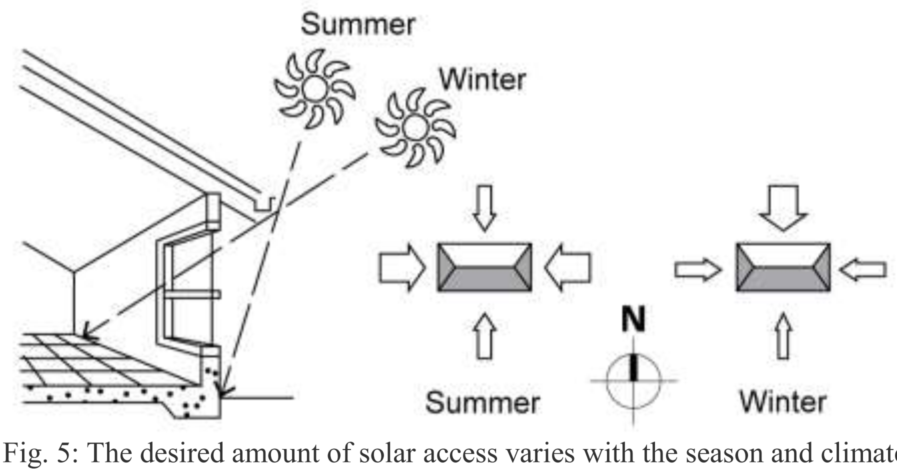

Fig. 5: The desired amount of solar access varies with the season and climate.

1.5 Glazing

Glazing simply means the windows in your home, including both openable and fixed windows, as well as doors with glass and skylights.

Glazing actually just means the glass part, but it is typically used to refer to all aspects of an assembly including glass, films, frames and furnishings

Glazing lets in light and fresh air and offer views that connect interior living spaces with the outdoors. Energy-efficient glazing makes home more comfortable and dramatically reduces your energy costs.

However, inappropriate or poorly designed glazing can be a major source of unwanted heat gain in summer and significant heat loss and condensation in winter. Up to 87% of a home's heating energy can be gained and up to 40% lost through windows. Improving glazing's thermal performance will reduce energy consumption, therefore lowering costs and greenhouse gas emissions.

Glazing is a significant investment in the quality of the home. The cost of glazing and the cost of heating and cooling the home are closely related. An initial investment in energy-efficient windows, skylights and doors can greatly reduce the annual heating and cooling bill. Energy-efficient glazing also reduces the peak heating and cooling load, which can reduce the required size of an air-conditioning system by 30%, leading to further cost savings.

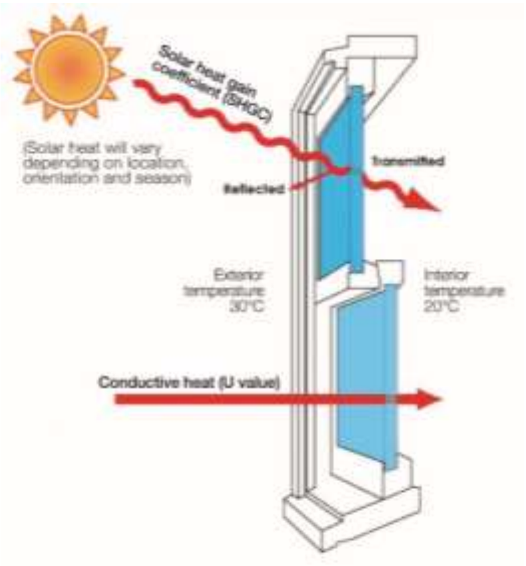

Fig. 6: Key properties of glass.

The amount of light that passes through the glazing is known as visible light transmittance (VLT) or visible transmittance (VT). A low VLT can reduce heat gain from the sun but if the VLT of your glass is too low, it will be too dark inside the room. This may lead you to switch on lights, which will result in higher energy costs.

1.5.1 Conduction

Conduction is how readily a material conducts heat. This is known as the U value. The U value for windows (expressed as Uw), describes the conduction of the whole window (glass and frame together). The lower the U value, the greater a window's resistance to heat flow and the better its insulating value.

1.5.2 Solar heat gain

The solar heat gain coefficient (SHGC) for windows (expressed as SHGCw) measures how readily heat from direct sunlight flows through a whole window (glass and frame together). SHGC is expressed as a number between 0 and 1. The lower a window's SHGC, the less solar heat it transmits to the house interior.

However, the actual SHGC for windows is affected by the angle that solar radiation strikes the glass. This is known as the angle of incidence. The angle of incidence is influenced by the orientation of the glazing and the position of the sun according to location, season and time of day.

When the sun is perpendicular (at 90°) to the glass, it has an angle of incidence of 0° and the window will experience the maximum possible solar heat gain. The SHGC declared by glazing manufacturers is always calculated as having a 0° angle of incidence.

As the angle increases, more solar radiation is reflected, and less is transmitted. It falls sharply once the angle exceeds 55°. Also, as the angle increases, the effective area of exposure to solar radiation decreases. There are many different types of glass products to choose from.

1.5.3 Single glazing

Single glazing uses a single pane of glass. Single glazing with clear glass is not very efficient when it comes to heat loss or gain. To improve performance, you can use single glazing with a more energy-efficient type of glass such as low emissivity (low-e) glass.

1.5.4 Double or triple glazing

Double or triple glazing (also known as insulated glass units or IGUs), is the combination of 2 or more layers of glass sealed into a frame with a gap between the layers. Multiple layers can be assembled with sealed cavities between each sheet of glass.

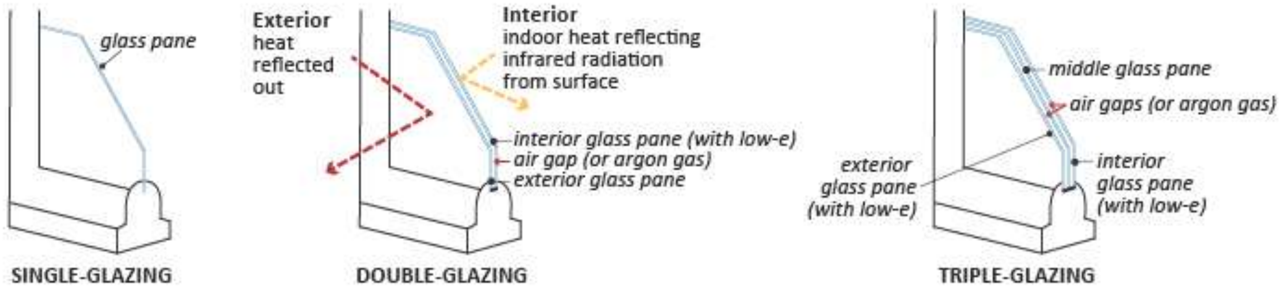

Fig. 7: Cross-section detail of single, double and triple-glazing units.

Low emissivity glass (commonly known as low-e glass) reduces heat transfer. Low-e glass has either a pyrolytic coating or a vacuum-deposited thin film metal coating. Pyrolytic coatings are durable and can be used for any glazing; vacuum-deposited coatings are soft and are only used within IGUs.

Toned glass has colouring additives included during manufacture. It is available in various colours, usually bronze, grey, blue and green. Different colours will change the amount of visible light transmitted (VLT) and the SHGC; however, the colours do not change the conduction (U value) of the glass.

Toned glass options include ‘supertoned’ glass, which has heavier colouration that transmits visible wavelengths while filtering out solar near-infrared wavelengths. This provides improved energy performance by lowering solar heat gain but does not affect light levels

Standard glass will readily break into long shards and small sharp slivers.

Laminated glass has a plastic glazing layer, called an interlayer, which is adhered permanently between 2 sheets of standard glass. This reduces the danger of the glass breaking, and if it does break, keeps all shards in place so they do not form loose dangerous shards. Laminated glass is often used in areas in the home most prone to injury from human impact such as bathrooms, doors, around staircases and in areas close to the floor.

1.6 Frames

Frames have a significant impact on the thermal performance of windows and doors, because energy can be gained and lost through the frame, as well as through the glass. Different types of frame will allow different levels of heat gain and loss, so careful choice of frame is important for effective passive design.

1.6.1 Aluminium

Aluminium frames are light, strong and durable, and come in a variety of powder-coated and anodised finishes. However, aluminium is also a very good conductor of heat and will decrease the insulating value of a glazing unit, unless specifically engineered to reduce this heat.

1.6.2 Timber frames

Timber frames are a good natural insulator that can suit some home designs. Timber frames should be made from species that have naturally high durability or be treated to prevent decay and deformation.

Because timber is an organic material that swells and shrinks with changes in atmospheric humidity, window and door frames require larger tolerances in openings.

1.6.3 uPVC

uPVC is a form of plastic (unplasticised polyvinyl chloride, also known as rigid PVC). uPVC frames provide excellent thermal performance, often better than timber or thermally broken aluminium. uPVC is long lasting and requires very little maintenance, and can be moulded into complex profiles that provide excellent air seals.

1.6.4 Composite frames

Composite frames use aluminium profiles on the outer sections with either a timber or uPVC inner section. These combine the low maintenance and durability of aluminium with much improved thermal performance.

1.7 Window furnishings

Window furnishings, blinds and curtains can improve the overall thermal performance of the window systems, and can be an effective way to overcome problems with existing windows.

Reduce convective heat transfer through windows with snugly fitted blinds and curtains with pelmets that trap a layer of still air next to the window. Eliminate air gaps around all perimeters of the curtain and pelmet to improve performance

1.8 Skylights and roof windows

Skylights and roof windows are glazed openings on a pitched or flat roof designed to provide more light to the home. As well as allowing natural light into your home, they can also allow fresh air to enter if they are openable or vented. As with conventional windows, they can be a major source of unwanted heat gain in the summer and significant heat loss in the winter

A skylight or roof window can admit more than 3 times as much light as a vertical window of the same size. Skylights and roof windows can thus increase the amenity of internal spaces that might otherwise require artificial lighting or ventilation, such as windowless rooms. The use of skylights or roof windows can ensure that spaces are predominantly lit by natural light, with little or no artificial lighting required.

They allow additional flexibility in architectural design. Skylights and roof windows can allow natural light and fresh air where vertical windows are not an option, where there are privacy issues, or when you want to create a different architectural look.

Skylights can be made of glass, acrylic, or single glazed ‘opal’ (ie light-diffusing) moulded units. The top glazing of the skylights can also be in clear or tinted glass, acrylic or polycarbonate. Skylights typically have long white-coloured or flexible light wells and a diffuser panel fitted at ceiling level.

Fig. 8: Skylights can be vented or non-vented, fixed or openable, in any shape

Roof windows are simply windows set into the roof of a home. Roof windows are usually combined with light wells or shafts in homes that have flat ceilings.

Almost all roof windows use sealed double glazing to reduce heat losses while minimising condensation. Typically, they are openable. This feature is highly recommended during summer conditions, especially in 2-storey houses where heat would otherwise tend to concentrate in the upper level. Roof window frames come in a variety of different materials and have a major impact on thermal performance. Frames are typically timber with external weatherproof cladding, but may be aluminium, steel or uPVC. Uninsulated metal frames can cause condensation during times of cooler weather, and lose heat to the outside through conduction.

Roof windows are commonly used for attic rooms where there is a cathedral ceiling but little roof space. They are also used for other living areas with a conventional flat ceiling where a plasterboard-lined light well and no diffuser is used to bring the outside in.

Fig. 9: Roof windows in a cathedral ceiling

2 Building the first Romanian Passive house

2.1 Introduction

Our goal is to demonstrate that it is possible to create an innovative, sustainable office building by respecting the passive house standard with very easy to build efficient energy technology. We used Amvic Insulated Concrete Forms (ICF), produced in Romania, at Bragadiru, for the envelope and excellent work areas for headquarters of Amvic Group (Fig.1). This building is the first passive office building in Romania which was planned in year 2007 and built in 2008, in BRAGADIRU.

2.2 Context for the first Romanian passive house

Starting in 2000, we began studying passive house standards. We fail in love with this great idea, and we take the decision in year 2004 to build the first house in Romania, in Burlusi. We want to demonstrate that with inspiration and ambition it is possible to create an innovative, sustainable family house, by respecting the passive house standard with a classical building technology-masonry with BCA. This building is the first passive residential building in Romania and was planned in 2003 and built in 2004, in Burlusi, Ciofringeni city, Arges region. We want to give an example for everyone to show the very big advantages of the passive house standard. We hope that this will increase the courage of the Romanian architects, engineers and especially of authorities to follow our example. For the participants at this conference, we want to present how good the sustainable efficient concept was put in value in this first passive residential building in Romania. What should be emphasized here is that we consider all conditions of real estate for maximum benefit of its advantages. We wish to share our experience with all the specialists who are interested in getting to know this concept. Further we want to point out that the passive house standard is an ongoing success story if you know how to take it into account in an intelligent way.

Fig. 10: Amvic Group company.

2.3 Planning the first Romanian passive house

Starting with the planning of an energy efficient and sustainable solution and continuing with the building process, we have obtained an environmentally friendly result by using a classical building system.

The most important aspects are:

- For the envelope and structure of the building we have masonry from BCA (like Ytong) with a 30 cm additional thermal insulation of Polystyrene 24 kg/m^3 for exterior and mineral wool 7 cm for interior
- For roof thermal insulation we used mineral wool and Polystyrene
- For window have 0,8 W(m^{2}K)
- Jalousies for solar protection
- For preheating/precooling of the fresh air we installed this tear an Awa duct (Rehau) in the garden nearby
- The building has a good site protection – it is in a valley
- Using renewable energy from the sun
- Floor heating system
- Wood combustion heating system
- Using the rainwater for the garden and using the gravitation to bring water in the house from the ground water (storage basin situated on the hill, with 30 m^3).

2.4 Amvic Insulated Concrete Forms (ICF)

Amvic insulated concrete forms (ICF) are hollow, lightweight forms manufactured using two 1.5 lb./ft³ (24 kg/m3) density, closed cell, expanded polystyrene (EPS) panels which are connected by 8 (R22) or 6 (R30) uniquely designed, high impact polypropylene webs. Amvic ICF R22 blocks use 2-1/2” (63mm) thick panels while 3-1/4” (82mm) panels are used for the Amvic ICF R30 blocks. During construction, the forms are stacked then filled with concrete making stable, durable and sustainable walls. Amvic ICF combines the insulation effectiveness of EPS with the thermal mass and structural strength of reinforced concrete, in an air and vapor tight wall. ICF offers a “5 in 1” solution that provides structure, insulation, air and vapor barrier, sound attenuation and attachment for interior and exterior finishes in one easy step. Amvic ICF provides a thermal resistance of 22 hr.ft2. F/Btu (3.87 m2 K/W) with the R22 blocks and 30 hr.ft2. F/Btu (5.28 m2 K/W) with the Amvic R30 blocks. A Fire Resistance Rating (FRR) of 3+

hours can be easily achieved along with an apparent Sound Transmission Class (ASTC) of 47+ depending on the wall assembly. The combination of the thermal mass, inherent air and vapor tightness and sound attenuation of an ICF wall creates a very durable and comfortable space for the occupants to enjoy for many years.

Fig. 11: Amvic ICF products.

The webs used in Amvic ICF greatly reduce the need for rebar tie downs while placing rebar most effectively to ensure superior structural strength.

The webs are manufactured using more raw material than competing products allowing for superior finishing capabilities and 198lbs (90kg) pull out strength for drywall screws. Webs are spaced 6” (152mm) on center for the Amvic R22 block or 8” (203mm) on center for the Amvic R30 resulting in greater rigidity, which keeps the wall straight and plumb during stacking and pouring of the concrete.

Amvic webs connect the EPS panels and terminate with a 1-1/2” (38mm) flange which is embedded 1/2” (13mm) beneath the outside surface of the panels. The flange has a height of 15” (381mm) in all blocks except the 1 (254mm) and 12” (305mm) block which has a flange height of 22” (559mm). When the blocks are stacked, t flanges form a continuous horizontal and vertical grid which is used to attach interior finishes like gypsum board (drywall) and exterior finishes like stucco, wood siding and brick veneer ties.

Amvic ICF blocks use the FormLock™ interlocking system developed by Amvic, which has considerably deeper grooves than competing products. The interlock exists on all long edges allowing the blocks to be fully reversible. They also secure the courses together, preventing any movement or leakage during the concrete pour. This unique feature allows Amvic ICF to be stacked quickly, easily and there is little need for glue or ties. Amvic’s user friendly, easy to install system increases job site efficiency and worker productivity which saves time and money.

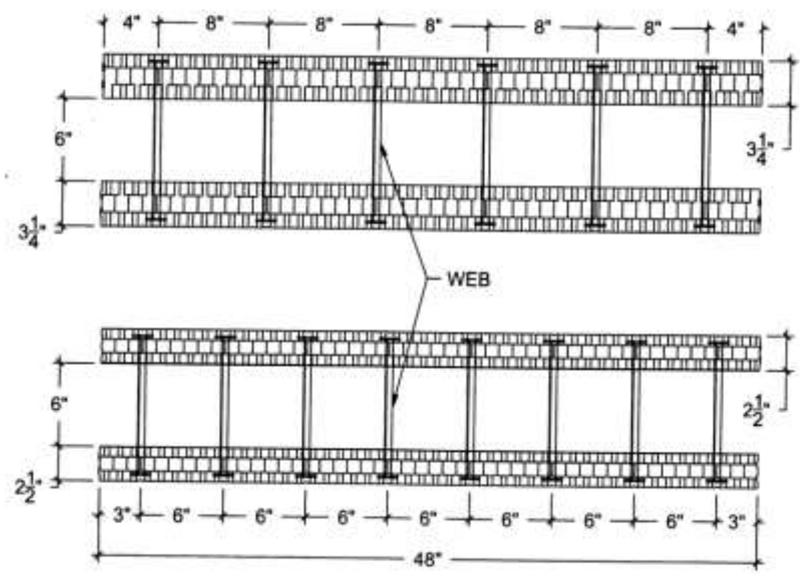

Fig. 12: Typical Amvic straight ICF blocks (R30 6” block at the top and R22 6”, bottom).

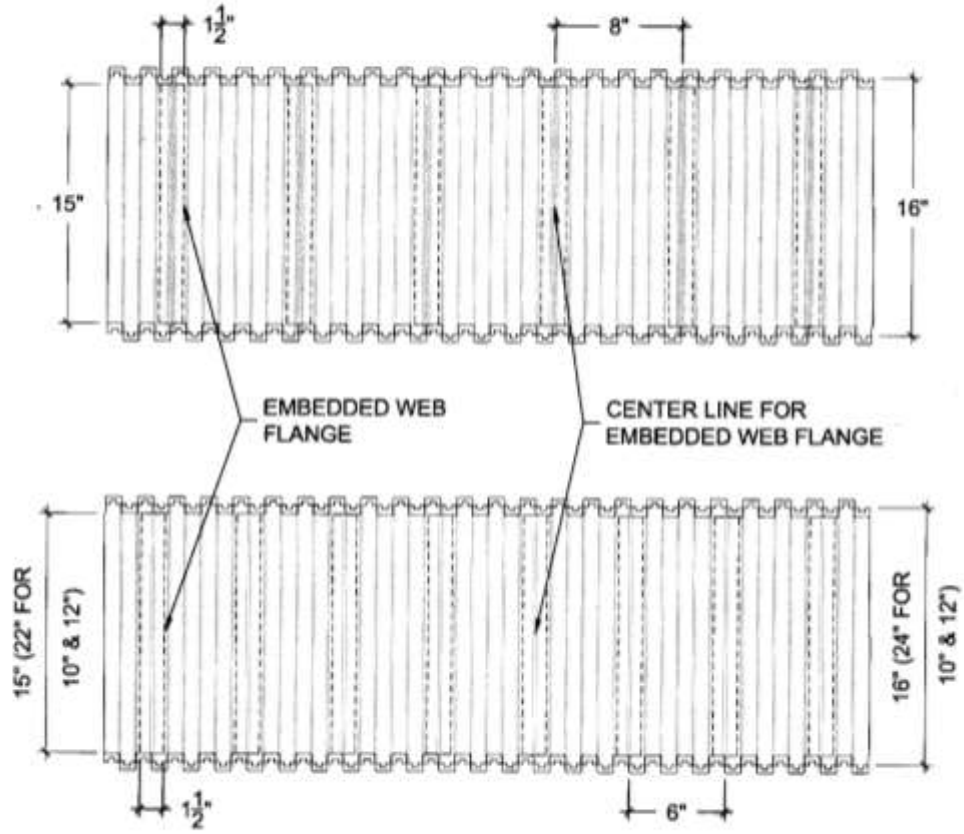

Fig. 13: Side view of Amvic ICF straight block showing web flanges.

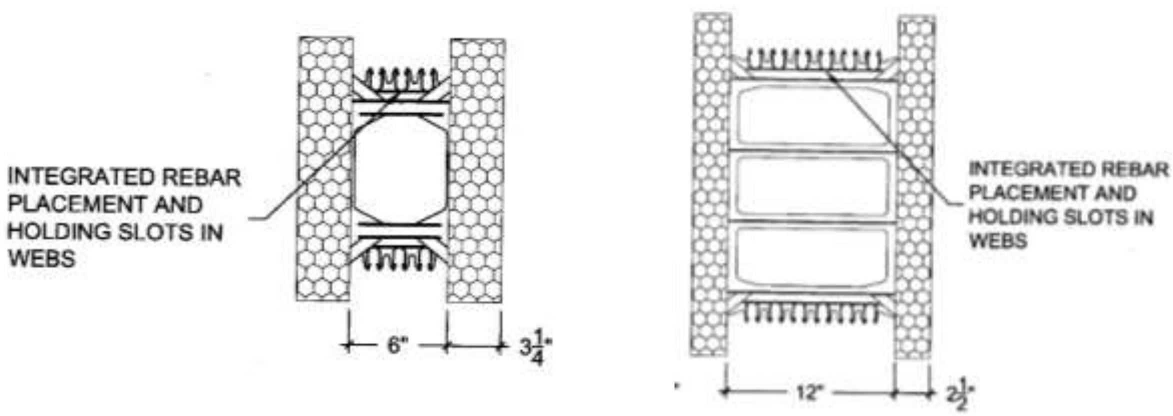

Fig. 14: Cross section of Amvic ICF blocks.

Amvic ICF R22 is available in a variety of sizes allowing for concrete cores of 4” (102mm), 6” (152mm), 8” (203mm), 10” (254mm) and 12” (305mm). Straight, 90° corner, 45° corner, taper top, brick ledge, T-block and radius blocks are available in most core sizes. For Amvic ICF R30 straight, 90° corner, 45° corner, taper top and brick ledge blocks (only in 6” (152mm)) are available in 6” (152mm) and 8” (203mm) core sizes.

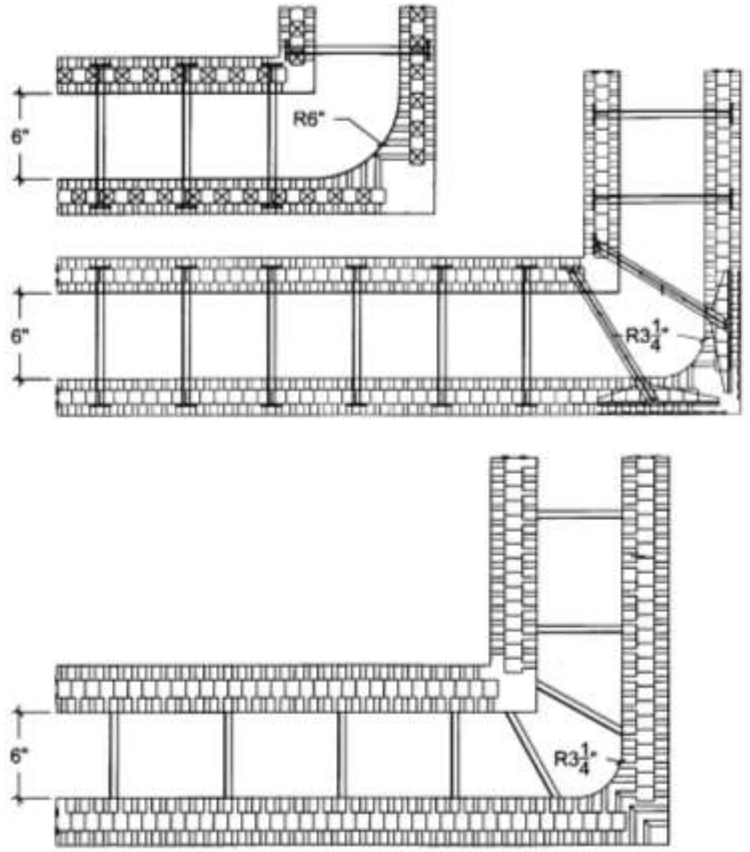

Fig. 15: Typical Amvic ICF corners. Short R22 corner (above), long R22 corner (middle) and R30 corner (bottom).

2.4.1 Ten Steps ICF construction guide

Step 1 (Fig.16)
Plan the outline of the blocks and the location of door and window openings on a conventional footing or a slab that is level, straight and square. Rebar should extend upward at least 24" (610mm) from the footing into the cavity of the block or as per structural requirement.

Step 2 (Fig.17)
Place the first corner blocks at each corner, then lay the straight blocks toward the center of each wall segment. On the first course, use zip ties on the webs to connect the blocks and pull them snugly together. Following this, install horizontal rebar by placing it in the clips at the top of the internal webs within the block cavity. The clips hold the rebar securely a eliminate the need for wire tying. (Repeat this process for each course of block).

Step 3 (Fig.18)
Install the second course of blocks by reversing the corner blocks, so that the second course of block is offset from the first, in a running bond pattern. At this point check for level across all the blocks. If the courses are not level, use shims or trim the block as required.

Step 4 (Fig.19)
Install window and door frames (bucks) at each location where an opening is required; cut and fit the ICF blocks around them. Bucks are used to hold back the concrete and stay in place permanently providing a nailing surface for the installation of windows and doors. Pressure-treated lumber or vinyl bucks may be used.

Step 5 (Fig.20)
Install additional block courses by continuing to overlap the courses so that all joints are locked both above and below by overlapping blocks.

Step 6 (Fig.21)
Install alignment bracing along the entire interior (recommended) of the wall perimeter. This ensures that the walls are straight and plumb and allow alignment adjustment before and during the pour. The bracing also serves the dual purpose of providing a secure and safe framework to support scaffolding planks once five courses have been stacked.

Step7 (Fig.22)
Stack the block to the full wall height for single story construction, or to just above floor height for multi-story construction. Cut the vertical rebar to length and begin installing it from the opening at the top of the wall, through the spaces between the horizontal rebar.

Step 8 (Fig.23)
Pour the concrete into the stacked walls using a boom pump. Do this in layers approximately 3-(0.9-1.2m) at a time, circling the structure until the top of the wall is reached. Use a mechanical pencil vibrator (stinger) to vibrate the concrete and remove all air pockets within the wall. Up to one story can poured each day using this method.

Step 9 (Fig.24)
Screed off the concrete until it is even with the block top and then "wet set" anchor bolts into the concrete top. These bolts will be used later to install the top plate (mud sill) for the installation of rafters or trusses.

Step 10
Remove bracing after the concrete has cured, then proceed with further stages of construction.

Fig. 16: Outline walls

Fig. 17: Place corner blocks first

Fig. 18: Install horizontal reinforcing steel and lap splicing

Fig.19: Install second course of blocks.

Fig. 20: Install window and door bucks.

Fig. 21: Continue installing block courses.

Fig. 22: Install alignment and bracing around the interior of the perimeter wall.

Fig. 23: Install vertical reinforcing bars after top course of blocks.

Fig. 24: Install vertical reinforcing bars after top course of blocks.

3. Footings, Slabs and Coursing

An Amvic ICF wall can be started from either a footing or a slab depending on the design and structural requirements. There are benefits and drawbacks to both methods ultimately depending on the specific site conditions.

3.1 First course of block set on slab

The benefit of starting an Amvic ICF wall on a slab is that it provides a hard, level surface to work on and to anchor bracing too. A sturdy working surface can increase job site efficiency.

3.2. First course of block set on a footing

The primary advantage to this method is that the block itself provides slab edge insulation. The edge of a slab, where the floor is located, acts as a thermal bridge.

By insulating this area, heat movement is minimized providing energy cost savings. This method is also preferable when a radiant hydronic floor system is used, or if the final floor finishes, it will be stained and sealed concrete.

3.3 Footing and walls for a raised floor

If the first floor is a raised floor, then the wall must start from a footing. In some cases, it might be beneficial to pour 2-3 courses of block initially and then install their floor system. Once the floor system is complete, the rest of the ICF wall is erected normally.

4. Wall reinforcement

4.1. Vertical Reinforcement

Vertical reinforcement is placed after the Amvic ICF wall has been stacked and completely erected. In the case of a multi-story wall, the vertical reinforcement is placed after the erection of each individual storey. As mentioned above, vertical reinforcement bars are slid into place from the top and weaved into horizontal reinforcement and secured into the proper place according to the project requirements.

Steel Reinforcing Bars and Jobsite Safety Unguarded protruding steel rebar are hazardous and can result in serious internal injuries or death due to impalement from falling or stumbling. The following measures should greatly reduce the hazards of exposed reinforcing steel:

- Guard all protruding ends of steel rebar with rebar caps or wooden troughs.
- Bend rebar so exposed ends are no longer upright.

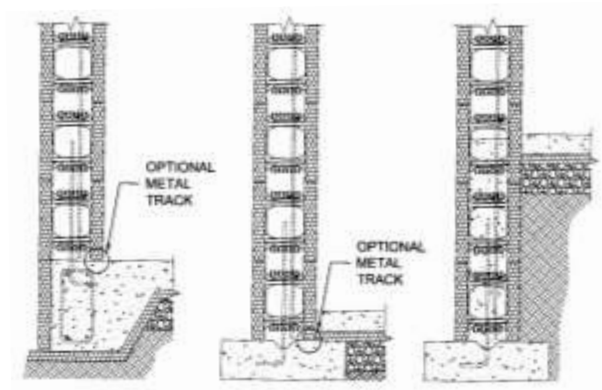

Fig. 25: Typical ICF footing types.

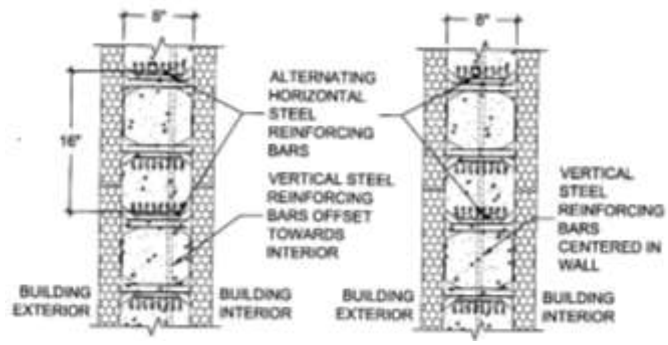

Fig. 26: Typical reinforcing steel placement below (left) and above (right) grade

Fig. 27: Plastic mushroom caps on protruding steel bars

5. Wall openings

Window and door bucks are an integral part of the ICF construction process. Some contractors build their own bucks using two-by lumber, while others prefer using a vinyl buck. Experienced ICF installers use a variety of methods for forming and installing bucks.

5.1 Wood Bucks - Constructing Wood Bucks with R22 ICF

When constructing a wood buck for Amvic R22 6” (152mm) block, use 2”x10” (38mm x 254mm) stock lumber for the top and sides of the buck since the thickness of the concrete and one panel is 8.5” (216mm). The lumber must be trimmed down to 8.5” (216mm) wide to ensure a proper fit. This may be done using a table saw. The bottom of the buck should be constructed using a single pressure treated (or with membrane) 2x4’ (38mm x 89mm) on the interior. This leaves an opening at the bottom of the window which will be used to pour concrete and insert the concrete vibrator. Additional horizontal and vertical supports are needed inside and around the buck which are removed after the concrete consolidation.

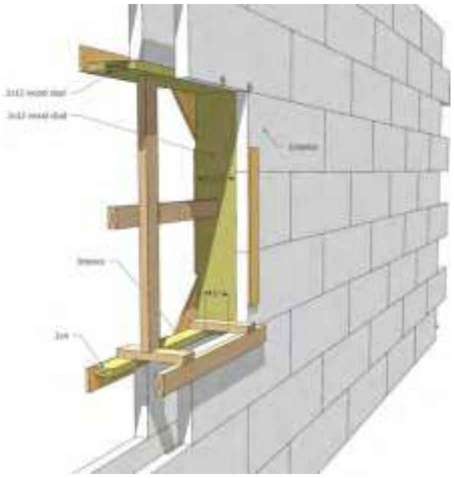

Fig. 28: Typical wood buck for 6” (152mm) Amvic R22 ICF.

5.2 Placing First Course of Block

Once the pre-planning stages are complete, begin placing the first course of block by following the steps outlined below. 1) Place door bucks in their proper location on the footing/slab. Install a temporary kicker, stacked outside to hold each safely in place.

Fig. 29: Placing corner block first

Fig. 30: Placing straight blocks

Fig. 31: Cutting the final block for a wall section.

Fig. 32: Fitting the cut block in place.

Connect blocks in the first two courses together using zip ties (plastic ties). One zip tie per end joint is generally sufficient. Place zip ties towards either edge (next to the EPS inside face). Tightening the zip ties at the center will flex the webs and may lead to foam fracturing at that location creating a source of failure during the concrete pour.

Fig. 33: Using zip toes to tie the first course of blocks together.

5.3 Placing the Second Course of Block

1) Stacking with the corner blocks first. Every corner block has a short leg and a long leg. Make sure that the corner block is reversed at the corners on the second course by flipping them upside down so that the long leg interlocks with the short leg of the first course. This will create a running bond pattern between the two courses.
2) Stack the straight forms, working towards the center of the wall.
3) Place the cut block on this course at the same location as the first course. This will ensure the offset joint remains roughly in the same place.

Fig. 34: Second course placement.

Fig. 35: Reversing 45^0 corner blocks for bay window

5.4 Securing First Course to Foundation/Slab

Ensure that all walls are on their layout lines then use low expansion foam adhesive to glue the base of the first course to the footing/slab. Insert the nose of the foam gun into one of the notches every 6–12 inches (152-305mm) along the footing and squirt a small amount of foam adhesive under the block along the entire wall. Allow the adhesive to set for up for 30-60 minutes.

Fig. 36: Using foam adhesive to secure the first course of block to the foundation/slab

Fig. 37: Gluing an unshaven course to the footing/slab

5.5 Placing Third & Subsequent Courses of Block

The installation of subsequent courses of block is the same as the second course of block.
1) Start in the corners, alternating the direction of the corner forms.
2) After setting corners, work towards the center of the wall.
3) Keep offset joints in the same place as the wall goes up.
4) Place horizontal steel reinforcement as required by engineering or local building code.

5.5.1 Installing Wall Alignment & Bracing

Alignment and bracing systems are required during construction with Amvic ICF and perform the three main functions listed below.
1) Ensure blocks are straight, plumb and properly aligned along each wall length.
2) Support stacked walls against wind gusts and other lateral loads until the concrete is poured and gains enough strength.
3) Act as a scaffold for construction workers to stack the block courses.

5.5.2 Short corners using 90° corner blocks with a running bond pattern

Corners shorter than the minimum allowed by our 90° blocks can be achieved by using straight Amvic ICF blocks.

5.5.3 Radius Wall Construction

Amvic manufacturing facilities provide pre-cut radius forms which ensure that courses fit together easily, and installation goes smoothly with minimal labor costs. Pre-cut radius forms are tongue and groove cut on the inside EPS panel and slit cut on the outside EPS panel. Radius forms can also be constructed by the contractor on site using straight Amvic IC

Fig. 38: Bracing corners

Fig. 39: Platform and scaffold planks.

Fig.40: Short corner made of 90^0 forms with a running bond

Fig.41: Using cut-off pieces to close the open ends and create a corner

5.5.3 Radius Wall Construction

Amvic manufacturing facilities provide pre-cut radius forms which ensure that courses fit together easily, and installation goes smoothly with minimal labor costs.

Fig. 44: Bending and securing the radius form into place

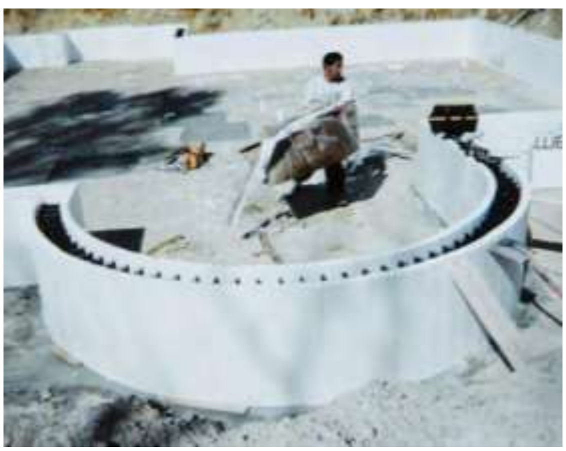

Fig. 45: Several courses of radius blocks installed

Pre-cut radius forms are tongue and groove cut on the inside EPS panel and slit cut on the outside EPS panel. Radius forms can also be constructed by the contractor on site using straight Amvic ICF.

5.5.4 T-wall Construction

T-walls require special attention before the concrete pour. Proper bracing and alignment are essential. Steps to construct T-Walls:

1. Locate the T-wall intersection as you lay the first course.
2. Cut the Amvic blocks appropriately and put them together to form the T-intersection. Use zip ties (or equivalent) to secure the blocks together.

Fig. 46: Placing the T-wall forms together and tying intersecting blocks. Use metal or plastic wire ties supplied by Amvic

3. Install horizontal reinforcing steel bars including bent 90° corner bars with proper lap splice length as per engineering requirements and/or local building code.
4. Continue stacking subsequent courses of block until the full wall height is achieved 5. Check walls for level. If the walls are level, run a bead of spray foam down along each side of the forms the T-wall.

Fig. 47: Install horizontal reinforcing steel bars as each course is laid

Fig. 48: Images from the first passive house built in Romania and the Quality Certificate obtained from Passivhaus Institute "Dr. W. Feist" Darmstadt Germany

6 CONCLUSIONS

The results of the building are in accordance with what was planned. At present, we have already 20 years of good results. We can prove that the energetic consumptions are very economic thus it is a big advantage for the owners. The conclusion is that we have a fully functional presentation and demonstration of a passive house in Burlusi, 150 km far from Bucharest.

The success is bigger with each visitor who comes and see this first passive house in Burlusi, Romania, and then he planes in his mind to make something like that and even better if he could. This is for us the biggest success.

A real example to look and touch is the most credible prove for the Romanian people and authorities who want to learn how to invest their money and not to spend it.

We hope in government recognition and support of the passive house standard for all new buildings in the very near future in European Union and in Romania, most for the social residential buildings, the administration buildings, schools and kindergarten who are using public money. Public money is the first who must be good invested and we could help on that with our experience in planning passive buildings and in building with insulated concrete forms systems.

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