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DESIGN CONSEQUENCES FOR THE CRAWL-SPACE FOUNDATION, REDUCING MOISTURE PROBLEMS

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ABSTRACT

Foundations with a crawl-space ventilated by outdoor air are common in Sweden. In summertime the relative humidity in these crawl-spaces becomes high and conditions for mould-growth and putrefaction of organic materials are good.

This paper presents measured and calculated temperatures and humidity in an outdoor ventilated crawl-space and in an unventilated crawl-space with all the insulation placed on the ground and the foundation walls. The results show that warm humid outdoor air coming into a chilly outdoor ventilated crawl-space can be sufficient to create problems with moisture. If all the insulation is placed on the ground and on the foundation walls in an unventilated crawl-space, the heat transfer through the floor and the temperature gradient through the insulation produces a crawl-space with a lower relative humidity and a lower heating cost.

1. INTRODUCTION

When constructing the foundation of a house without a basement, one common method in Sweden is to use a low foundation wall on which a floor framing is placed. The floor does not come into contact with the ground, and an enclosed space is formed which can be used for crawling in if perhaps pipes and plumbing installation have to be serviced. Most of the constructions are ventilated with outside air.

Crawl-space foundations have a long tradition and their value has been proven in many old buildings. Mould growth and also rot have however occurred on organic materials and reinforcement in aerated concrete has been attacked by corrosion in some houses built during the last 30 years. The worst problems with rot and corrosion can nowadays be eliminated, but houses are still attacked by mould growth and putrefaction, which sometimes cause bad smells and create problems for the owners.

The thickness of the heat insulation influences the temperature in the crawl-space. The calculated relative humidity without additional moisture is shown in Figure 5. The coefficient of thermal conductance (U-value) is 0.30 W/m^2 °C. The high U-value is valid for houses built in the 1960:s and the low U-value is valid for new well insulated houses. The ventilation has been set at 2 air changes per hour.

Extra heat insulation on the ground surface is one way to raise the temperature in the crawl-space. The effect of 0.05 m mineral wool with the plastic sheating remaning underneath has been calculated, see Figure 6. The ventilation has been set at 2 air changes per hour. During the summer there can be some condensation on the sheathing.

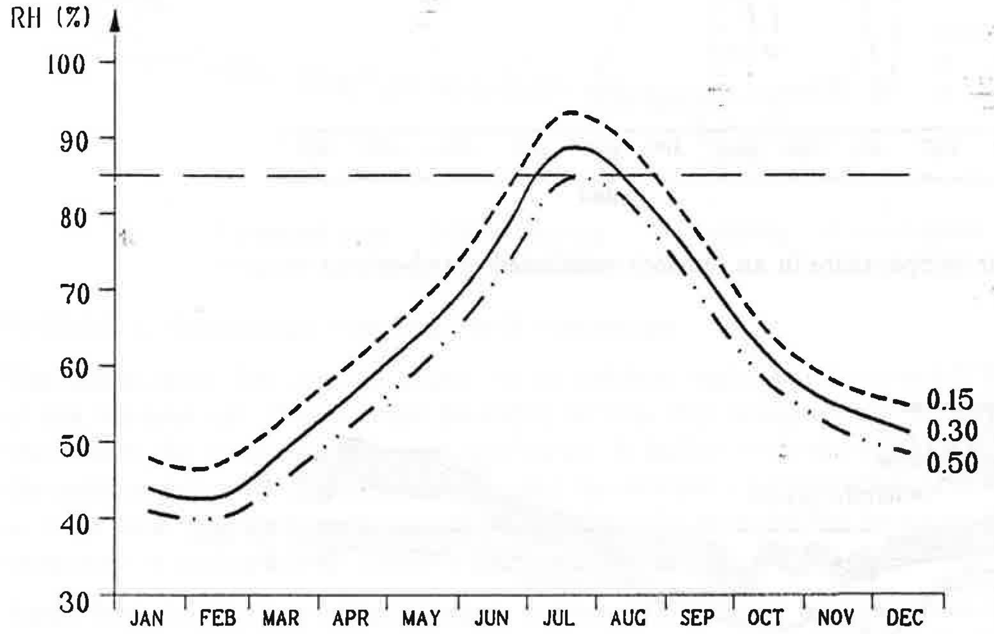


FIGURE 4. Calculated relative humidity in the crawl-space during a normal year. No additional moisture.Different heat insulation between the framework.

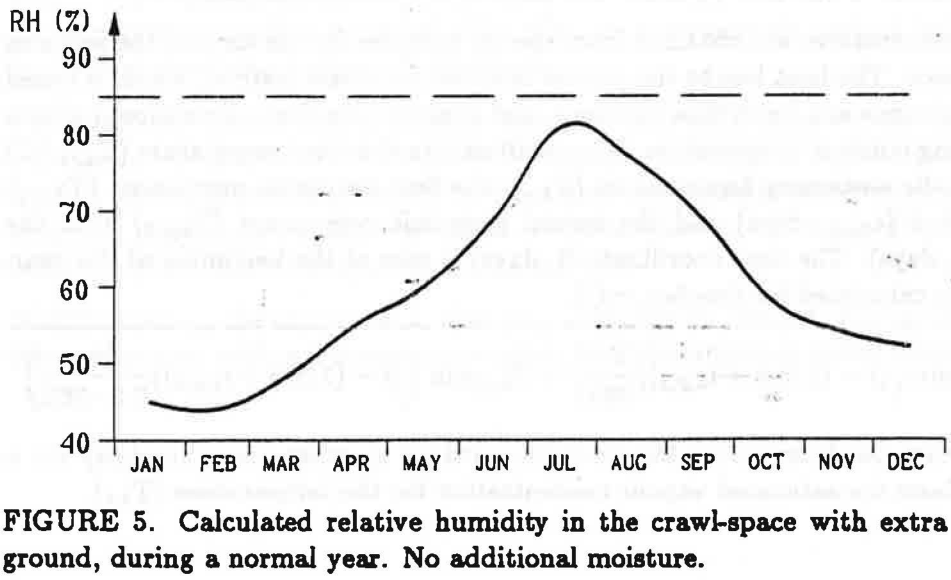
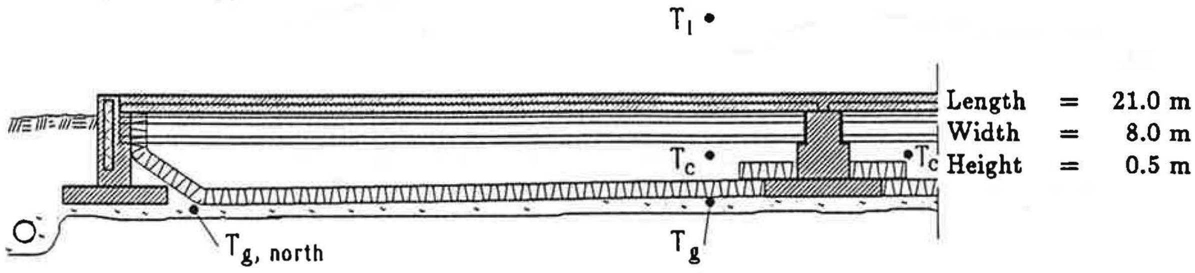


FIGURE 5. Calculated relative humidity in the crawl-space with extra insulation on the ground, during a normal year. No additional moisture.

3. UNVENTILATED CRAWL-SPACE

Another way of designing the foundation is to place all heat insulation under the framwork. The relative humidity in the space is then determined from the temperature gradient over the heat insulation and the space does not need to be ventilated. If the ground emits radon or the building is very large then the space can be ventilated by indoor air. In southern Sweden there is an unventilated crawl-space, as shown in Figure 6.



$T_{g,south}$ is equal to $T_{g,north}$ on the north side of the house.

FIGURE 6. Unventilated foundation with heat insulation under the subfloor.

Measurements of the temperatures and the relative humidity have been carried out. They are shown in Figure 7 and 8. The measuring was carried out during an extremely warm winter season with a monthly mean temperature of + 4.7 °C in February. Normal monthly mean temperature is -0.5 °C. Condensation will sometimes occur underneath the insulation and on the inside of the foundation wall. Any water can be drained into the ground.

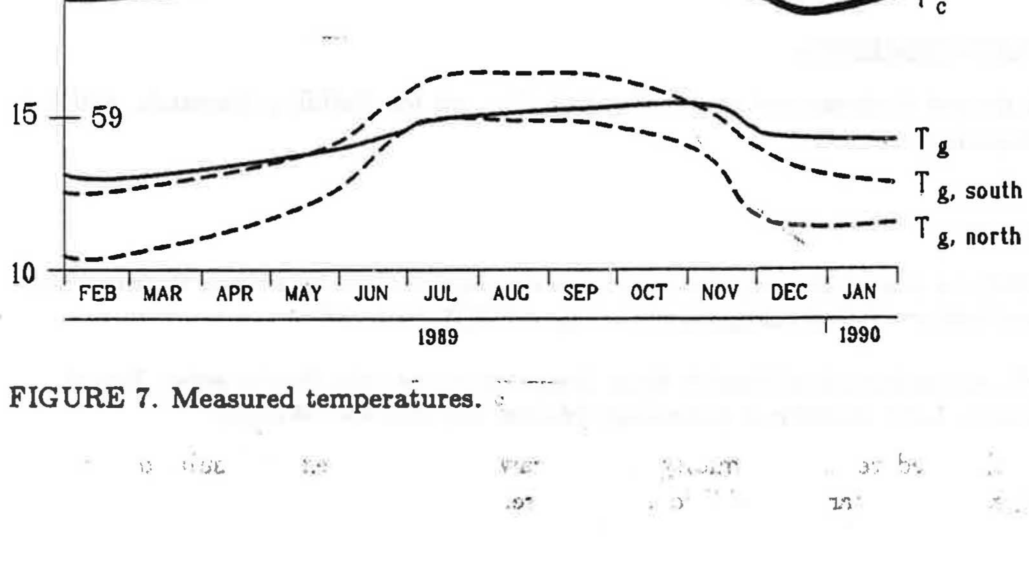


FIGURE 7. Measured temperatures.

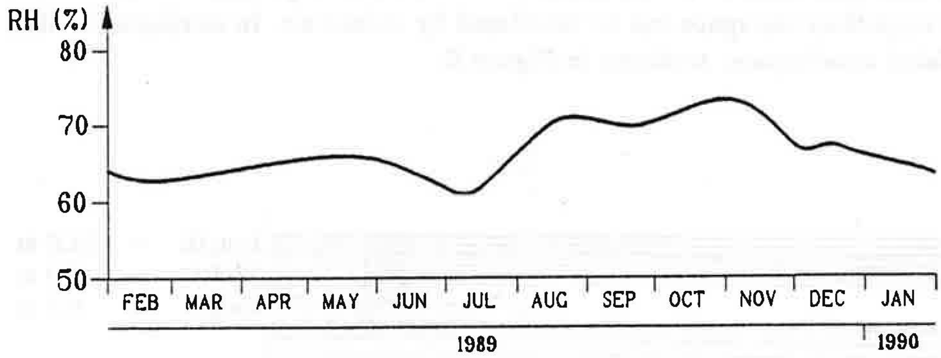


FIGURE 8. Measured relative humidity in the crawl-space.

4. CONCLUSIONS

A foundation with a crawl-space is a popular construction, but when ventilated with outdoor air there is a risk for mould growth. The possibility of improving the construction is small. This can only be done by raising the temperature in the crawl-space. One way is to reduce the heat insulation between the framework. Another way is to put extra heat insulation on the ground surface. The first solution will result in a poor heating economy and a cold floor surface. The other solution is unknown for many building contractors. Apart from these solutions the variations in the outdoor climate will always be an uncertain point.

A foundation can be made in another way. If all the heat insulation is placed on the ground surface and the space is not ventilated, then the relative humidity underneath the subfloor depends on the gradient of temperature above the heat insulation. The relative humidity in the space will be lower than for the other type of construction, provided the indoor temperature is higher than the ground temperature. Other advantages are lower heating costs and a warmer floor surface. If the ground emits radon or the building is very large the space can be ventilated by indoor air.

ACKNOWLEDGEMENTS

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REFERENCES

1. Hagentoft C-E. An analytical model for crawl-space temperatures and heat flows. Building Technology. Lund Institute of Technology, Sweden. Report:TVBH-3012,1986

2. Anderlind G. Approximation of Monthly Mean Temperatures by using Fourier series. Dep of Building Science. Lund Institute of Technology, Sweden. Report:BKL 1984:1(E).