COUNTER-MEASURES AND BETTER SOLUTIONS AGAINST MOISTURE AND MILDEW IN GROUND CONSTRUCTIONS

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ABSTRACT

During the last 10-20 years, many Swedish buildings have suffered from various forms of moisture damages. The underlying causes have varied widely, and corrective measures have been expensive in many cases. This has resulted in the development of alternative, cheaper methods of treatment. There has, however, been no comprehensive feedback of experience of the results of different methods.

We have evaluated some of the methods used today. Out of thirteen methods investigated, four can be regarded as successful, by eliminating moisture and mildew problems. The other projects have more or less failed depending on:

- not knowing the real reason of the damage;
- unsuitable method of treatment ;
- not knowing details about the design and/or the materials used.

In order to avoid moisture problems in new built houses, other safer constructions are developed. One method using ventilation under the base slab was evaluated. The result was very succssful.

SOME GENERAL NOTES ON MOISTURE IN BUILDINGS

If only the humidity of the surrounding air needs to be considered, present-day methods of theoretical design and analysis allow the moisture states likely to be encountered in a building to be estimated relatively accurately. From the known physical characteristics of the materials, and from the thermal and moisture conditions in the air, the moisture contents of the parts of the structure can be calculated.

Problems arise when moisture reaches the structure in the form of driving rain, water leaks, rising damp from the ground, residual building moisture or condensation, subjecting structures to higher moisture loadings than they were designed to withstand.

FORMS OF MOISTURE DAMAGES

The forms of damage that can be caused to damp foundation structures can be roughly divided into the following categories:

Mildew and Rot

The following conditions must be fulfilled if mildew is to be able to grow:

- spores must be present
- suitable organic material (e.g. wood or wood-based materials) must be available
- oxygen must be available
- the temperature must be above 0 °C
- relative humidity must exceed about 70 %, equivalent to a moisture ratio of about 17 % in wood.

The same conditions as above must be fulfilled if rot is to occur in wood, except that the relative humidity must be 100 % (=moisture ratio of 28 % or above).

Mildew occurs on external surfaces, such as painted wooden panels, on internal surfaces, and in the structure of the material itself. It is particularly the last one that gives rise to an unpleasant smell.

The presence of mildew causes primarily an odour problem, and possibly also health problems. At higher moisture levels, rot presents a threat to the structural integrity of wood-based materials. It has not been possible to prove any connection between the smell of mildew and an increased spore number in indoor air. However, intensive work is in progress to attempt to find relationships between the growth of mildew and the presence of an unpleasant odour.

Mildew in parts of buildings often gives rise to odour problems:

- in joisted floors resting directly on a concrete floor slab;
- from sill plates of internal and external walls;
- on wooden studding in internally insulated basement walls.

Self-levelling Flooring Compounds

An unpleasant smell can occur in buildings having floor structures finished with self-levelling floor compound. This applies to certain caseine-containing compounds that, in Sweden, were used between 1977 and 1983. When the relative humidity of the air in the structure exceeds about 75-85 %, a chemical process occurs that can result in the emission of ammonia. Besides an unpleasant smell, this can also affect surrounding materials, e.g. by discoloration of oak parquet or cork floors, smell from PVC floor coverings and saponification of adhesives.

PVS Floor Coverings

Excessive moisture content in concrete slabs covered by PVC flooring can give rise to an unpleasant smell from emitted octanoles. This may occur if the relative humidity of the concrete exceeds 95 %. The smell, which is sweet and acidic, is caused by disintegration of the plasticiser in the PVC sheet.

Where a caseine-containing self-levelling compound, which can emit ammonia, has been used under the PVC sheet, relative humidities of about 75-85 % are enough for the process to start. At high relative humidity levels, considerable displacements can occur in the floor covering: loss of the plasticiser means that it also becomes brittle.

Floor Adhesives

It is not uncommon for adhesives to saponify if used under plastic floor coverings on concrete and if the moisture content is high. Older solvent-based adhesives resisted higher moisture loadings (sometimes up to 100 % RH), while present-day water-based adhesives can saponify at relative humidities of 85-95 %.

Formaldehyde

Problems with formaldehyde emission from chipboard materials occurred during the 1960s and 1970s, due to an excessive phenol content in the adhesive at that time. Formaldehyde emission is accelerated by increased moisture contents. In high concentrations, formaldehyde has an unpleasant pungent smell.

CAUSES OF DAMAGE

The counter-measures used in buildings suffering from moisture damages are not always successful. One of the reasons may simply be that the cause of the damage has not been determined, or that one does not know how the proposed counter-measure is intended to work.

When dealing with existing buildings, it may be necessary to modify parts of the strucutre that cannot be entirely replaced. It is therefore important to know how new designed structures or elements work. A given counter-measure is seldom applicable to all types of damages.

COUNTER-MEASURES

The effects of the following counter-measue principles have been followed up:

1. Drainage/deep drainage.
2. Drying out floor joist structures with electric osmosis.
3. Impregnation of concrete surfaces of cast-on-ground floor slabs.
4. Supply and exhaust air ventilation under floor slabs.
5. Negative pressure ventilation under floor slabs.
6. Positive pressure ventilation under floor slabs.
7. Maintenance of negative pressure under suspended floors.
8. Negative pressure ventilation under suspended floors.
9. Maintenance of negative pressure in under-floor crawl spaces.
10. Maintenance of negative pressure behind stud walls against basement ground walls.
11. Injection of lower part of basement walls.
12. Drying out of sill plates with electric heating cables.
13. Negative pressure ventilation of exterior wall sill zones.

RESULTS

Table 1 gives a general summary of the results from the various methods of counter-measures.

TABLE 1. Results from the Various Methods of Counter-measure

No	Method Description	Problem	Our assess-ment	Result
1.	Drainage Deep drainage	Moisture in floor joists, odour	-	1
2.	Drying-out floor joists by electric osmosis	Moisture in floor joists, odour	-	1
3.	Impregnation of concrete surfaces of cast floor slabs	Moisture in floor joists, loosening of floor covering, odour	(+)	1
4.	Supply and exhaust ventilation under the floor slabs	Moisture in floor joists, loosening of floor covering	(+)	4-5
5.	Negative pressure ventilation under floor slabs	Moisture in floor joists, odour	(+)	1
6.	Positive pressure ventilation under floor slabs	Moisture in floor joists, odour	(+)	2-4
7.	Maintenance of negative pressure under suspended floors	Moisture in floor joists, odour	(+)	3-4
8.	Negative pressure ventilation under suspended floors	Moisture in floor joists, odour	(+)	4-5
9.	Maintenance of negative pressure in the under-floor crawl space	Odour in the crawl space	(+)	1-4
10.	Maintenance of negative pressure behind stud walls against basement ground walls	Odour from outer basement walls	(+)	4-5
11.	Injection of lower part of basement walls	Capillary attraction of moisture from be-low to basement walls	(+)	1
12.	Drying out of sill plates with electric heating cables	Moisture in sill plates, odour	(+)	2-4
13.	Negative pressure ventilation of exterior wall sill zones	Moisture in sill plates, odour	(+)	4-5

Our assessment of the efficacy of the method relates to its relevance to the problem to be dealt with:

+ = relevant method
– = not relevant mehtod
( ) = possible reservations

The results are evaluated on a scale from 1-5 as follows:

1. No measurable result - problems remain
2. Measurable change, although not sufficient - problems remain.
3. Measurable change - problems have been lessened, but not sufficiently.
4. Measurable change of expected extent - problems almost cured.
5. Measurable change of expected extent - problems completely cured.

A SAFER GROUND CONSTRUCTION REGARDING MOISTURE AND MOULD

Most damages in ground constructions are caused by high moisture content. By creating a dry construction with a minimum period of residual building moisture the risk for problems is almost eliminated.

The structure shown in figure 1 consists of a ventilated base slab with underlying heat insulation. The slab is ventilated with exhaust air from the dwelling (except from kitchen and lavatories).

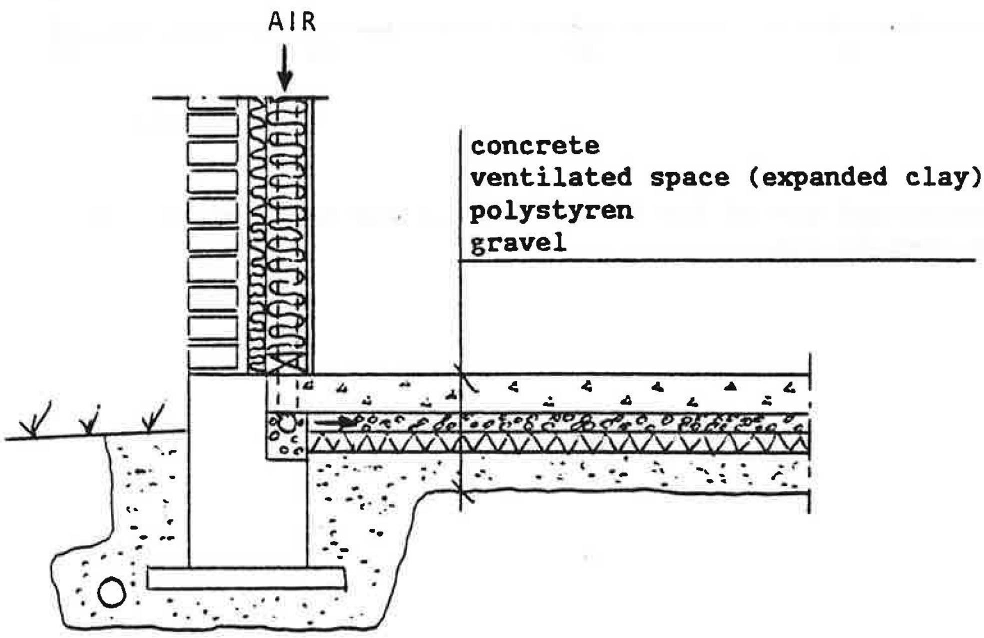

FIGURE 1. The principle of a ventilated base slab with underlying heat insulation.

In figure 2 the drying-out period is shown for the test house and for a reference house without ventilation.

Conclusion:

- The residual moisture in the slab dries out during much shorter time than in the reference house.

- The slab is a little warmer than the slab in the reference house depending on the ventilation.

- The method eliminates the main risks for moisture damages in a conventional structure.

By using experiences from damages and different counter-measures in existing houses much better and safer solutions can be created for new houses, as the last exemple shows.

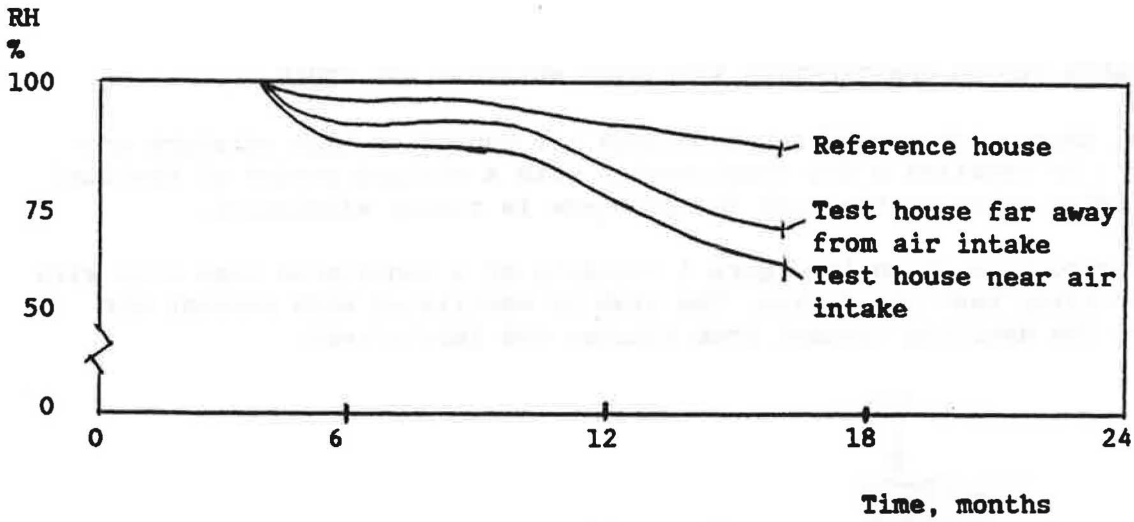

FIGURE 2. Drying-out period for the test house and for a reference house without ventilation.