THE SIGNIFICANCE OF GERMAN "GUIDELINES REGARDING THE PLANNING AND EXECUTION OF ROOFS WITH WATERPROOFING" AND NEW CONSIDERATIONS PERTAINING TO THE UNIFORM REQUIREMENTS OF ROOF SEALING

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The roof is a construction element that is exposed to extreme stresses due to the wide variety of weather conditions which can prevail in the central European climate. Such stresses result particularly as a consequence of wide and rapid temperature fluctuations combined with moisture, heat and frost. In contrast to coverings for pitched roofs, which are expected only to provide security against the ingress of rain, the sealing system used for flat roofs must be watertight, and not just temporarily, but over the longest period of time possible.

The turbulent developments in construction techniques, the high standards of quality and durability, the competitive situation and especially claims in case of liability, make it essential to prescribe codes of practice incorporating technical advances in flat roof waterproofing.

Codes of practice serve the interests of the consumer primarily, but also are a yardstick which can be used in competition. It is not sufficient simply to produce a roof. The variety of products available makes it necessary to establish quality standards. As early as 1963, the German roofing trade compiled and published the first code of practice for flat roofs. Since then the code has been revised several times to bring it into line with the current state of the art. The most recent revision was published in February 1982.

This code of practice refers not only to the built-up roofing paper, but also to all the layers and details requisite to satisfactory functioning of a flat roof. Today we assemble a complete roofing system with the goal of meeting these functional standards. We select the substructure or substrate, the vapor barrier when erecting a single-ply flat roof with insulation, the insulating material, the surface finish and the design of all joints, seams and flashings.

Joints, seams and flashings are critical elements. They are the most common source of problems. This is why we pay special attention to their careful, clean and professional design and execution. This is emphasized in the pertinent sections of the code.

The codes of practice are principally subdivided into

- concepts,
- effects on the roof,
- requirements, function, and construction measures,
- demands made on the underlying parts of the roof,
- laying down the various layers and sections, such as primer, vapor barrier, thermal insulation, waterproofing membrane,
- technical instructions on application,
- protection against wind up-lift,
- protection of the upper surface and layers,
- connections and flashings,
- maintenance and upkeep.

The effects of structural physics are particularly observed in the codes of practice.

The diffusion of moisture is a matter of great significance. Dampness can penetrate by diffusion directly into every layer of a roof. When aggravated by alternate rapid heating and cooling, the result can be annoying blisters, which can lead to damage to the roof structure. Planning and execution are given high priority, because any mistakes made at the planning stage are often irreversible.

The question of execution deals with installation techniques in general, attachment to the substrate, gluing techniques and particularly considers all factors which could give negative results.

Care and maintenance also are of major importance. It is not sufficient just to put a roof in place. It must fulfill all its functions over an extended period of time. The great quantities of dirt, dust and leaves which are deposited on a roof make it necessary to clean and inspect the roof surface and its components at regular intervals, particularly drains and flashing areas. Such inspections will reveal where weathering takes its toll, and where appropriate countermeasures must be initiated in order to extend the service life of the roof and maintain its function over the long term.

It always has been our practice to determine the quality of a roof by selecting the correct building materials. In our part of the world, there are some 34 different types of sheeting for bitumen roofs alone. This does not even cover the variety of fine particle minerals on the upper surface. When one considers that roof sealing with bitumen sheets always consists of several layers, then with 34 different sheets you can have millions of possible combinations. This is not practical of course. The various forms are comparable in quality, and this completely distorts the picture.

More recently, we have begun to consider the best way in which to achieve the performance expected of a roof.

We believe that roof sealing materials must retain their elasticity during the coldest weather encountered in the particular climate. In our case this can mean temperatures as low as −20C. On the other hand, the sealing materials must retain sufficient stability at the highest temperatures. Temperatures which change hourly, daily or seasonally cause continuous movement and deformation. The roof seal must be able to adapt to these effects. It must not develop its own, internal stresses. The roof seal must not only exhibit thermal characteristics, but mechanical properties as well. Among these, is that excessive forces are not generated when planar movements are encountered, since surface tensions woud be generated which could tear the roofing material at weak points or damage joints. On the other hand, a roofing material must be stable enough to resist penetration by mechanical loading when concentrated loads are applied as by traffic on the roof, for instance. Such strain is known as point loading.

The test procedure is relatively simple. The object to be tested, the roof sheeting, is laid tightly over an opening of 30 mm diameter and a stylus with 12mm diameter point is driven towards the sheet at a velocity of approximately 40mm per minute. The force and distortion curve is registered. The test is done at room temperature. It also can be carried out at temperatures of −10C or −15C and at +60C. The result is very interesting and makes it possible to compare different types of sheeting and results at different temperatures.

The most significant factor, however, is pore volume. Moisture creeps into the pores and settles there. The structure of the bitumen is influenced and changed by moisture. This has an adverse effect on the properties of the roof. We have therefore devoted a great deal of attention to measureing pore volume.

This test procedure is simple. The sheeting to be tested is cut into small strips of approximately 15mm wide. Loose particles are removed. By dipping the strips in water with reduced surface tension, they become wet on the surface and are weighed. Thereafter, 5 test specimens are laid in warm water, to which a softening chemical is added. The test are repeated 5 times, each lasting 5 minutes, under a pressure of −1 bar. Ever time there is a recovery period. In this way, the air in the pores is replaced by water. Subsequently, the weight of the strip is measured again after the surface has dried. This type of analysis has revealed clearly apparent differences and it indicates how complete the initial impregnation is and the pore volume.

We have mentioned all the essential paramenters. Differences naturally arise because of the substrate for the roof membrane. If the roof sealing layer is to be laid on thermal insulation, that is on a relatively soft substrate, it will become hot fairly rapidly. On the other hand, solid substrate allows only minimal warming of the upper surface, and consequently minimum mechanical thermal loading.

We have concluded that it is possible to divide the thermal and the mechanical characteristics into two categories each, giving us roof structures which are highly or minimally resistant to thermal loads, and highly or minimally resistant to mechanical loads. The thermal loading capacities and thermal characteristics are determined primarily by the bitumen layers. Today, we prefer elastomer bitumen. In bituminous webs the mechanical characteristics are determined primarily by the reinforcing plies. The material specifications of such combinations can be formulated as needed, so that we are in a position to match the characteristics of the roofing to all the requirements which may be encountered.

There is no doubt that all this has great significance on materials in common use today. The introduction of such tailor-made systems necessitates changes in the specifications for the material. In our opinion the material must adapt to the requirements of the roof and not vice versa. We feel that this will make a significant contribution to improving the quality of roof sealing.

Plastics also are being used in Germany today. Nine different types of plastics are in general use. In combination with other materials they represent some 120 different types of plastic-web roofing systems suitable for sealing roofs . These, too, can be integrated into the system outlined above with minimal modification.

Another essential factor in the life of the roof is the durability of the materials. That is why we require aging tests, although this is quite controversial. It is not yet generally possible to evaluate the multitude of weathering effects in short-term testing. There are some useful approaches which we use: thermal storage at 70C for 1, 3 and 6 months; humidity saturation; and temperature cycling or thermal shock.

In each case changes in elasticity and flexure properties are determined at low temperatures. We feel that this gives us points of reference for determining the long-term properties of these materials when used in roof sealing systems.

For some ten years now we have been attempting to codify these findings in a standard for roof sealing. The specifications are absolutely impartial and are not based on any particular materials system. They are valid for all types of roof sealing, independent of their constituent components. We expect all the manufacturers of materials for use in roof sealing will take these general guidelines into account.

Our German building codes oblige us to assume liability for the materials which we use in roofing. This gives us the right to set forth specifications as required. It will certainly come as no surprise to you when I report that our position vis a vis the roofing materials industry is quite a difficult one.

Essentially identical requirements have been set down in a code of practice published by the IFD, an international federation of roofers. The roofing contractors' associations in nine European nations are members. This code of practice serves as the basis for national and professional standards.

In our trade the exchange of experience and knowledge beyond our own national borders is extremely important. Waterproof roofs are needed everywhere. Otherwise one lands up like this poor poet in the well-known picture of Spitzweg.

Impermeable and efficient roofing are certainly the aim of this congress, to which we are happy to contribute our experiences. We also hope to take home significant new suggestions and ideas.