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ENGINEERING PROPERTIES OF ROOFING SYSTEMS

Introduction

The most important function of a roofing system is to provide a watertight or watershedding covering to keep the interior of a building dry. The performance of a roof covering is not controlled entirely, however, by the characteristics of the covering itself. The over-all performance of the total roofing system will depend upon the properties of the various components and their interaction and interdependence upon one another. Many laboratories in many countries are studying roofing systems; the papers given at this symposium present the latest information on the engineering properties of roofing systems that are pertinent to the performance of a total roof covering.

In order to prevent water leakage into the interior of a building, two types of roof coverings are used. The overlapping unit or shingle roof covering controls the force that moves water inward and so prevents its entrance into the interior; at the same time, these overlapping units permit diffusion of water vapor from the interior of the roofing system. The second type of roof covering is the membrane waterproofing which depends upon the continued existence of an impermeable membrane, so that no holes, cracks, or other forms of discontinuity occur. In the service life of these roof coverings they are subjected to rain and other forms of precipitation, changes in the moisture and thermal conditions, and the harmful effects of solar radiation and air pollution.

Roof coverings are also subjected to wind forces which may be very large and cause extensive damage to roofing systems. In the past few years there has developed an interest in the nature and distribution of wind loads and their effects on various roofing systems. Two papers in the symposium consider this topic. One describes tests to evaluate the resistance to wind that is offered by roof shingles and other roof assemblies. This type of study should prove valuable to those interested in the effectiveness of self-sealing shingles and in the amount of resistance that is offered to wind uplift by various roof assemblies. The second paper considers the amount of wind uplift and how this may be resisted by nailing. Again, this information should prove valuable to those concerned with the problem of dislodged shingles, the stripping of roll roofing, and the blowoff of membrane-type systems.

The adhesive property of bitumens is one that has made bitumens useful for centuries. It is recognized, however, that the adhesion of a bitumen to a surface will depend upon the nature of the surface as well as the nature and state of the bitumen. The strength and deformation properties of bitumens when adhered to solid surfaces are of interest to all who use such systems. The relationship between this adhesive strength and the thickness of adhesive used is discussed in one of the papers. This information will be essential as the design of roofing systems progresses.

No full understanding has yet been achieved of all of the factors that induce deformation in a roofing system. Certainly one of the factors is moisture; this factor and its effects upon roofing systems is discussed in two papers. One of these considers the combined moisture and thermal changes that may take place in a roofing system and the accompanying dimensional changes. The other paper on this topic deals particularly with the moisture changes in the covering of a roofing system due to the weathering action. These two papers provide information that is needed in order to understand the moisture response of bituminous roofing membranes.

In recent years, sheet-applied and fluid-applied roof membrane systems composed of nonbituminous polymeric materials have been introduced in order to overcome some of the inherent problems of conventional membranes. These so-called "new" roof systems, however, are still subject to deformation due to thermal and moisture changes and structural movements in the roofing system. An appreciation is thus required of the ability of such materials to undergo deformation. One of the papers describes a series of experiments the aim of which was to measure the deformation properties of fluid-applied nonbituminous roof membranes. The techniques described may prove valuable in other studies on these and similar materials and may also be useful in assessing the performance of conventional bituminous membrane coverings.

Whenever a roofing system is designed, provision must be made for the edge details and for waterproofing elements that pass through the membrane. The need of providing expansion joints must also be considered. If flashings and expansion joints are to be installed, they must be adequately designed and constructed. The many failures of roofing systems that occur at such locations indicate that there is a need to understand the factors that affect the performance of flashings and expansion joints. The paper concerned with this subject should prove useful to designers and to all who are concerned with the satisfactory performance of roofing systems.

In recent years, interest has increased in the performance of bituminous roofing membranes and what possible improvements might be made in the system. One suggestion is to tape the joint between insulation units. An investigation into the usefulness of this approach is presented in one of the papers. This paper provides useful information not only on the subject of taped insulation joints but also upon the response of the roofing system to an imposed deformation.

Two papers from widely separated geographical locations examine the deformation response of roofing membranes at various temperatures. The first of these also includes a report of the performance of a bituminous adhesive under shear deformation and relates the thickness of the adhesive to the performance of the membrane, particularly with respect to the splitting failure of these materials. The second of these papers examines the effect of repetitive deformation of membranes using a deformation below that required for ultimate failure. Also included is a description of the techniques used to examine the ability of various bituminous membranes to undergo deformations at the very slow rates of deformation that take place in service. Both of these papers provide information on the mechanical properties of bituminous membranes, which should be valuable in the consideration of the performance of these membranes.

The final paper is also concerned with the deformation qualities of bituminous membranes but relates their performance to a thermal-shock factor which combines the thermal-expansion coefficient of the materials with their ability to deform as expressed by the modulus of elasticity. The approach is of interest in trying to bridge the gap between laboratory measurements of the deformation properties of membranes and the field performance with regard to thermal deformations.

ASTM Committee D-8 sponsored this symposium to make available the latest information on the nature of the forces to which a roofing system is subjected and the response of the roofing systems and their components under the action of these forces. It is hoped that the information will prove useful in the design considerations of roofing systems, and that these papers will stimulate discussion and further research on these materials, alone and in combination with each other.

P. M. Jones
Research officer,
National Research Council,
Ottawa, Canada