and less soluble mineral grains together. The hard cement stones of the lias and the oolite clay districts of the south-eastern Midlands often go to pieces from this cause. Corallian calcareous grits of Yorkshire and Dorset, upper and lower greensand of Devonshire and the Weald, and even the famous Kentish rag in its less compact condition, should be protected from the solvent action of water, and when buried are never free from suspicion. Bastard limestones, much used for second-class roads in the Pennine district, as well as in parts of Devonshire, Shropshire and North Wales, also suffer solution changes, but with the increase in the percentage of lime carbonate the dissolving waters become saturated at the surface of the stones, and the danger of actual disintegration by partial solution is reduced.

Igneous rocks, when compact and fresh, are attacked so slowly that through the space of one man's life they may be considered as immune. If already porous and partly weathered in the quarry they generally contain some carbonate of lime, and may quickly go to pieces when subjected to continuous soaking within the road. In certain regions, such as the English Lake District, the Breidden District, the mountain district of North Wales (including a certain section—now proverbial—of the Holyhead road), it often happens that this type of altered igneous rock is the only rock which the casual laborer has skill enough to quarry, and though excellent material is available at no great distance, these, and these only, are used upon the roads.

Of all road materials now in common use, those that are most rapidly affected by the solvent action of water are the slags. Slags upon a road crust can be observed, and though after every shower the characteristic aroma of their reaction with water can be smelt, it is a matter for argument whether their cheapness does not compensate for the rapidity with which they disintegrate, whether under the action of atmospheric water or under traffic. Placed beneath the crust to act as a go-between and weight distributor from the road surface to the foundations, no slag is ever safe, and numerous are the cases known to me where estate roads made up with slags and dressed with satisfactory coatings of the best macadam developed crop after crop of potholes by reason of the spasmodic and irregular, sudden or gradual disintegration of odd pieces of the slag which lie invisible and soaking continuously in the ground waters below.

Physical Characteristics of Water in a Road.

The speaker considered first the property by which water wets the solids with which it comes in contact. The primitive concept of a liquid as a fluid which wets things is widespread. Certainly the liquid water does wet—that is, spreads as a film over the surface of most common solids—but it is not difficult to mention a score of liquids which, when sprinkled upon the surface of common solids, refuse to wet them, and which, instead, curl up into globules and remain as scattered drops upon the surface. This difference of behaviour is due to intrinsic differences between two classes of liquids, and the physical property which controls it can be numerically evaluated and tabulated, and is known under the name of "surface energy" or "surface tension."

For a liquid to wet a solid there must be a degradation of energy when the two surface films (solid-liquid and liquid-air) are substituted for the one surface film (solid-air). When, on the other hand, a liquid refuses to wet a solid, there is indication that the energy value of the solid-liquid plus liquid-air surfaces would be greater than the energy value of the existing single surface film of solid air.

Glass is a solid readily wetted by water. When two glass plates are brought close together with one or more drops of water between, the two plates stick together, and the force required to drag them apart is considerable. Professor Fearnsides did not attempt the mathematical analysis of the manner in which the force which resists the parting of the plates is developed—it is discussed in Poynting and Thomson's "Properties of Matter"—but merely said that it was determined by (1) the surface tension—i.e., the skin strength of the water; (2) the curved water-air surface, which, by reason of its surface tension, the water in the narrow space between the plates develops, and (3) the difference of pressure inside and outside the water film which the curved skin of the water renders possible and necessary. The net result is that two glass plates with a water film between require a force almost equal to the pressure of the atmosphere (about 15 lbs. to the square inch) to begin to separate them.

This experiment may be repeated using plates of mica instead of glass, and find that the force required to drag apart the wet mica plates is slightly greater than in the case of glass. A whole series of damp mica plates may be piled together and it will be found that in order to break the column of the mica pile force almost as great must be employed. In order to obtain the maximum tensile strength of piled plates it is essential that the plates should be flat-sided and in parallel position. Plates with water drops between, and kept from parallelism by a match stalk wedged in at one edge, are not difficult to separate. To separate curved surfaces of glass with water drops between requires some expenditure of energy, but the plates come apart quite easily.

Behaviour of Water-bound Materials.

The experiments just indicated exactly reproduce the behaviour of water-bound materials in a road. The road materials which, bound with water, are most strong, are those which break into pieces with flat faces, and whose constituent minerals break with a cleavage into flat-faced grains, and are readily wetted by water. Derbyshire limestone, for instance, breaks into flat-sided tetrahedral pieces which will pack, and its powder consists of the flat-faced rhombohedra of calcite. With the right amount of water Derbyshire limestone binds magnificently.

Our experiment was made with mica. Sorby, Hutchins and others have proved that most clays consist of minute flakes of mica. Clay makes excellent bricks, which, when dried, are strong enough to stand one upon another to the full height of the kilns even before they are burnt. This strength is the strength of the water films between neighboring mica plates, strength exactly analogous to the strength of water-bound macadam.

If the experimental pile of mica plates, or the brick dried ready for the kiln, be dropped into water, the air which with water shares the narrow places between the mica flakes is displaced, and the strength of the aggregate so diminished that the mica pile becomes "weak as water," and the brick "falls" to muddy clay like, but more muddy than, the clay from which it was made.

Tensile and Crushing Strength.

The professor mentioned this behaviour of bricks to suggest that, by making briquettes of crushed road