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D00629

Distr.
LIMITED

IP/WG.441
5 September 1969

ORIGINAL: ENGLISH

United Nations Industrial Development Organization

Expert Working Group Meeting on
Fibre-cement Composites

Vienna, 20 - 24 October 1969

PROPOSED RESEARCH AND DEVELOPMENT PROGRAMME AT THE TROPICAL PRODUCTS INSTITUTE IN WOOD-WOOL SLAB MANUFACTURE IN DEVELOPING COUNTRIES 1/

by

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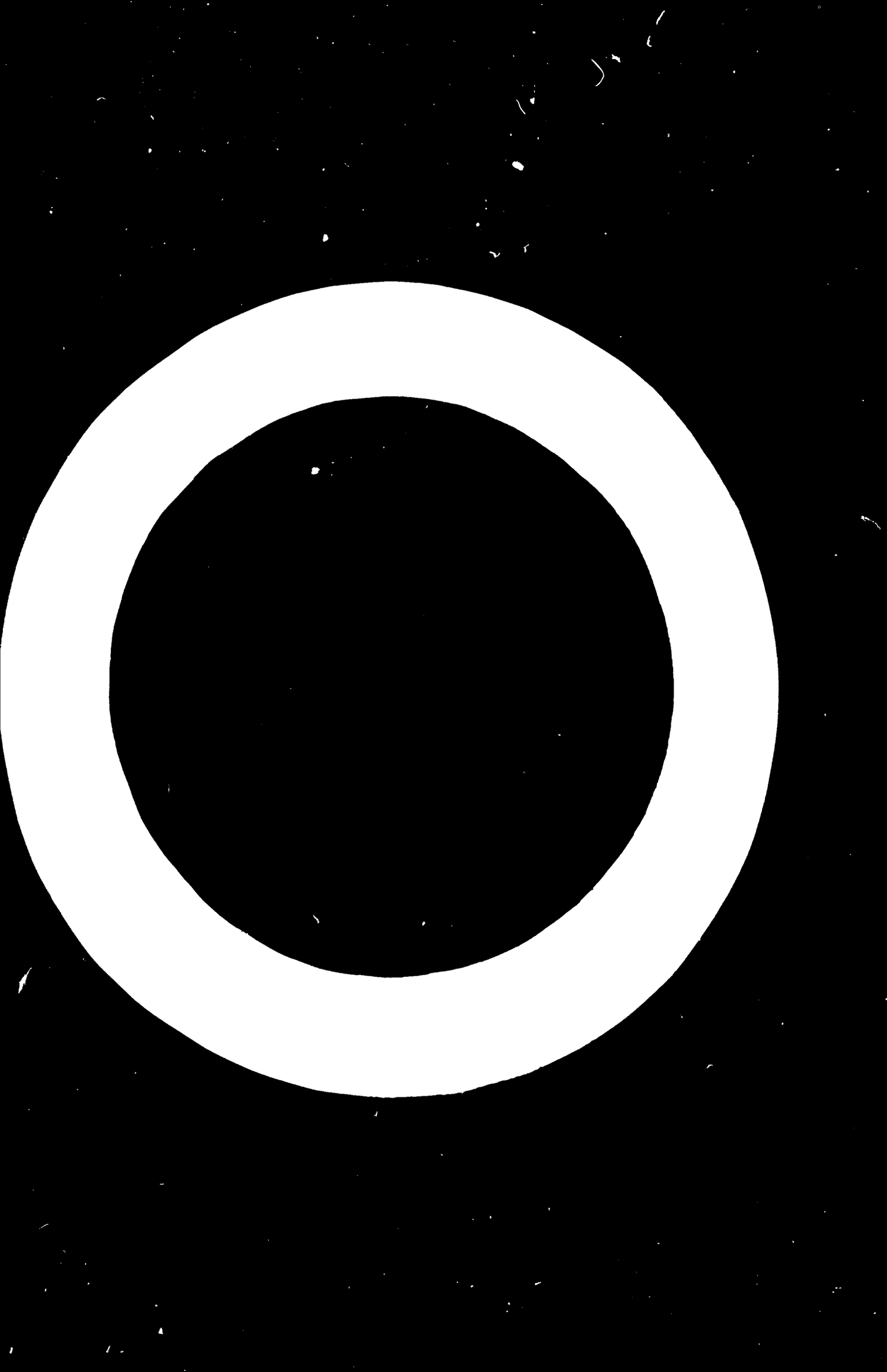

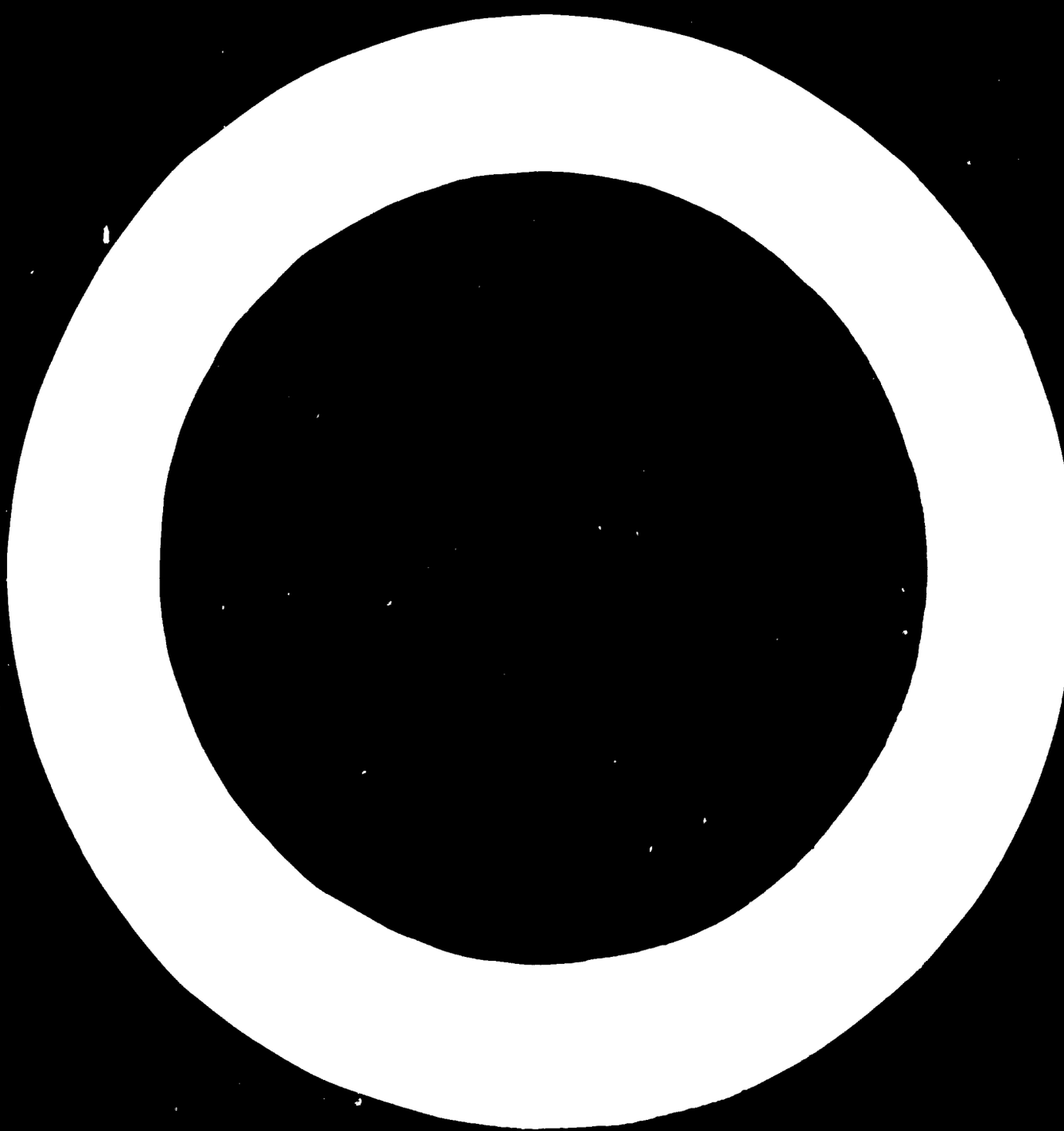

INTRODUCTION

The investigational work on this project is to take place at the Industrial Technology Department, Tropical Products Institute, Ministry of Overseas Development, situated at Culham near Oxford, etc. The plans for the project is on order and it is hoped to start work at a later date.

The project is a collaborative one between the T.P.I. and the Commonwealth Forestry Institute, Oxford, who is currently carrying out a research project into some other aspects of the industrial utilization of fast-grown tropical timbers (1). This collaboration has the advantage that, whereas the control of sound advice on the quality and cost of the timber we shall be using; secondly, the sampling techniques used in this way will be applicable and ensure that the results are meaningful; and thirdly, this particular project fits in with the much larger one referred to above for which the Institute is carrying completely integrated forest industries based on fast-growing tropical timbers in developing countries.

In particular, wood-wool slab production is an attractive industry for many developing countries because of the low capital cost, the possibility of operating economically on a labour intensive basis and its potential use to the industry's low cost housing programmes.

It is relevant to briefly look at the history of wood-wool slab development in Europe in that it may provide a clue on which the development of a well-established low cost industry for developing countries could be based. Unfortunately, the history is not very well documented, and will be seen later, that which does is in German. It is generally accepted that the industry was born and grew up in Austria and Germany, the first patent for wood wool and the formulation of the present product was granted in Austria in 1908. It was not, however, until the early 1920's that the industry really began to expand and the wood-wool slab became an acceptable building material in Europe. Due probably to the high cost of imported timber and the very small home timber production at the time, wood-wool slabs did not, until comparatively recently, take on as common building material in the U.K. This indicates that first necessity of a successful wood-wool industry, is cheap timber of suitable quality. The second World War saw a tremendous increase

in the wood-wool slab industry particularly in war-time conditions in Germany. It is most unfortunate that on account of the industry there during this time is not more generally available because a great deal of ingenuity and innovation to suit the difficult conditions of the times were apparently utilised which would possibly be most useful for developing countries. It is thought that it was during this period that the use of calcium chloride as a co-called "mineralising fluid" was almost standardised. The use of these mineralising fluids have been the source of a considerable amount of mystique in wood-wool slab production for a very long time. In fact, after the Second World War there were a number of proprietary processes for cement - wood-wool manufacture which based their novelty only on the secret formulae of mineralising fluids. Very briefly, it has become virtually standard practice to soak wood-wool in one of these mineralising fluids (sodium silicate is another commonly used one) before mixing with the cement. There has been some research work done (mostly in Germany, and mostly on temperate soft-woods) on the technology of this part of the process; more needs to be done in relation to their utilisation with tropical timbers. If only the very minimum amounts required could be clearly determined this would be of some importance in a country where for ign currency would be needed for importing these chemicals. The precise mechanism of mineralising fluids in the wood-wool process is not easy to study because of the complex nature of the wood extractives involved. The situation is further complicated by the fact that both water soluble and lime-water soluble extractives are leached from the wood when it is in contact with cement and water. It is now fairly well established that some of these extractives from some (probably to a greater or lesser degree from all vegetable matter) timbers inhibit the setting of cement. Further, even if the setting time of the cement is not appreciably retarded there is evidence that its compressive strength will suffer. The most widely held theory of the effect of mineralising fluids is that they are used as localised cement accelerators around each strand of wood-wool. This has the effect of rapidly producing a coating of set cement around the strands which prevents leached-out inhibitors from extending beyond this barrier to the large part of the cement binder. With some timbers, however, not even relatively high concentrations of mineralising fluids will prevent serious interference with the setting of the cement. In these cases, there is a suspicion that some inherent property of the timber other than water or lime-water soluble extractives are the cause. Again, more work on this problem is required particularly with tropical woods.

So far, the chemical structure of the timber has been discussed, the physical

structure can also be of importance. Even if it proves possible to get a satisfactory cement bond between the wood-wool strands it may be that the strands themselves will not flex sufficiently during the mixing and moulding (the slabs are generally formed in moulds under slight pressure) and crack or split when bent into curves of small radii. Going further back in the process it could well be that the actual machining of the wood-wool presents difficulties with some species. To date, virtually no results of scientifically conducted machining trials on the non-conventionally used wood-wool timbers have been published but it can be foreseen that the machining of some species will just not be economic because of known short time between sharpening of wood-working tools used on them. In many respects, the physical aspects of tropical timbers for wood-wool making will have to be looked at most closely because many developing countries will wish to use timbers for this purpose which are not otherwise useable. It may well be that the same factors which result in this material being unuseable for sawn timber, for instance, will also render them unuseable for wood-wool.

Sufficient has been said, it is felt, to indicate that a sorting procedure for identifying those timbers available in developing countries which are potentially useable for wood-wool manufacture is urgently needed. Consequently it has been decided that a project designed to do this should be started by the Tropical Products Institute.

WOOD-WOOL SLABS

In its most commonly used form this material is made by mixing strands of wood-wool bonded together with Portland Cement. The wood-wool used is generally machined from timber in the round, although there are machines for producing it from saw-mill waste, off-cuts etc. but this product is probably only suitable for use as a packing material. The individual strands of the slab material are in the range 0.3 - 0.5mm. thick, the lengths being governed by the length of the logs being machined. These strands are soaked in one of the mineralising fluids mixed with cement and formed into boards or slabs under slight pressure. Two main types are currently manufactured in Europe, unreinforced and the reinforced type which consist essentially of the unreinforced slabs enclosed in some sort of metal framework for infill units etc. The British Standard Specification (2) recognises two sub-types of unreinforced slabs. Type A intended primarily for non-load bearing purposes which must withstand a minimum specified test load (2 inch thick slab) of 200lb. over a 30 inch span, and Type B intended particularly for roof construction, the minimum test load for this type is about twice that of Type A.

All types are made in varying thicknesses of between 1 inch and 3 inches,

the normal sized slab in U.K. is 2ft. by 1ft. although longer ones are also made. Unsurfaced, they present a very rough appearance due to the open structure of the timber strands. They are pervious to air, water and water vapour but can be soaked and dried repeatedly without serious consequences. After 4 hours immersion they have a moisture movement of about 0.2 per cent. They have a thermal conductivity (K) of 0.5 at 10°C and possess a good degree of fibre resistance. They are, in fact a permanent building material which is substantially unaffected by climatic conditions and have a high resistance to fungal and termite attack. Their chief uses are for roof decking, partition walling and for ceilings. It must be mentioned here that most Euro can countries have slightly differing specifications to these and also different methods of test which makes any comparison very difficult.

RESEARCH PROGRAMME

This falls into three main parts: -

(1) A laboratory assessment of the individual wood species concerned for their suitability for the manufacture of wood-wool slabs,

(2) small scale production trials of wood-wool and wood-wool slabs followed by the physical testing of the slabs and

(3) the design and development of a complete small plant for a particular country.

Much has been published on (1) particularly in Germany but the greater part of this has concerned European timber species. One exception is the work by Sandermann (2) which contains a go - no list of many species including tropical ones. Much of this data is based upon the ingenious indirect method determining whether or not a material interferes with the setting of cement. This method was originally published by Sandermann et al. in 1960 (3). This is a "sorting" method based on the fact that the setting of a cement/water mixture is an exother ic reaction there being a reduction in heat output ("hydration temperature") in the presence of interfering substances. Since the method was originally published it has been adopted by several laboratories working in this field (including the Tropical Products Institute) and the original authors have developed and refined it to a high degree (4). Despite the apparent simplicity of the method, it has been found at T.P.I. that considerable caution is need in carrying out the test and in the interpretation of the results. Nevertheless, there is no doubt that it is a most useful short method for sorting out materials which are gross cement-setting retarders, but still further development of it is needed for it to be used with confidence in marginal cases.

It is known that different provenances can produce timber having different extractive contents and this factor could well be an important one in establishing its suitability or otherwise for wood-wool slab production. Further, it is hoped that thinnings from fast growing tropical timber plantations will provide a useful and economic source of material for this purpose and here, of course, the effect of timber age as well as the other considerations will have to be elucidated. Consequently this part of the investigation will really consist of adding to rather than duplicating data produced by other workers.

Small scale production of most manufactured articles presents many problems in the technology of scaling down operations whilst at the same time ensuring that the whole operation is still economically viable. These problems generally devolve around a piece of key equipment which tends to govern both the minimum output and the minimum capital cost of the plant. In the case of wood-wool machine we have been able to find is said by the manufacturers to produce 300 tons of wood-wool per annum (based on 40 hour week, 3-4mm. thick wood-wool). This figure is presumably based upon the use of European softwoods. On the published evidence available there would appear to be an enormous range in the size of commercial wood-wool plants throughout the world. The smallest (now apparently closed down) appeared to have an annual production of about 2000m^3 per annum. In trying to correlate these figures without precise confirmation on the density of the timber used, in the density of the finished board and on moisture contents of raw material and finished product it is most difficult to achieve any sort of accuracy. It is our plan to purchase one of these very small machines and to run it at the Tropical Products Institute with precise measurements of input and output quantities to obtain an accurate production figure.

Within this section the quantity, type and effect of different mineralising fluids will be studied. This is a subject on which almost nothing has been published or on which information exists which is freely available.

SMALL SCALE MANUFACTURE OF WOOD-WOOL SLABS

This aspect of the research programme is discussed within the context of a small industry in one of the less developed countries. Previous experience in development work at the Tropical Products Institute indicates that both the technological and economic conditions are so sufficiently different between developing and highly industrialised developed countries that a small industry in one would be viable, whilst in the other it would not. The problems here are common to all industrialisations on a small scale in developing countries and need not be enlarged upon here. Suffice it to say that the problem is most acute,

for obvious reasons, with capital intensive industries. As has been mentioned above, it is thought to be possible to design a wood-wool industry with relatively simple equipment but at this stage there is insufficient data on wood-wool machine figures. There should not be any great difficulty with costs of non-mineral raw materials, timber costs of the type which it is hoped to utilise for this plant should be much lower than the European equivalent. The mineral raw material costs will, however, need to be carefully studied. Mention has been made of the work which it is proposed to do on reducing mineralising fluid costs but there still remains the cost of the cement. This can be expensive in developing countries and, as far as is known, no work has been done on reducing the binder cost in wood-wool slabs. Some work has been done on using synthetic resins as alternative binders (5) but, apart from the actual cost, these would almost certainly need to be imported, which brings the foreign exchange problem to the fore again. The Tropical Products Institute is already engaged on a project to try and find a suitable naturally occurring binder (i.e. a binder which need not be imported) for use in particle board manufacture, and it is proposed to see if it is possible to develop an alternative, or at the least, a part alternative binder to cement in wood-wool slab manufacture.

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(1) Commonwealth Forestry Review 46 (3) 1967 p.206.

(2) British Standard 1105: 1963, Specification for Unreinforced Wood-Wool Slabs.

(3) Sandermann, Preusser and Schwiers, "Studien über mineralgebundene Holzwerkstoffe Holzforschung 14 (1960) (3) p.70.

(4) Sandermann and Kohler, "Über eine kurze Eignungsprüfung von Hölzern für zement-gebundene Werkstoffe", Holzforschung 13 (1964) (1/2) p.53.

(5) The Manufacture of Resin Bonded Wood Wool Products by Industrial Section, Timber Research and Development Association, U.K. P.D. 1968.

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Subject to review by the Tropical Products Institute before final publication.

United Nations Industrial Development Organization

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Distr.
LIMITED

ID/WG.14/3 SUMMARY
5 September 1969

ORIGINAL: ENGLISH

Expert Working Group Meeting on
Fibro-cement Composites

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SUMMARY

PROPOSED RESEARCH AND DEVELOPMENT PROGRAMME AT THE TROPICAL PRODUCTS INSTITUTE IN WOOD-WOOL SLAB MANUFACTURE IN DEVELOPING COUNTRIES [1/]

by

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Tropical Products Institute, Ministry of Overseas Development,
Culham, Abingdon, England

The project is carried out in collaboration with the Commonwealth Forestry Institute at Oxford. It is hoped to start work on it later this year.

Wood-wool slab production is an attractive industry for many developing countries because of the low capital cost, the possibility of operating economically on a labour intensive basis and its assistance to the countries' low cost housing programme.

The first patent for wood-wool slabs was granted in Austria in 1908. In the 1920's the wood-wool slab became an acceptable building material in Europe. During the second World War the consumption increased tremendously.

It has become standard practice to soak the wood-wool in a "mineralising fluid" (calcium chloride, sodium silicate) before mixing it with the cement. The theory of the effect of mineralising fluids is that they act as cement accelerators around each strand of wood-wool. A coating of set cement is rapidly produced around the strands. This prevents leaching-out of extractives from the wood which act as inhibitors and prevent the setting of the cement.

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The physical structure of the wood can be of importance. If the strands are not sufficiently flexible they may crack when compressed. The machining of the wood-wool may present difficulties e.g., the short time between sharpening of the wood-working tools and other factors which result in certain wood species being unusable for sawn timber in which case they probably will be unusable for wood-wool slabs too.

The wood-wool is generally prepared from timber in the round, the strands being 0,3 - 0,5 mm. thick. The strands are soaked in the mineralising fluid, mixed with cement and formed into slabs under slight pressure. The thickness of the slabs is between one and three inches, the normal size in U.K. 6 ft. by 2 ft. The slabs have a very rough appearance due to the open structure of the timber strands. They are pervious to air, water and water vapour but can be soaked and dried repeatedly without serious consequences. The thermal conductivity (K) is 0,58. The slabs posses a good degree of fire resistance, are unaffected by climatic conditions and have a high resistance to fungal and termite attack. They are mostly used for roof decking, partition walling and ceilings.

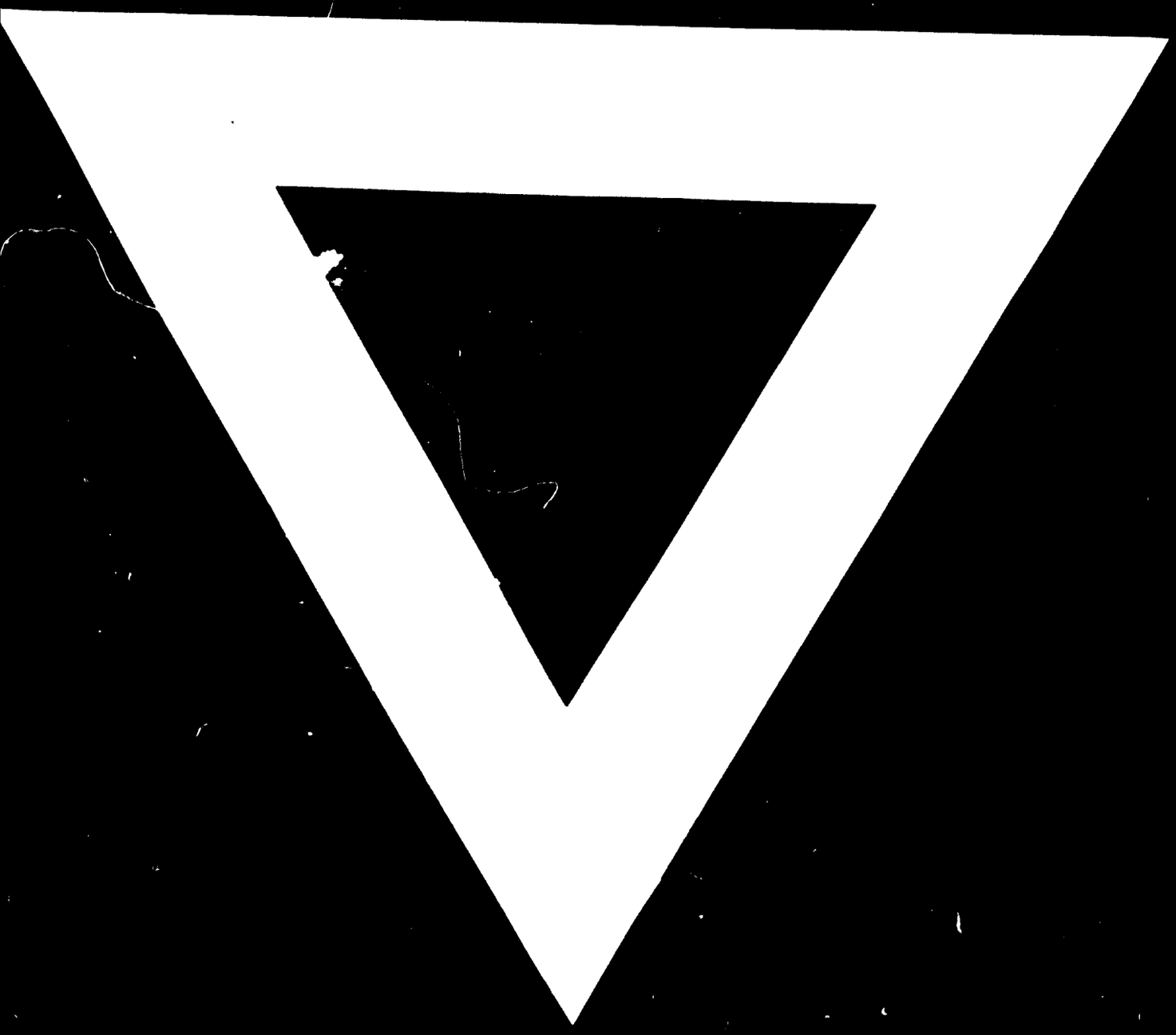
The research programme falls into three main parts:

1. laboratory assessment of the wood species regarding their suitability for the manufacture of wood-wool slabs,

2. small scale production trials of wood-wool and wood-wool slabs with physical testing of the slabs, and

3. design and development of a complete small plant for a particular country.

A small wood-wool making machine will be purchased and run at the Tropical Products Institute. The quantity, type and effect of different mineralising fluids will be examined. The possibility of reducing the costs of mineralising fluid and cement will be carefully studied. A wood-wool industry with relatively simple equipment will be designed within the context of a small industry in one of the less developed countries.



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