Some facts about timber for structural purposes, its production, and possible use of Ceylon woods

By Mr. H. E. C. Lushington,
Diploma of Forestry (Edin.)
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It is unnecessary to emphasise the antiquity of the use of wood as a structural material; with the advance of engineering experience, however, its use has to a considerable extent been replaced by that of other materials. In questioning, whether this substitution has been of real advantage to the Engineer I quote the words of Sir Gerald Trevor, C.I.E., late Inspector-General of Forests in India. He says: "Steel and concrete have been looked upon as the chief structural materials of the Engineer. This has been due to the fact that these two materials have been widely advertised and strongly assisted by powerful organisations, whereas wood, being nobody's child, has gone by default. Recently, in some advanced countries, there has been a distinct change in favour of wood, and Engineers are discovering that, far from being an unimportant auxiliary, wood is the most economical and practical material for many modern structures. There are two reasons for this change. The first is that wood can now be made durable for a very long period, and the second is that new ideas in timber joints and wood structures have been evolved, which place wood on a very different footing from that of twenty years ago. If the question of primary and recurring costs are considered, an increased use of wood as a structural material is also justified."

Before proceeding to consider the part which timber plays in building and construction problems, it is necessary to have a clear conception of the various properties of timber, which render it suitable for structural purposes.
To the average layman timber is just a log, or scantling of wood—some heavier, some lighter in weight, some darker, some lighter in colour, some easy and some more difficult to work.

The figure, illustrating a block of Mahogany, shows that wood is composed of a number of different tissues, or cells, each performing a different function in the living tree. The cells which are ordinarily considered as the essential characteristic of a timber are the wood fibres. These cells have small cavities and thick cell walls in order to carry out their primary function of supporting the tree in an erect position.

The life of a tree, however, depends on its ability to draw up from the soil food material in solution into the leaves, the passage of the solution being by way of another type of cells, known as "vessels" or "pores."

In the longitudinal section—that is, parallel with the grain—these vessels resemble a series of sectional water-pipes; in the cross-section—that is to say, perpendicular to the grain—they appear as pores or small holes in the wood. These "pores" may appear singly or in groups, their size and distribution varying with the species of timber.

In the figure illustrating a cross-section of Teak it will be noticed that the larger pores occur close to the "growth-rings," a timber showing such distribution is said to be "ring-porous." This form of distribution is also seen in a much less marked degree in the cross-section of *Lunumidella* illustrated.

In the illustrations of cross-sections of satin, milla, ranai and halmilla it will be noticed that the pores are more equal in size and more evenly distributed throughout the wood tissue; and timbers showing this form of distribution are referred to as "diffuse-porous." When the solution has passed up through these vessels or pores, the food material is "digested" in the leaves under the influence of sunlight and passes back into the trunk of the tree and stored in yet another type of cells, known as "parenchyma." These parenchymatous cells are individually invisible except under a microscope, and their distribution also varies with the species of timber.
The cell walls of both "vessels" and "parenchyma" are markedly thinner than those of the wood fibres. When the food material has been restored to the trunk of the tree their radial transport between the centre and circumference is effected by the cells forming the "medullary rays." In the cross-section these rays are usually lighter in colour than the ground tissue, and their size and distribution form a valuable aid in the identification of species.

The "growth-rings," to which reference has been made, are made up of two more or less well defined parts—the part nearest the centre of the tree being usually more open in texture and lighter in colour than the part nearer the circumference. The former is referred to as early (or spring) wood, being put on during the early part of the season of growth, the latter is known as late (or summer) wood, being put on towards the end of the season of growth. One complete growth-ring is laid down by a tree in each season of growth. The rate at which the tissue within the growth-rings is developed may have an important bearing on the strength of a timber. This is, perhaps, more particularly the case in respect of "ring-porous" woods; for the wood fibres themselves provide the strength of a timber, while the "pores" or "vessels" are a source of weakness. Thus, in a "ring-porous" wood, slower growth results in a diminution of the development of the wood fibres, while the pores remain undiminished. The timber, in consequence, is lighter in weight, more open in texture and less resistant to mechanical stresses.

If one examines the end of a log it will be noticed that the part nearer the centre is usually, though by no means always, considerably darker in colour, than the outer portion; this feature is more marked in some species than in others. The former is known as the heartwood and the latter as the sapwood. Sapwood is intimately connected with the growth of the tree itself and the passage of food materials; and, in the earlier life of the tree, occupies the whole of the trunk. Later, however, the inner portion of the sapwood ceases to be concerned with the passage of food materials and becomes more associated with the mechanical support of the tree. As this situation develops
the cells of the inner core become gradually trans-
fused with tannins, oils, resins and a substance
known as "lignin," and are, consequently, said
to be lignified. The process of lignification
usually becomes more rapid as the age of the tree
increases. Although this lignification tends to
give it a darker and stronger appearance, the
heartwood of any timber is not in reality any
stronger than the sapwood, if the latter is dried
to the same moisture content as the former. In
the latter conditions the sapwood possesses the
advantage of being capable of treatment with
preservative and fire-proofing materials, while
the heartwood is either entirely or far less amen-
able to such treatment.

Having considered the "technical" properties
of timber, it is necessary to turn our attention to
the mechanical properties. These are, however,
intimately connected with and dependent on the
former. Briefly, the mechanical properties con-
sist in the degree of ability of a timber to resist
external stresses. As applied in the consideration
of engineering problems these are determined
under the following heads:—

(1) Extreme fibre stress in bending
(2) Horizontal shear
(3) Compression perpendicular to the grain
(4) Compression parallel to the grain, and
(5) Modulus of elasticity.

A knowledge of the properties of a timber under
the above heads is obtained either by laboratory
tests or by practical use of the timber for a given
purpose. It is always preferable that knowledge
gained by the former should be supplemented
by practical experiment before being generally
adopted. Resistance to compression parallel to
the grain is the factor of greatest importance in
timbers used for upright columns or posts. In
beams and scantlings used in construction of spans
extreme fibre stress in bending as well as horizontal
shear are the most important qualities; in timbers
used for supporting heavy loads without any
appreciable span compression perpendicular to
the grain is of greatest importance. In cases
where wood is used in the construction of heavy
traffic bridges, in which it is subject to impact
stresses caused by the momentum of heavy-moving
vehicles extreme fibre stress in bending, horizontal shear and modulus of elasticity all play an almost equally important part.

Green timber contains free moisture within the cell spaces and moisture "adsorbed" in the cell walls. In the process of drying it is the free moisture which is first evaporated; and when all free moisture has been given off a point is reached which is known as the "fibre saturation point." If the moisture content of a piece of timber is above this latter point its mechanical strength and dimensions remain more or less constant. If the moisture content falls below the "fibre saturation point" the wood begins to shrink, while its mechanical strength increases until the timber is quite dry.

There is also an intimate relation between the weight of a timber and its strength, the heavier and closer grained woods being harder and stronger. Generally speaking, too, the strength and stiffness of round timbers are usually somewhat greater than those of squared timbers. The American Railway Engineering Association have accepted that "the strength, stiffness and shearing value in bending of round timbers of any species may be assumed to be identical with that of square timbers of the same grade and cross-sectional area. Tapered timbers should be assumed of uniform diameter, the point of measurement (of the diameter) being one-third the span from the small end."

In past centuries, when timber was more frequently used in the construction of buildings in Europe, it was the common practice to fashion the timber to its required dimensions with an axe or an adze and not with a saw. When the latter is used it is now the usual practice to saw the material parallel to the axis of the tree. When sawing tapering logs this results in what is known as "diagonal grain." For constructional purposes timber having as straight a grain as possible is desirable, and, in practice, may be obtained by sawing the logs parallel to the bark instead of parallel to the axis of the tree. The straighter grain results in greater strength, there being less interference with the natural position and interconnection of the fibres.
Splits, cracks, checks and shakes in timber

Other factors which affect the strength of timbers for structural purposes are splits, cracks, checks and shakes which may appear. These are general terms applied to openings in the timber due to the separation of the wood fibres. Such defects have less effect on the strength of upright columns and posts, than on the strength of beams. Loss of strength in timbers, resulting from shakes and cracks can, however, largely be reduced by fixing dowels.

The loss of strength in timber due to the presence of knots depends on the one hand on the nature of the stresses to which the timber will be exposed and, on the other, to the position, size and soundness of the knots. In shearing along the grain the presence of knots frequently increases the strength of the wood, and in compression perpendicular to the grain they do not materially detract from its strength. In selecting timber for structural purposes, however, scantlings containing groups of knots should be discarded.

Insect and fungal attack

The sap-wood and, to a considerably lesser extent, the heartwood is also liable to loss of strength through fungal and insect attack; in tropical countries structural timbers probably suffer worse from the ravages of white ants than from other insects or from fungal growths. Correct seasoning, and more especially in the case of sapwood, antiseptic treatment render timbers immune from such dangers for a very considerable period.

Seasoning

In his book "Madras Timbers," the late Mr. A. W. Lushington, C.I.E. writes "The operation of seasoning comprises two phases (1) the speedy elimination, as far as practicable, of fermentable or decomposable matters, and especially proteins and carbohydrates and (2) the drying of the moisture content of the timber, combined with necessary precautions against staining, warping, cracking and splitting. Although there are different methods of treatment for soft woods and hard woods there are certain features common to both methods (1) the timbers should be cut up as expeditiously as possible after felling into scantlings, planks or boards for which they are, or likely to be, required and not ordinarily left in large logs; if they are to be so left, the treatment
required for their seasoning must be far more careful, and must take far longer; and (2) it is essential that during the period of drying, the timber should be kept out of the range of either sun or rain, and off the ground; if left lying on the ground they absorb moisture from the soil on the surface touching the ground, and there is unequal drying and, in consequence, unequal shrinkage, and a tendency to both warp and crack; they must therefore be kept under cover raised up in a well ventilated place, so that all parts of the exterior of the seasoning timber have equal ventilation."

The statements contained in para. (2) of the latter remarks apply to the method of natural or air seasoning, which in course of time, dependent on the size of the scantlings or boards and the species under treatment, produces a thoroughly air-dry condition. In such condition wood is rendered suitable for use in structural works. By the artificial or kiln method of seasoning it is possible to dry out wood beyond the air-dry condition. Although this adds to the strength of the material it has to be remembered that kiln-dry wood and wood, which has been steamed, will, on being resoaked, become weaker even than in the natural green condition. Where therefore, timber used in structural works is likely to be exposed to rain or water, care must be taken in kiln-seasoning to dry it out only to a moisture content corresponding with that of a thoroughly air-dry condition. In all cases where wood is required for structural works, care should be taken to ensure that it is thoroughly seasoned prior to use. Unseasoned timber is more prone to the mechanical defects of warping, cracking and splitting, and far more susceptible to damage by fungal and insect attack.

In order further to immunise timber—and more particularly the sapwood—from fungi and insects, it can be treated with antiseptic preservatives. Of these "creosote" is probably the best known, though there are many others including mixtures covered by patent rights. Apart from its antiseptic qualities, the qualities required in a good preservative are (1) penetrative ability—some mixtures penetrate more deeply into the wood fibres than others. (2) Ability to remain fixed in the
wood, after the latter has been treated; copper-sulphate, for instance, is very liable to leach out under the action of rain or water after treatment and (3) economic cost.

The three methods of treatment with an anti-septic mixture are (1) Brush-painting (2) Immersion in either hot or cold solution—known as the "open-tank" method and (3) treatment under pressure in special cylinders—known as "pressure-treatment," of which there are several processes.

Least penetration is obtained by the brush-painting method, which is usually only applicable to timber used for internal construction and of small dimension. Greatest penetration is obtained by the pressure-system. In all cases care must be taken to see that the material is at least in a thoroughly air-dry condition before treatment.

The factors which have the greatest influence in the selection of materials for structural works are (1) availability of supplies in sufficient quantities (2) durability and (3) cost per unit of safe strength—not the cost per unit of volume or weight.

It may not, perhaps, be generally realised that weight for weight (not volume for volume) wood, irrespective of species, is at least as strong as steel and far stronger than concrete. For instance it has been shown in India that an air-dry beam of sal timber, having a cross-section of 4"×12", can safely be substituted for a steel I-girder 4"×9", though the weight of the former would be about fifteen per cent. and its cost about fifty per cent. less than the latter. Steel is preferable to wood in structures or structural members where the requisite strength cannot be obtained in a certain limited or economical volume. As regards durability, the science of wood preservation has now so far advanced that timber can be made to last at least as long as steel in practically any situation.

The strongest argument in favour of concrete as a structural material is its chemical permanence, but it is questionable whether this chemical permanence is always worth the initial cost involved. Buildings may quite conceivably become obsolete within twenty or twenty-five years of construction,
and a wood structure is replaced far more easily and at far less cost than one built of concrete.

A very common argument advanced against the use of wood as a building material is that it is far more open to danger from fire. Mr. S. Kamesam, M.I.E. (India), Officer-in-Charge of Timber Development and Wood Preservation Sections of the Forest Research Institute, Dehra Dun, has written a booklet on this subject, pointing out the fallacy of this argument. As he states, fires almost invariably start with some combustible material inside a building. If the fire is promptly put out, the question of fire resistance does not arise. If the fire is not checked within a short time, it does not matter what structural material is used for the building itself; the structure will in any case be destroyed. He also points out that the usual temperature of building fires range between 700° and 800° centigrade, and as steel becomes plastic at a temperature of 350° centigrade, there is an early distortion of steel structural members, followed by collapse. On the other hand wood beams give off moisture in the early stages and, in consequence, their strength increases almost up to the time of actual combustion.

One of the most cogent points raised by Mr. Kamesam in defence of the fire resistant qualities of wood is that the well-known insurance Association, Lloyd’s of London, now insure timber buildings at the same rates as for brick and stone buildings. Generally speaking the fire-resistant qualities of timber increase pro rata with increase of weight and density according to species. Further there are chemical preparations on the market, which increase the fire resistance of wood impregnated with them in the same way as antiseptic treatment increases the resistance to insect and fungal attack.

I have stated above that, weight for weight, wood is equally as strong as steel, and this applies also to wood itself. The weight of woods is closely related with the mechanical structure, and consequently differs quite considerably according to species. The dry weight of the heaviest timbers may exceed eighty pounds per cubic foot, while, that of the lightest is less than twenty pounds per
cubic foot. The structural purpose for which a wood is required must influence greatly the choice of species; wood members required for heavy construction and to support heavy loads usually have a dry weight of not less than fifty pounds per cubic foot. Where a lesser strength is adequate for the purpose as, for instance, for door and window frames of dwelling-houses—woods having a dry weight less than fifty pounds per cubic foot are suitable. In cases where lightness of weight is required and strength is not a necessary qualification, as in roofing and ceiling work, species, whose weight is less than 35-40 lbs. per cubic foot, are preferable. In this latter connection, mention must be made of the use of ply-wood which is becoming increasingly popular, and which is described later.

Some species, too, have a greater resistance against the action of water, and especially seawater, than others, and, the choice of timbers for hydraulic constructions may consequently be limited.

Colour and grain have an influence on the choice of species used for panelling and flooring.

The above are the main factors which have to be considered in the use of wood for structural purposes; and it is as well to reiterate that timbers for such requirements must be absolutely sound—particularly when great stresses are likely to be experienced. For a wood member to be absolutely sound it must be fully seasoned. This naturally must add to the cost because air-seasoning, especially, takes a considerable time. The time required is dependent on two factors (1) the species of wood—some species are far less tractable to seasoning than others and (2) the thickness of the cross-section—the time required increases as the thickness increases.

Secondly, for a wood member to remain sound it must be resistant to insect and fungal attack, and, when necessary, sapwood should be treated with antiseptic preservatives to secure this end.

I will now pass on to some of the problems which confront the forester in the production of timber for structural purposes.

The first problem is that of cost. In his book entitled "The Economics of Forestry" Mr. W. E.
Hiley states: "The most important factor which influences the per capita consumption of wood is the relative cheapness of wood and other commodities which may be used as substitutes."

Working back through the various stages the costs of producing sound structural timber are:
(1) Antiseptic treatment when necessary, and fire-proofing if desired, (2) Seasoning, (3) Conversion from the log into required dimensions, (4) Transport, handling and extraction, (5) Control of exploitation by working plans and (6) Growth.

The costs of antiseptic treatment vary with the method employed—brush-painting being the cheapest and pressure-treatment the most costly—as well as with the cost of the preservative used. Under the pressure-treatment the cost of a timber may be increased by about fifty cents per cubic foot.

It is very difficult to give a cost per cubic foot for seasoning as this varies considerably with the species and the thickness of the cross-section. Costs under this head, in effect, are represented by the interest on the capital (i.e., quantity of stock under treatment) during the time required to complete the operation.

In regard to costs under "conversion" the following extract from a paper submitted by the Forest Products Research Laboratory, Princes Risborough to the last Imperial Forestry Conference, which was held in South Africa in 1935, is of interest. It reads as follows: "The utilisation of small low grade timber may be said to be the key problem in economic forestry, since, unless the small timber can be made to stand some share of the cost of timber production, it eats into the final return to such an extent that growing timber ceases to be a profitable undertaking."

Loss of material in conversion from log to scantling form varies considerably, and, in general, roughly increases pro rata with increase of area of the cross-section of the scantling. When the Forest Department resuscitated the supply of sleepers to the Railway about six years ago, it was found in the earlier years of the work that, owing to inexperience of the contractors, we were actually producing only one acceptable broad gauge sleeper, containing rather over three cubic feet of timber,
from every fifteen cubic feet of timber felled, and
that very little of the balance found its way to the
markets. This was a very high loss in conversion;
but since then other factors have intervened to
reduce this loss and, on a recent inspection, I found
that one of our contractors is now only attempting
to produce two sleepers where formerly he would
have sawn three, and that the innermost core of
the log was being sawn into small dimension
scantling and the rough outside slabs were being
resawn into one-inch and half-inch planks. The
contractor is now placing all the smaller material
in stock where, being under cover, it is being
seasoned and hopes to find a market for it later.

This has resulted in a reduction of the loss in
conversion from over sixty per cent. to probably
not more than thirty-five to forty per cent. If all
the balance waste material could be sold as fuel
there would be practically no loss whatever.

Reference has already been made to the increa-
sing popularity of ply-wood for certain purposes.
Its use in the manufacture of tea-chests is well
known, but in relation to structural works it will
probably be of greater value for roofing and
ceiling materials as well as for door-panels.

Ply-wood may be two, three, or multi-ply; the
basic principle underlying its manufacture is that
layers of wood of varying thickness are laid one
on top of another and securely glued, while the
direction of the wood fibres of any one layer is at
right angles to the direction of the fibres of the layer
immediately adjacent to it.

This artificial "inter-weaving" of the fibres,
as it may be termed, adds very materially to the
strength—particularly in the extreme fibre stress
in bending and in horizontal shear—while it has
the added advantage of considerably reducing
the tendency of a wood to split, warp, crack or
shrink.

In roof and ceiling materials "figure" in the
grain is of little importance, but in building up
door-panels it is the common practice to glue a
"veneer" of a valuable and well-figured wood
to a cheaper base.

In all cases the strength of ply-wood is very
largely dependent on the strength and efficiency
of the adhesive material used.
There are two methods of obtaining veneers for ply-wood manufacture. (1) By slicing on exactly the same principle as that used in machines in grocers' shops for cutting a thin slice of ham or bacon. This method is more commonly used for veneering the more valuable and figured woods. (2) By the use of the rotary veneer. In this method the log is held firmly between 'chucks,' as in a lathe, and revolved at the required speed against the cutting edge of the veneering knife. The wood is thus peeled off like paper off a roll. In either case the logs have to be 'cooked' or steamed prior to the operation.

Conversion costs of solid scantlings are dependent on three primary factors—(1) Species to be converted—normally the cost is higher for heavy, hard woods than for lighter and softer material, (2) local cost of labour and (3) size of material. In Ceylon, local sawyers are usually paid according to what is known as Ceylon carpenter's measure. By this method the dimensions of width and thickness of the cross-section are first added together and reduced to lineal feet and the result multiplied by the length of the material. Sawing rates are quoted "per square" of a hundred square feet.

It will be seen, therefore, that the cost of sawing increases more or less in proportion to any increase in the sides of the cross-section.

In considering the suitability of saw-mills for the conversion of timber it has to be remembered that the economic value of a mill is dependent on a more or less constant supply of logs, at an economic rate, in order to maintain the minimum economic output of the mill. Cessation of supply below that minimum results in, at least, periodic cessation of work with consequent increase of over-head charges and reduction of interest on capital. The minimum economic output of a mill is, in turn, very largely governed by the capital expenditure involved in erecting the mill.

Probably the heaviest charges which have to be incurred in the production of timber and placing it on the markets are those of transport, handling and extraction.

Under the term "transport" are included water-haulage, rail-haulage and road-haulage.
Handling includes charges incurred in loading material at points of extraction into vehicles for water, rail or road-haulage as well as those incurred in transporting the materials from such vehicles to the ultimate destination and, not in frequently, to other vehicles en route.

Extraction charges are those incurred in conveying the materials from the stump sites to the points from which haulage can be effected.

Of the three forms of "haulage" that by water is undoubtedly the cheapest. Unfortunately, in Ceylon this form is restricted by the fact that few of our rivers are suitable for this form of transport, and those, frequently, for limited periods of the year. The comparative merits of rail and road haulage is, I fear, too controversial a subject for me to enter lightly upon. Suffice it to say that each form has its own advantages, and that there are circumstances in which road-haulage can eliminate fairly heavy handling charges—particularly over shorter distances.

The cost of road haulage over metalled roads may be estimated roughly at one to one and a quarter cent per cubic foot per mile of transport. This compares very favourably with cart-haulage extraction within the forest itself—usually over tracks, which are heavy with mud during the rainy season and may even be fairly heavy owing to sand in the dry season. Over such tracks the cost of cart-haulage range between four and eight cents per cubic foot per mile, depending on the conditions and the nature of the country—over steep inclines the costs naturally increase. When dragging by elephants has to be resorted to, the costs range much higher and may even amount to fifteen to twenty cents per cubic foot per mile.

From this it will be seen that every mile of extraction within the forest to a point from which haulage over metalled road can be effected adds approximately five cents to the cost of every cubic foot; and it is obvious that only such material as commands a reasonably high price in the markets can afford to bear such costs.

For instance if one were to compare two timbers, one having a value, delivered in the market, of Rs. 2 per cubic foot, and the other having one
of 75 cents per cubic foot, and assuming both had to undergo fifty miles of haulage along a metalled road, and five miles of extraction from the forest to reach the market, the extraction and haulage costs alone would in each case amount to about 75 cents per cubic foot, to which would have to be added felling and handling charges. While, therefore, it would be an economic proposition to extract the higher priced timber, a loss would be incurred in extracting the lower valued one.

If, on the other hand, the haulage along a road were increased to fifty-four miles and the distance of extraction correspondingly reduced to one mile (maintaining a total distance of 55 miles) the costs under these heads would be reduced to under sixty cents, and even the lower priced timber would then show a margin of profit.

In the forests of this Island we have a very small percentage of timbers which command a reasonably high price on the markets and a preponderance of species whose market value is very low. The problems which confront us, therefore, are how to make the cheap low grade materials bear some of the costs of production, and to what extent the building of metalled roads within the forests themselves will help us to achieve that end. Capital expenditure incurred on building such roads must, at least, yield a reasonable rate of interest by increase of revenue from the forest.

Apart from any capital expenditure which may be incurred on construction of roads and buildings, there are two forms of capital recognised in forestry—(1) the soil, which is the fixed capital and (2) the trees themselves, usually referred to as the "growing stock," which comprise the movable capital. The interest earned by these two forms of capital is represented by the increase of volume—or increment—put on by the trees during the natural process of growth. It follows that any felling in excess of the increment will result in a diminution of the movable capital (the growing stock) with consequent diminution in the future interest earned. On the other hand if less than the normal increment is felled over a number of years, the full interest on the capital will not be earned, and may even be lost by the death of some of the trees.
One of the primary duties of the forester, therefore, is to determine the normal yield which can be expected from a forest, and to limit the exploitation to that yield, a margin on either side being permissible to meet variations of markets or other conditions, but such margin being balanced in subsequent fellings. Thus if, as is not infrequently the case in Ceylon, excessive fellings have been carried out in the past, future fellings would have to be restricted—in some cases even discontinued—for a number of years in order to allow the growing stock to reach "normality" again. In order to assess the yield of a forest there are three factors which the forester must know—(1) the extent of the fixed capital, i.e., the area of land under forest, (2) the extent of the movable capital, i.e., the normal volume of the growing stock which that area of land is able to support and (3) the rate of interest—or increment put on by the normal growth of the trees.

Frequent changes in the area under forest results in a disability correctly to estimate the capital under this head. In regard to the growing stock, in Ceylon we suffer from a disadvantage in having no standard of normal volume for areas of forest under different conditions. It would appear that a correct knowledge under this head will only be obtainable by the maintenance of records for, as well as careful protection of forest areas over a considerable number of years.

In regard to the "rate of interest" there has been considerable controversy, more especially during the last twenty years, on this subject; one school of thought maintaining that a fixed rate of interest of 4% should be adopted, and another school maintaining that for an industry like forestry—which is largely a Government concern—this rate is too high and that 2% or 2½% should be the accepted rate. Both sides have good arguments to support their claims, but neither school seems to have taken into consideration the fact that the increment put on by a forest under favourable conditions of soil and climatic must be considerably greater than that put on under more adverse conditions, and that, consequently, the rate of interest is likely to vary with difference in conditions.
It has been stated that the fixed capital in forestry—as also in agriculture—is the soil. Any loss of capital under this head is of graver consequence than loss of the movable capital through over-felling or other causes. Indeed, the preservation if not the improvement of the quality of the soil is the most fundamental principle of all silviculture.

Silvicultural systems, employed in the production of timber for structural purposes, normally fall under two main heads—(1) clear felling systems and (2) shelterwood systems. The essential difference between these two groups is that under clear felling systems all the trees standing in an area are removed before the area is regenerated; in shelterwood systems the regeneration operations are undertaken first and the older trees—usually referred to as "the over-wood"—are removed subsequently—in some cases within a few years, in others more gradually over longer periods.

Clear felling has great advantages in concentration of work with consequent easier control; but writing as far back as 1925 in the introduction to his revised Manual on Forest Management, the late Sir William Schlich, F.C.I.E. states that it had been found that every uncovering of the soil under clear felling has a tendency to reduce its fertility; and that foresters of experience in Europe are tending to revert to shelterwood system which eliminate this danger. The question of soil erosion is one which has been seriously engaging the attention of Governments all over the world, and clear felling systems in forestry are intimately connected with the erosion problem—more particularly on sloping ground.

There has also been a tendency of recent years in Europe to revert to a mixture of species in place of raising stands of timber of a single species. This is a point which has also to be considered in relation to production of cheap low-grade materials, which will bear some of the costs of producing higher grade structural material.

The problems which confront the forester in the production of timber are further complicated by the fact that different species may, and usually do require different lines of treatment. Speaking in general, all species require complete overhead
light at some time of their life to ensure the full development. Some species, however, require such light almost from the time the seedling appears above the ground; and are, consequently, referred to as "light-demanders." Others, on the other hand, will tolerate and develop under a certain amount of shade, particularly in the earlier stages of development, and are, consequently, known as "shade-bearers." Some particularly tender species may even require shade in their earlier years and are referred to as "shade-demanders."

A correct knowledge of the shade requirements of species is essential in drawing up the plan of management of a forest, and may be obtained by experiment and also by observation of the species under natural conditions.

The primary factors which influence forest growth are (1) soil and (2) climate. The latter, may be further sub-divided under the heads of Temperature and Rainfall. Temperature may be influenced to some extent by rainfall and is markedly influenced by elevation.

In Ceylon there are three primary climatic zones — (1) the Wet Zone, (2) the Dry Zone and (3) the Montane Zone. These, however, are by no means clearly defined and there are intermediate zones between each of the three types, with a gradual differentiation of species between one zone and another.

High and desiccating winds also considerably influence forest growth, and, as is seen in the forests up-country, frequently result in a considerably reduced height of the trees.

The above are, perhaps, the principal problems which confront the forester in the production of timber, for whatever purpose that timber may be used. It must be emphasised, however, that important as the economic side of production is, all forest operations must be based on correct silvicultural principles. Whether it be the regeneration of a forest, the removal of trees in intermediate fellings ("thinnings"), or the removal of mature timber in final fellings, the correct silvicultural treatment of the forest is of primary and paramount importance.

In Ceylon there are between three hundred and four hundred species which reach tree dimensions; of these not more than about ten are used
in structural works. Burma experienced similar difficulties at one time, but shortly after the Great War a serious attempt was made to extend the number of species used, and by experiment and, with the collaboration of engineers and engineering firms, the number was increased from approximately a dozen to between thirty and forty.

Apart from the fact that restriction of choice to a limited number of species may result in over-felling of and a subsequent dearth of mature timber of such species, increase in the number may quite reasonably be expected to reduce costs of production. This is especially the case where haulage distances and, consequently, haulage costs can be reduced. In a consideration of this question, one has to bear in mind that, speaking generally, the volume of timber necessary to give the strength required for a given purpose is very largely dependent on and proportional to the weight per cubic foot. It is possible, therefore, that some of the wet zone timbers, which are usually lighter in weight than those grown in the dry zone, may be capable of being produced more economically for use within the wet zone, provided a larger cross-section is employed. For instance, the cross-section of a broad gauge railway sleeper produced from a dry zone species is 10" × 5". It is possible it may be found that some wet zone species, having a cross-section of 10" × 6", would withstand the mechanical stresses equally well; while preservation by antiseptic treatment would render them equally durable. If this were to be the case there would be a considerable reduction in haulage costs.

Over ten years ago it was laid down as one of the fundamental points in forest policy that this Island should make itself self-supporting in the matter of timber. Engineers can assist in bringing this desirable object to fruition by close collaboration and co-operation with the Forest Department. The forester, as has been shown, has to base his output (1) on the silvicultural requirements of the forests, (2) on the area maintained under forest, (3) on the “growing stock,” (4) on the rate of growth of the trees and (5) on the economic costs of production.
On their side, Engineers are concerned only with the utilisation of material and the cost per unit of safe strength. They can however, render valuable assistance by co-operation with the Forest Department and by carrying out tests of different species under practical conditions. An increase in the number of the species that can be used for structural purposes seems desirable for many reasons, the more so as present indications are that, if utilisation is restricted to the present few timbers, there is every likelihood of there being at least a shortage of those species in the future. As an instance it may be said that since the resuscitation of supplies of sleepers to the Railway of this Island less than six years ago, we have exploited to the maximum very nearly the whole area of forest land excluding the Reserved Forests and areas proposed for reservation, and even some of the latter have already been tapped, to meet these supplies.

The problems are by no means easy of solution, but close co-operation between Engineers with the Forest Department will at least help us all along the road of progress.

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Photographs by C. P. Jayawardana, M.A., F.L.S.
DISCUSSION

Mr. J. D. Sargent, formerly Conservator of Forests, now exploiting a large area of Crown Forest for the supply of railway sleepers and timber for general use, next addressing the Meeting, stated that he had been invited to make a contribution to the subject at very short notice, had had no time to prepare any notes, and had only learned that morning which aspect of the question he was expected to touch upon. He felt that, having had considerable experience of forest contract work in the field, he might most usefully contribute a few remarks on marketing methods, and the bringing together of buyer and seller.

After a brief reference to the earlier departmental contract system of supplying sleepers and firewood to the Railway Department, and timber in the log to various Government Departments, on a non-revenue, paper credit basis, and the absence of any methods, other than a few local sale depots, and a casual and limited license system, for supplying the trade with the timbers of the country, the speaker passed to the stage at which the Railway Department was commercialized, and the departmental supply system of the Forest Department was, in consequence, terminated. With the loss of paper credit earned thereby, the subsequent closing of its sale depots, and the complete cessation of departmental extraction, the Department faced the New Constitution with an overwhelmingly and disastrously adverse balance of expenditure over revenue, and was in great danger of being closed down altogether. Except for the sale, by lump sum offers, of forest blocks intended for reforestation, by means of clear-felling, no systematic exploitation of any kind was practised, or possible, owing to the lack of sustained markets.

It was obvious that, if the Department was to survive, some new method of marketing had to be built up on the ashes of the old, but the difficulty was to know where to make a beginning. Imported timber had obtained a firm footing in the Island, and Government Departments, as well as the trade, had turned to it. The Utilization Branch of the Department had not come into existence,
the Department could carry no stocks, and was without the means to push its wares.

The position was serious, and the Department found it difficult to justify its existence as a mere guardian of the forest estate, the latter stagnating through the non-exploitation of its overmature crop, and the lack of improvement of its lower age classes.

At this stage (1932) assistance was sought from outside, and the Forestry Department of the Federated Malay States kindly supplied a description of its newly-introduced Timber Purchase Section, which aimed at developing trade in the timbers of the country through the medium of the sleeper supply.

It was, there, realized that, in attempting to develop trade through forest contractors (as opposed to departmental extraction) who were for the most part petty contractors without capital, and changed from time to time, it was necessary to provide some secured and permanent outlet, from which the contractors might obtain speedy reimbursement of their out-of-pocket expenses, and be enabled to convert and carry stocks of timber in other forms, for the development of outside markets.

The sleeper supply alone met this requirement, and the Forestry Department, having arranged an all-in rate with the Railway (revised annually) for sleepers delivered on lineside, proceeded to lease forest blocks (known as coupes) on a monopoly- cum-royalty basis, to forest contractors, offering them the sleeper supply, as an inducement, and an Insurance Policy, at rates within the all-in rate agreed upon with the Railway. Acceptance was voluntary, and the contractor was by no means bound to supply railway sleepers if he could find better markets for himself. In practice all contractors accepted the sleeper supply for a greater or lesser proportion of the out-turn from their coupes, and were then placed under contract for the number agreed upon. The rates paid to these contractors differed according to the prospects, or otherwise, of developing outside markets. Many contractors, in remote areas, supplied sleepers only. Of the all-in rate to the Railway, a fixed
amount represented royalty, which was credited to Forest revenue by book transfer, and not recovered in cash from the contractors.

Thus not only was the sleeper supply itself organized, but the contractors obtained punctual reimbursement of a large portion of their expenditure, and were soon in a position to supply other demands. The Department was, all the while, planning further ahead, probing fresh markets, and securing fresh orders for timber, first from other Government Departments, and gradually from the trade, which it placed, by means of direct proposals, with the contractors, whose business was the supplying of orders placed by the Department, and not the actual finding of the markets. In due course the Department was able to publish, monthly, its standing market prices for timber, at the contractors’ depots, to which the cost of transport to destination was added, on receipt of enquiries.

Today the Federated Malay States Forest Service has the sleeper supply, supplies to other Departments and to the trade, in its own hands, and shows a large balance of revenue over expenditure, a liberal portion of which is returned to the Department in the following year for forest improvement. Scarcely any timber is imported into the country. These results, based entirely on the re-organization of the sleeper supply, in 1930, have been reached in less than eight years.

The Department attributes its success (1) to the fact that it acts as the medium between the producer (the forest contractor) and the purchaser, by carrying out all the preliminary negotiations for purchase, and by fixing the sale rate, and (2) to the separation of the cost of transport to destination from the contractor’s supply rates, which are worked out very carefully, for delivery at his checking station, or sale depot. These rates are now, for all practical purposes, standardized, and Government Departments, as well as the trade, buy at those rates, from the contractors’ depots, and arrange for transport to destination themselves. By each sale that the Department negotiates it adds to its revenue, recovering royalty through the contractors (coupe-holders)
who are the nominal, but not the actual, buyers of the timber. The contractors are financed by their sleeper operations.

This is the reason, and almost the only reason, from the point of view of the Forest Department, why the sleeper supply is necessary in Ceylon—as an aid to the marketing of forest produce, and to give financial assistance to contractors. For many reasons the sleeper supply is, with the material available, unsuited to the Ceylon dry zone forests, but without it there would, with the strangle-hold which imported timber has all over the country, be no regular forest exploitation at all, and little or no forest revenue.

Thus the sleeper supply came to be revived, on a revenue-earning basis, in the dry zone, and was intended to be the foundation on which the larger utilization of local timbers should be built up. (In the same way the successful establishment of a large industry like the supply of tea chests would be the foundation of forest exploitation in the wet zone).

But the sleeper supply was only intended to be the starting point, and not the final objective, of the new venture, and it is open to doubt whether large progress will be made along present lines. For the Department is not making any concerted effort to develop practical marketing methods, and the contractors are considered as the buyers, and not the suppliers, of timber. Thus, when enquiries are received by the Department, it merely passes them on to the contractors, who are invited to get into touch with the enquirer. There the Department leaves the matter, and does not follow it up. In consequence little business results, though the volume of work on paper is enormous. In the case of timber for other Government Departments, nothing better than an inapplicable system of inviting tenders has materialized.

Forest contractors, many of whom are illiterate, cannot be expected to develop trade for the Department, and the Department must develop trade for itself, obtain the orders, and execute them through the agency of the contractors working in the forest.
Some Facts about Timber for Structural Purposes 51

The speaker quoted, as an instance, the supply of Bridge Planks to the Public Works Department, and the inapplicability of the tender system to this supply. Thus, when an indent is received in the Conservator's office, all coupe-holders are invited to tender, regardless of their location, for delivery at the site required. Thus a coupe-holder, whose distance of transport for a given indent may be anything up to 150 miles, is expected to tender against another, whose area may be less than 20 miles distant, and the all-important question of transport is overlooked. It is thus all waste paper, owing to slavish adherence, for the sake of form, to an inapplicable tender system, which, inter alia, results in green, freshly felled timber being used for the purpose.

How much easier would this particular supply be if each coupe were given a definite radius for this requirement, and rates were standardized, for delivery at the contractor's depot, and the contractor encouraged to combine this form of conversion with his sleeper operations, the Public Works Department purchasing at his depot, and arranging its own transport by the cheapest methods possible. The contractor would then stock the material (which he cannot do at present, as he does not know if his tender will be successful) it would be ready for delivery when required, and would be, at least, partly seasoned. As matters are the Public Works Department experiences very great difficulty in obtaining these supplies, forest contractors limit their exploitation to sleepers, and there is enormous waste, owing to the large section of the railway sleeper, and the absence of mixed conversion.

A further instance was quoted, where a Government Department annually requires some 2,000 broad gauge sleepers, and accepts a "standard lower than that accepted by the Railway," i.e., contractors' rejections. All contractors have rejections, but few, if any, have enough for this indent. Tenders are, however, invited. The successful tenderer disposes of all his own rejections, including his worst, and buys up the worst of other contractors' stocks (they will not sell the best at the rate he offers), to make up the shortage.
As all contractors pay royalty to the Forest Department for their rejected sleepers, it would be fairer to give all of them an opportunity of recovering a part of their losses, instead of giving one of them a monopoly. A fixed rate at railhead, and selection at source by responsible officers of the Forest Department, would thus secure the best of this material for the indenting Department, and a fair division of the indent, while contractors would be saved the cost of rail freight on material rejected at destination. With the prospect of this market contractors would take care of their rejections. Under the tender system the indenting Department obtains the worst of this material, and the best is left derelict, without a market.

The speaker could multiply instances, if time permitted, and was of opinion that, although the Island’s timber requirements could never be wholly met within the country, far more might be done than is at present done, if more practical means were devised for bringing buyer and seller together, and the Department realized that the coupe system does, or should, not exist for the mere sale of the raw material to the coupe-holder, but is the means by which the Department should itself develop the sale of the converted article to the consumer.

The Honorary Secretary read the following notes submitted by Mr. C. A. H. P. Jayawardana:

As the Utilization Officer of the Forest Department, I should like to speak for a few minutes on reasons why more indigenous timber is not used in Ceylon in preference to imported timber.

From inquiries made from all Government Departments, and the leading timber merchants, I find that they prefer a timber such as Teak, because it is available in unlimited quantities in the form of squares, and sawn to accepted standard specifications; what is most important is that it is thoroughly seasoned. I do not know if all of you are aware of the various stages through which a Teak tree in Burma is subjected to before the timber comes to Ceylon.
A Teak tree is girdled, in order to kill it, three years before felling in forests far distant from Rangoon. It is then felled and transported in slow stages along streams and rivers to Rangoon. Transport is dependent on the weather. Logs lie up for quite a considerable time until water is available in streams, which have often to be dammed to float them. It takes about two years for this timber to arrive at Rangoon. There it is stored in log ponds from which the sea water has to be blocked out and fresh water allowed in, to prevent the serious damage caused by the teredo which cannot live in fresh water. The log is then squared and also converted into scantling form and stored in sheds. It is this timber which is sent abroad. In all nearly seven years elapse before we get it here.

It is not surprising that such timber is seasoned.

What happens in Ceylon? Timber merchants have not got capital to convert logs and store them for seasoning in properly erected sheds. Their timber yards are not large enough for adequate seasoning and very little attention is paid to proper air seasoning methods. On advice given by the Forest Department they have improved their methods of stacking, but they are indifferent about it. Although they realise that ventilation is necessary, very few of them use crossevs to separate their sawn timber.

Consequently if seasoned timber is required in any appreciable quantity supplies are not available and the order goes to Teak.

Insect and fungus attacks are two other important matters which require much greater attention than is paid now. Proper air seasoning would prevent both to a very great extent but certain of our wet zone timbers need preservative treatment. There are several suitable antiseptics in the market but the most effective treatment would be a pressure treating plant which would drive a preservative as deep into the timber as possible. The Railway Department has experimented with creosoted Hora sleepers treated under pressure and after ten years of experiment on the lines, report very favourably on them.
COMMUNICATION

From Messrs. Aitken, Spence & Co., Ltd.,
Lloyds' Agents in Ceylon.

To the Honorary Secretary,
Engineering Association of Ceylon,
Colombo.

Dear Sir,

At a meeting of your Association held last month a paper was read by Mr. H. E. C. Lushington in which it was stated that Lloyds' Underwriters now insure timber buildings at the same rates as for brick and stone buildings. As we were not aware of this concession being allowed by Underwriters we wrote to the Committee of Lloyds to ascertain whether this statement is correct.

We have now been informed by the Committee of Lloyds' Underwriters' Fire and Non-Marine Association that it is most unlikely that Underwriters insure timber buildings in Ceylon at the same rate as buildings of brick and stone construction.

In order to avoid any misunderstanding by your members in this matter we shall esteem it a favour if you will publish our letter in your book.

Thanking you in anticipation.

Colombo, 27th September, 1938.
MAHOGANY  Swietenia Macrophylla King
TECTONA GRANDIS. Linn. F.
SATINWOOD  Chloroxyylon Swietenia
MILLA  Vitex Altissima
HALMILLA  Berria Cordifolia
RANAI Alseodaphne Semecarpifolia