The Utilisation of Timber by the ESB

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The Electricity Supply Board (ESB), a state sponsored body, has sole responsibility for generation, transmission, distribution and sale of electricity in the Republic of Ireland.

The ESB, founded in 1927, has its centre in Dublin. It has 25 generating stations, six regional and numerous area offices scattered throughout the country. It has a generating capacity of 3,274 M.watts with an additional 900 M.w. coming on stream in phases during 1987 from the new coal burning station at Moneypoint.

To support the network of cables necessary to carry this amount of electricity through the country both metal and wooden supports are needed in large numbers. The following gives some appreciation of the enormous amount of various types of wood items used in the construction and maintenance of this distribution network.

ESB Usage of Forest Material in 1986

Item	Size category	Numbers used
Transmission poles	14-23 metres	137
Distribution poles	9-20 metres	30,000
Staylogs	As described	24,000
Cattleguards	,, ,,	20,000
Earth wire guards	,, ,,	7,000
Marker Boards	,, ,,	101,000
Sleepers	,, ,,	800

It might be useful to look at each of these items in turn to see how and why they are used and to establish what is required from each category of timber used.

IRISH FORESTRY, 1987, Vol. 44, No. 1: 50-58.

Transmission Poles

Electricity is generated at a voltage of 17 kiloVolts from oil, gas, coal, turf or hydro power and enters a step-up transformer to increase its voltage to the primary transmission voltages of 400 kV., 220kV. or 110 kV. The 220 kV. voltage is transmitted through steel core aluminium conductors supported on galvanised steel pylons. The 110 kV. voltage is transmitted through conductors supported on wooden poles which range in length from 14-22.9 metres and with a minimum top circumference of 63 centimetres. These poles are used in pairs at five metre spacing to carry galvanised steel crossarms nine metres in length, and disc insulators and steel core aluminium conductor. The span between each pair of poles is approximately 220 metres, and there are 3,500 kilometres of wood supported 110 kV. line in the country. All the ESB's requirements for these poles are met from native sources. The species predominantly used is Douglas fir.

Distribution poles

The distribution network begins at 38 kV. outlets of 110 kV./38 kV. transmission transformer stations, each of which supplies approximately five 38 kV. lines. The conductor used for carrying this voltage is 100 mm., 200 mm. or 300 mm. steel core aluminium which is carried on galvanised steel crossarms four metres in length and insulated by pin or disc insulators. The conductor and headgear is supported overground by wooden poles which range in length from 12-20 metres and with top circumferences ranging from a minimum of 50 centimetres to over 63 centimetres. There are 5,700 km. of 38 kV. lines in the country of which up to two thirds are supported by pairs of wooden poles (portals) at two metre spacing. The span between each pair of poles is about 150 metres and the length of 38 kV. line averages between 10-15 km. The ESB's requirements for this category of pole is fully met by native supplies. The species used are Douglas fir and European and Japanese larch.

Each of these 38 kV. lines supply a 38 kV./10 kV. transformer station which in turn supplies five 10 kiloVolt lines (3 phase) called "backbone lines". The average length of a backbone line is 25 km. with approximately 75 km. of branch or spur lines being supplied from this backbone line. The conductors and headgear of these lines are supported on wooden poles which range in length from 9-11 metres with top diameters of 15 to 26 centimetres. The poles with the heavier top diameters are used as angle or end poles because of the greater stresses involved, while the lighter category of pole is used in intermediate positions. The heaviest category of pole is used to carry transformers which are bolted directly onto the pole. The average span between these poles is 100 metres and the depth of foundation is two metres. This 10 kV. network distributes three phase electricity to every part of the country and is in turn stepped down for domestic consumption.

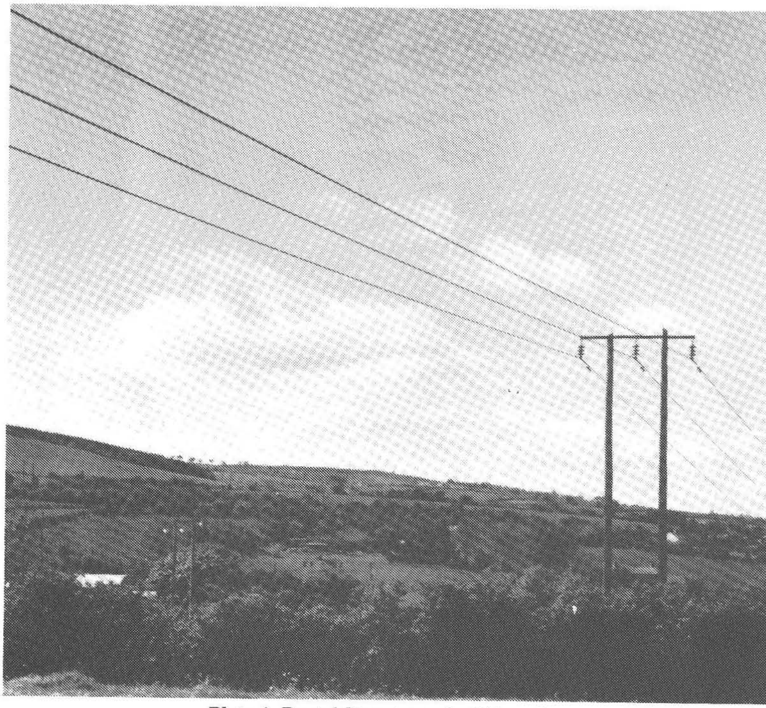

Plate 1: Portal Structure of a 38 k.v. line.

Since the inception of the rural electrification scheme in 1946 over 1.7 million 10 kV./1V. poles have been erected throughout the country. The ESB's needs for this category of pole are not fully met from native sources. The ESB generally obtains between 50-55% of its supply from the home market. The species used are Douglas fir, European and Japanese larch and imported Scots pine. In order to diversify species choice the ESB has engaged in research into other home grown species such as eucalyptus, Corsican pine, Norway spruce and ponded Sitka spruce. Presently the feasibility of using unponded Sitka spruce for 10 kV./1V. poles is being examined.

SMALLWOODS

Besides poles the ESB requires large quantities of smaller wooden material which it defines as "smallwoods". All of the material is supplied by Irish sawmills. These materials fall into the following categories:

Staylogs

Staylogs are half round logs 1.3 m long with a minimum diameter of about 20 cm. These logs are pressure treated and are buried at a depth of 1.2-1.4 metres. Approximately 24,000 pieces of staylog are used annually by the ESB.

Staylogs are in turn attached to "staywire" (strainer wire) which function to give additional stability to end poles or to poles positioned at an angle in the line.

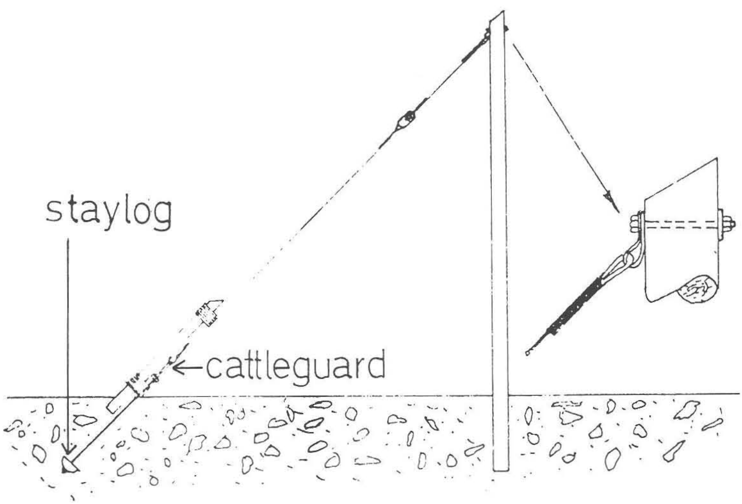

Fig 1: Sketch of Staylog and Cattleguard.

Cattleguards

These are sawn from Scots pine, larch, Douglas fir or spruce and are pressure treated with an approved preservative. Cattleguards are half round logs two metres long with a mid diameter of about 12 centimetres and a minimum diameter of nine centimetres at the small end. Cattleguards, as the name implies, are attached at ground level to 'staybows' (part of the straining wire) to prevent livestock from injuring themselves against the staywire. Somewhere in the order of 20,000 cattleguards are needed each year.

In a typical low voltage line every fifth pole would be earthed. To protect this earth from damage and for safety reasons it is concealed behind one or two wooden guards where the wire approaches ground level. Each earthware guard is grooved on one side to carry the wire and is pressure treated with a suitable preservative. Suitable species for making these guards are the same as for cattleguards and dimensions would run to lengths of 2.3 metres by 5 centimetres x 2.5 centimetres. Wooden guards are being superceded by plastic piping.

Marker Boards

These are used to cover underground cable. Each board is 1.8 m x 15 cm x 2.5 cm. All are pressure treated and sawn from the same species used to make cattleguards. In 1985 enough Marker Boards were used to cover 184 kilometres of cable.

Sleepers

Sleepers are used as temporary transformer foundations and as pole foundations particularly in soft ground. On occasion they are used in loading and unloading of transformers onto ESB transport. This is accomplished using sleepers, jacks and winches. The transformer is jacked up and a foundation is built up under it with sleepers. Steel cables are then tied to the transformer which is then winched from the foundation of sleepers onto the trailer. The reverse happens in unloading.

Bog Boards

These are blocks of wood which are pressure treated and bolted onto the butts of poles which are used to carry an ESB line across bog or marshy ground.

THE SUPPLY OF POLES FROM IRISH FORESTS

The Department of Energy is the main supplier of home grown poles, with a small percentage being supplied by private woodland owners. The suppliers are responsible for the selection, felling, shedding and debarking of the trees. They cut them to the required length and dimensions with the top cut, on the slope, to provide a run-off for rain. The poles are usually placed on a ramp constructed beside the forest road. The ramps should be constructed so as to leave the poles at least 12" clear off the ground and should be located away from overhanging trees. The vegetation under these ramps should be kept under control while the poles are being stored on them.

The Inspection of the Poles

The poles are inspected by an ESB Inspector who ensures that all poles are turned on the ramp. This enables him to spot defects such as splits, cracks, decay, sweep, excessive knots and insect attack. Any poles with these defects are marked for rejection. When all the poles have been turned, he then goes back and measures the poles for length and top diameter. When each pole is measured and accepted by the Inspector he calls the code to a member of the forestry staff who proceeds to chalk the code onto the butt of the pole. (Each size category is coded). The process often involves further cutting to fit a pole into one of the size categories. After all the poles on the ramp have been measured the Inspector stamps the butts of all poles accepted by him with a hammer bearing his initials. The number of stamps denoting species: one stamp — Sitka spruce; two stamps — European/Japanese larch; three stamps — Douglas fir. A tag is affixed to the butt of each pole accepted which is inscribed with a code denoting the size of the pole. Upon completion of tagging, the Inspector records the number of poles accepted against each size category and the number of poles rejected. When all the poles have been inspected in the forest centre an inspection report is prepared. A copy of this report is sent to the ESB Transport Supervisor who makes arrangements with the supplier for the collection of the poles, another copy is sent to the supplier, while a third copy is retained by the Forestry Unit, ESB. The supplier is responsible for loading the poles onto ESB transport. The poles are brought to one of the two creosoting depots in the country where they are offloaded and put into stock to air season.

Timber Preservation

Given the usage to which timber is put in the ESB network preservation of such wood is an important consideration. Untreated timber under such conditions would last perhaps 5-7 years. To extend their service life timber preservative is essential. The ESB expects a minimum service life of 30 years from a creosated pole. However in reality poles are lasting considerably longer than this. At age 42 years 50% of the original population will still be in the sound category (no rot). When poles where examined for rot it was found that of those that showed rot 67% showed external rot and 33% had internal rot. Of the poles showing external rot 90% of these had rot located below groundline to 60 centimetres above ground level. There is no significant difference in rot performance between imported and native grown poles.

Description of Wood Preservatives used by the ESB

(1) Cresote Oil

Cresote oil is a distillate of coal tar which is produced by the high temperature carbonisation of bituminous coal. It is a complex substance that is composed principally of hydrocarbons, tar acids and tar bases. It has a specific gravity of approximately 1.05 kilogrammes/litres and has a distillation range from 200°C-350°C. The tar acids comprise phenols, xylenols and naphthols, all of whlich are toxic to fungi. The tar bases are represented by pyridines, quinolenes and acidines which are mostly toxic. The hydrocarbons comprise the bulk of the volume and include benzene, toluene, xylene and naphthalene. Research has shown that the hydrocarbons which distills between 200°-275°C are more toxic to wood destroying fungi than the whole creosote. A number of individual hydrocarbons found within this boiling range are extremely toxic, while others are not soluble enough to exert their full poisonous effect — hydrocarbons distilling above 275°C are too insoluble to be effective against fungi (Hunt & Garratt, 1953). Cresote confers a degree of water repellency on timber and consequently checking is slight in comparison to poles treated by inorganic salts. It also has a preservation effect on steel in galvanised steel crossarms and coach screws. Poles treated with cresote are not particularly flammable.

(2) Water Borne Preservatives

Water borne preservatives consist of an inorganic preservative with a fixing agent such as dichromate dissolved in water. Its main advantages are cheapness and availability, together with the fact that large stocks of the salts can be stored easily in comparison with the previous two categories of preservative. Another advantage is that this type of preservative is clean and free from odour. Its disadvantages are that wood impregnated with it swells upon treatment and shrinks considerably on drying, often with severe checks.

The ESB utilised this type of preservative on it wood poles. One type consisting of a mixture of arsenic acid, copper arsenate and chromic acid was used on Scots pine in 1954/1955. These poles have been carefully monitored since then and it would appear that this is a very effective preservative.

Preparation of Poles Prior to Treatment

The poles are machine dressed which removes stubs, inner bark and the cambium layer. This process aids penetration and improves the visual appearance of the pole. They are then scribed at at point 3 metres from the butt end. This is to ensure that the pole is placed at the correct depth of foundation. The scribe marks denote year of treatment, species and whether native or imported, e.g.:

D86 — Native Douglas fir	Treated 1986
L86 — Native larch	Treated 1986
86P — Imported Scots pine	Treated 1986

The tops are cut at a slope of 30° (if necessary) and drilling carried out (in the case of transmission poles) prior to treatment, which is standard practice. The poles would have been air seasoned for a period of 12-18 months so that the moisture content has fallen to between 25-30%.

PRESSURE TREATMENT OF POLES

Pressure treatment of poles is achieved by placing them into cylinders approximately 70'-75' in length and 6' in diameter. The cylinder is sealed and preservative is pumped in and pressed into poles at pressures of 8-10 atmospheres. The various pressure methods used for injecting preservative into wood in closed cylinders may be divided into two main groups: designated full cell and empty cell processes. The object of the full cell process is to inject as much preservative inot the wood during the pressure period as possible i.e. cell walls and cell spaces are filled with preservative. In the empty cell processes part of the preservative injected into the timber is recovered and the cells tended to be coated with preservative rather than filled with it.

FULL CELL PROCESS

(a) Bethell Process

The poles are loaded into tram cars or bogies which are then pushed into the treatment cylinder; approximately forty five 10 kV./1V.; fifteen 38 kV. or nine 110 kV. poles per charge. The cylinder is sealed and a partial vacuum of 60 cm Hg is achieved and held for approximately 30 minutes. The purpose of applying this vacuum is to exhaust part of the air from the outer layers of the poles, then while holding this vacuum the cylinger is filled with hot creosote — the temperature of which is maintained at 80°C. When the cylinger is full the pressing pumps are turned on and the pressure is allowed to build up to 10.5 kgs/cm^2 (150 P.S.I.). This pressure is maintained during the pressing period, which in the case of Scots pine (which is classed as moderately resistant) the pressing period may last from 10 minutes-2 hours, although more usually the pressing is completed in 15-25 minutes by which time adequate creosote retentions have been achieved e.g. a minimum retention of 115 kgs/cubic metres. The pressing period for Douglas fir, which is classed as resistent, is eight hours. At the end of the pressing period the cylinder is emptied and a partial vacuum of 60 cm Hg is applied for a duration fo 30 minutes.

The poles generally emerge dry after this process. Average retentions achieved by this process in recent times are as follows:

Douglas fir	— 192 kg/m^3
Scots pine	— 240 kg/m^3
Ponded Sitka spruce	— 211 kg/m^3

Empty Cell Process

(a) Reuping Process

The poles are put into the cylinger which is then sealed. The air pumps are switched on and the air pressure is allowed to build up to 1.75 kgs/cm^2 (25 P.S.I.). While maintaining this air pressure the cylinder is filled with hot creosote at 80°C. When the cylinder is almost full the air is slowly released whilst maintaining pressure. Once the cylinger is full with creosote the pressing pumps are switched on and the pressure is allowed to build up from 1.75 kg/cm^2 to 10.5 kg/cm^2 (150 P.S.I.). The same pressing periods are applied to the different species of timber as for the Bethell process. When the pressing period is completed the cylinder is emptied and a vacuum is applied. This causes the entrapped air to escape and thereby return a proportion of creosote to the cylinder. Typical retentions achieved by this process in recent years are given below:

Douglas fir	— 96 kg/m^3
Scots pine	— 122 kg/m^3
Ponded Sitka spruce	— 118 kg/m^3

REFERENCES

HUNT, G. M. and GARRATT, G. A., 1953. Wood Preservations. Second Edition, pp. 90-91; 103-104.