CONCRETE POLES FOR OVERHEAD LINES OR ANTENNAS, FABRICATED BY MULTIPLE ELEMENTS WITH POSSIBILITIES FOR ASSEMBLY BY HELICOPTER

Philippe Bettens
Engineer ETS, Technical department
Electricité Neuchâteloise SA
CH-2035 Corcelles
Tel : +41-32-7.324.296
Fax : +41 - 32- 7.324.414
E-mail : pbettens@ensa.ch

Albert Ghiraldi
Managing director
GRAM SA
CH-1527 Villeneuve-près-Lucens
Tel : +41-26-668.53.54
Fax : +41 - 26- 668.53.51
E-mail : GRAM@com.mcnet.ch

INTRODUCTION

The selection of supports for overhead lines (or antennas) in all cases corresponds to a decision based on multiple considerations. Aspects to be considered include their mechanical strength, their ageing behaviour, their appearance, possible methods of assembly or installation, environmental aspects and of course, associated costs.
Moreover there are technical impossibilities.
From now on the use of concrete poles in any terrain whatsoever no longer figures amongst these impossibilities. That fact has been confirmed by several realisations in difficult areas.

CONCRETE POLES FOR OVERHEAD LINES

Advantages of concrete supports

The use of poles of centrifuged or prestressed concrete, 20 to 40 meters in height is a technique widely tried out in Switzerland. A major part of the subtransmission network in service (40 to 150 kV) has been constructed with this type of support for approximately fifty years. These are also to be found in higher levels (transmission network 220/400 kV) or lower levels (medium voltage electricity distribution).

Doubtless the absence of maintenance requirements is the characteristic most esteemed by the operators of overhead lines, considering the alternatives of steel pylons or timber posts. This interest must certainly increase in the future with the growth of constraints to the use of anti-corrosion treatments for metal superstructures [1].

Limited land acquisition, of the order of a square meter is the second advantage of concrete poles over metal lattice pylons, generally designed with four widely spaced feet.

In the more subjective sphere of the impact on the landscape, they present slender silhouettes, more or less comparable to the trunks of trees.

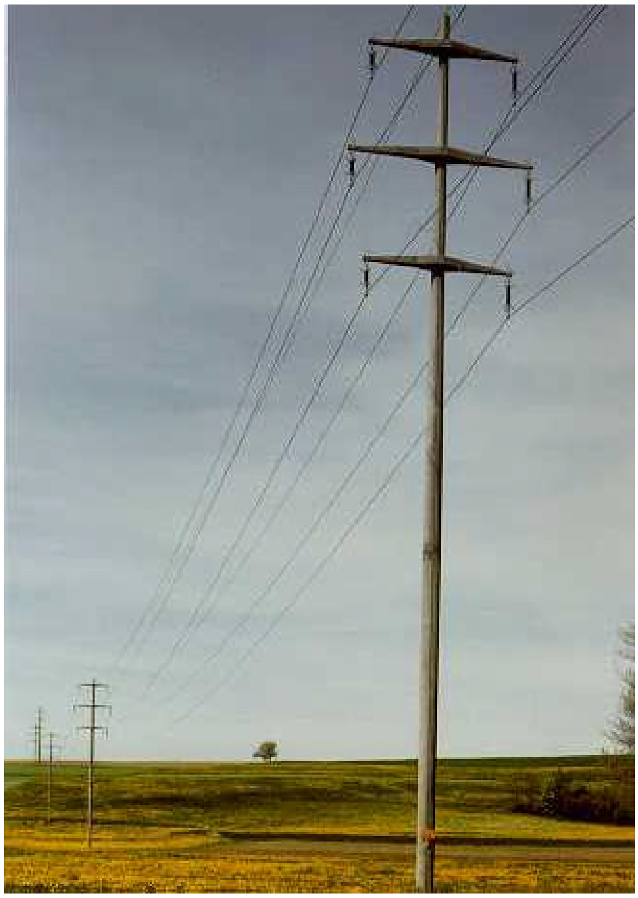

Photo N°1 :
Typical concrete pole on a 60 kV line in Switzerland

Beyond the Swiss frontiers, concrete supports are less used at present. In view of their advantages in saline or aggressive atmospheres, some developments can already be observed.

These latter are to be understood as realised with poles as called to mind previously, that is to say, prefabricated in a factory under ideal conditions. The carbonation phenomenon is practically unknown (1 to 2 mm in 50 years), with compression strengths of 70 to 80 N/mm2 in laboratory tests on cubes with sides of 20 cm, over 28 days).

Decisive inconveniences during a long time

Fabrication in a factory presumes firstly transport and secondly, means of installation. Applied to concrete poles, it often signifies very long road transport loads, and the need for mobile lifting equipment (cranes on wheels or tracks, or combinations of formwork and winches).

Photo N°2 :
Placing in position a bracket of a 60 kV concrete pole with a braced formwork assembly combined with a tractor borne winch

The transportation of concrete poles and that of the cranes generally used to erect them has long been represented as an obstacle, in some cases judged insurmountable. These are the main difficulties to be resolved with the supports in question, taking into account the weight and size of their elements. In the absence of practicable roads, the necessity to provide provisional transportation measures has been a powerful dissuasive argument.

In all cases this represented significant avoidable expenditure, to say nothing of the impact on the environment (temporary roads through fields and forests).

CONSTRAINTS OF THE ELECTRICITY SUPPLY NETWORK OF THE CANTON OF NEUCHATEL

The region served by Electricité Neuchâteloise SA (ENSA), in the northern part of West Switzerland, is characterised by the Jura mountain chain on which it is situated. The corresponding population basin of some 170'000 inhabitants is distributed in the valleys and by the side of the lake which borders the region in the south.

This situation results in a high voltage electricity network installed mainly on steeply sloped sites, frequently in the forest.

More than elsewhere, operations of surveillance, maintenance and fault rectification are extremely difficult. The solution to use concrete poles is interesting in this context, but its handicaps with respect to access represented a real problem.

THE INNOVATION

With regard to this problem, the implementation of a new system of assembly for prefabricated concrete poles using tapered elements is an incomparable innovation. Today it is possible to establish projects with shafts by sections, transportable by relatively light means, and in particular, by air. Always with this innovation, the vertical installation of the said elements, which are low in weight, is also possible by helicopters. This is effected by dry interlocking, without adhesives and the joining of fittings.

Birth of the idea

Faced with the snag of access, which opposed the use of traditional concrete poles, their producers first developed butt joint techniques between the vertical elements of the supports. Such solutions are more or less costly and in all cases very delicate.

Generally these run into difficulties due to the fact that they have to be applied in assembly locations, under site conditions, to products whose level of quality resulted from optimal prefabrication in the factory.

In spite of everything, ideas were sketched out by imagining elements of reduced length and weight, following the numerous examples for tubular metal pylons.

The comparison extended implicitly to the idea of using a helicopter, both for the final transport and for the assembly of the main elements (experience with the mounting of brackets had already demonstrated its feasibility). This idea however suffered from limitations in the useful payload of helicopters currently used in the first half of the present decade.

Implementation

Encouraged by a notable increase in the payloads transportable by helicopter, in 1995, the West Switzerland manufacturer of poles at this time recommenced its research relating to concrete shafts in sections.

Its efforts resulted in the implementation of an assembly cone system with a length of approximately two metres. The first versions included a small quantity of filling mortars. The later ones no longer imposed the construction of a joint. In its final and patented form (under the name HELIGRAM) it comprises only two elements for assembly.

It results from high performance techniques in the sphere of reinforced concrete. The fabrication of the cone (male part) was already considered an impossibility, whilst the second piece (female part), perfectly matched and likewise of concrete represents a real technical feat.

Photo N°3 :
Store of the elements of a 60 kV pole of centrifuged concrete, with a view of the assembly cone at the top of the lower part.

Initial applications

Even though its development was not fully completed, the above mentioned assembly system has been used in practical applications.

This was notably for one of the largest supports installed in recent years in the Neuchatel high voltage network. The pole in question with a total length of 49 metres (3 embedded in the ground by the intermediary of a foundation cast on the site) was made in three vertical elements (plus three brackets). It was installed using the formwork/winch combination described above.

In its situation in the middle of a forest, the given example is a characteristic case of where a concrete pole would have been out of the question one or two years before.

Prototype operation

After some applications in the course of development, using classic installation procedures, the assembly system detailed here was tried out on a grand scale with a helicopter, and directly in public view!

The machine used for this demonstration (world’s first) was a helicopter of the type SUPER-PUMA. This is one of the most powerful in service and is relatively available in Switzerland. Fitted with two turbines, each of 1400 kW, it can lift and manipulate useful loads up to 4500 kg under optimal conditions. Its Swiss experience commenced in the eighties with the transport of long tree trunks (« logging ») in alpine regions. Subsequently it took part in the work of assembling transmitters, cableways and electrical power lines.

The stated prototype operation took place at the beginning of July 1996, on an ENSA site. Two 60 kV supports were installed in six turn-rounds, where the skill of the pilot was naturally one of the keys to success.

The first of these was a pole fabricated by centrifuging (round section) with a total length of 23 meters. Its maximum design force is 1200 kg. Its vertical shaft comprises two sections : the lower element with a length of 7.00 meters has a weight of 3.0 tonnes ; the upper element has a length of 16.00 meters and weighs 3.7 tonnes.

The second support assembled at the demonstration was a pole of prestressed concrete (octagonal section) with a total length of 21.50 meters. Its maximum design force is 2700 kg. Its shaft comprises a lower element with a length of 6.80 meters weighing 3.8 tonnes, an intermediate element with a length of 9.00 meters weighing 3.1 tonnes and a top element, 5.70 meters long. This latter, with the brackets already assembled weighs 3.3 tonnes.

The two poles assembled as detailed support six Aldrey 240 mm conductors and a 242 mm2 Aldrey/steel cable with optical fibres.

Photo N°4 :
Placing in position the top element of the prestressed concrete pole assembled by helicopter in July 1996.

APPLICATIONS

Realisation in the ENSA high voltage network

Following the successes described above, ENSA constructed a three kilometre section of two 60 kV three-phase subtransmission lines in 1997 with almost half the concrete poles being transported by helicopter, all having no existing access.

This method of procedure was decided upon after a comparative economic analysis ; the alternative being a classic mode of transport and installation, in this case across agricultural and wine growing regions. An estimate of the cost of provisional transportation routes and potential damage was shown to exceed any extra costs resulting from the use of helicopters on the one hand and the fabrication of the poles by elements on the other hand (5 to 15% increase according to the number of elements per support).

Outside a purely financial framework (where the above mentioned costs were confirmed by the reality), the selected option comprises advantages which are difficult to calculate. The affected landowners appreciated the small impact of the construction site ; contacts with them were facilitated. The reduction in impact extends to the more general aspects of the preservation of the environment (risks of settlement of the sites on the provisional access routes or tree felling in wooded strips for example).

From the technical aspect, the realisation in question of course enriched experience in the process. In the first place it confirmed that any use of a helicopter demanded meticulous preparation in order to reduce flying times and the corresponding costs (unavoidable risks must be only those associated with weather conditions). These preparations begin to get ready a free store site and extend to the detailed coordination between those taking part.

The arrangements for guidance from the ground are extremely important. Naturally the use of radios is assumed, as are hand-holds or tethering points for the handling ropes, on the intermediate or top parts of the poles. The available personnel is also a fundamental factor; the tests in 1996 took place with a divided team, two fitters operating on the support itself ; in 1997 it seemed more profitable to keep all the assistance at ground level, where the forces can be fully deployed by the intermediary of the ropes, taking into account the weights and inertia involved.

Finally, as regards the helicopter used, the work at ENSA in 1997 showed the advantage of using the most powerful machine available. In the event this was a KAMOV KA32 twin rotor model (2 x 1800 kW), one of the most stable in flight. Under ideal conditions this machine can lift 5000 kg.

Photos N°5 and 6 :
Installing a 60 kV line of concrete using a helicopter type KAMOV.

Other realisations for overhead lines

Several other overhead lines for the Swiss electricity network have been realised over recent months, using poles fitted with a new assembly cone. In January 1999 the number of these concrete supports per element marketed will total more than 100.

The practical experience thus acquired has resulted in a continuous improvement in the ground assistance functions.

Antenna realisations

Developments in progress in the telecommunications sector demand antenna installations for which the erection techniques are relatively similar to those used for the supports of overhead lines.

This similarity has led to the development of transmitter/receiver projects in Switzerland and France on concrete products, fitted with assembly cones presented here.

In this sphere the most spectacular realisation is doubtless a fifty metres high antenna, fabricated in five elements and installed at the end of 1998 in the western suburb of the city of Lausanne.

Photo N°7 : Placing in position element No 5 of the 50 meters antenna installed at Lausanne (Switzerland) in December 1998.

FUTURE OUTLOOK

The system of assembly by cone as described above will probably permit greater use of prefabricated concrete poles in the country of its conception.

Beyond the frontiers the device in question will interest more and more responsible persons, likewise for projects in zones with difficult access, but also for coastal regions or those characterised by certain pollution. Today the responsible persons mentioned can easily imagine delivery by containers (road or maritime) for the concrete supports they select. Additionally they are in a position to envisage transport by air in the event of road networks being practically non-existent, as it is the case in certain developing countries.

Returning to Europe, where pressures are increasing for low visibility overhead lines, otherwise known as compact lines [2 – 6], the solution using poles provides a lot of interest. The ability to provide these in concrete is increasingly attractive.

More generally and at a time when the conservation of the environment is impinging on an increasing number of constructions, economy of access is not only expressed in financial terms. Any applicant for rights of passage will value the extended use of the helicopter, if this method has the approval of his discussion partners, desirous of keeping impact on the site to a bare minimum.

CONCLUSIONS

Thanks to the new system presented here (a system capable of being mastered by any superstructure construction specialist), it is now possible to overcome the main obstacles to the more extensive use of concrete poles (which require no maintenance).

This type of support for an overhead electricity line or a telecommunications antenna can however be selected independently of its installation in the terrain. The solution is specially valued in wooded areas or those with steep slopes.

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