Cable cranes are still up to date

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I am very pleased to have occasion today to have a little talk about cable cranes.

Let me tell you two words about us and the reason of my interest in cable cranes.

I started my activity in the ropeways field in 1971 in Breco (British Ropeway Company) as a young engineer and I was immediately fascinated by the Ropeway field and especially by this strange type of equipment transporting huge buckets full of concrete from one side to the other of steep valleys.

So as soon I had an occasion I joined Agudio company (lately incorporated by Poma Italia S.p.A.) and I could go on with my experience with this type of installation.

Mr. Gianfranco Marten – Perolino, General Manager of Poma Italia is also deeply interested in this type of installation and has given new impulse to the cable crane market.

The cable cranes (or blondins) I am referring to as they are called in French are used mainly for concrete dam construction. Smaller types of cable cranes are used for ropeways erection or wood transportation.

The cable cranes consist essentially of a single or twin track rope pulled between the two sides of a valley where a concrete dam has to be build.

On the track rope a carriage goes to and fro, moved by a ring of rope (the translation rope). The winch moving this rope is usually an winch with a driving sheave.

An hook transporting the bucket is suspended to the carriage by means of a hoisting rope, usually moved by a drum winch.

There are many different layouts of cable cranes, depending from the system used to move the track ropes in order to cover the required dam area.

There are radial cable cranes: one side of the track rope is fixed to a fixed point, and the other is fixed to a mobile tower or carriage moving on a circular runaway. In this type of layout a circular sector area is covered. The fixed point can be at ground level or on top of a high tower (towers up to 120 m were built)
Also the mobile carriage can be at ground level, or a tower with an height up to 20 ÷ 30 or more

There are parallel cable cranes: the two sides of the track rope are fixed to mobile towers moving each one on a runaway . In this layout a rectangular area is

covered. Also in this case the mobile towers can be at ground level or with an height of many meters, depending from the terrain characteristics and the necessity of keeping the bucket clear from the dam crest.

There are oscillating cable cranes, where the two sides of the track rope are fixed to the top of oscillating towers. The synchronous oscillation of the two towers allows to the track rope to cover a rectangular area.
Again the height of the towers can change. In any case in this type of arrangement a certain height of the tower is requested in order to cover the required area, since the head of an oscillating tower can usually move each side up to approximately 30 % of his height.

The name used in French, Italian, Spanish and many other languages to designate this type of installations is " blondin "

The first known " blondins " were built around 1860, mainly for wood transportation.
The name blondin comes from the French acrobat Jean François Gravelet Blondin known as " *The Great Blondin* " who the 4th July 1859 crossed the Niagara Falls walking on a rope tightened on top of the falls.

You can see in the overhead projection the original poster announcing the performance of Blondin as well as the same Blondin during the performance.

The preference given to cable cranes for dam construction instead than to other means of construction as tower cranes or derricks is generally determined by three principal reasons, namely:

- Safety
- Rationality
- Economical operation

From the safety point of view, the cable cranes are certainly the most appropriate.

In fact a dam is always built where there is a river, which can subject to floods, with possible inundation of the dam's building yard.

The use of cable cranes permits to place the most important equipment used during its construction in position which can not be reached by the waters even in case of flood.

Furthermore, it is not rare that, in case of flood, the minor equipment in operation within the dam's area and even workmen are rescued, by using the cable crane. It happened also that with two cable cranes coupled by means of lifting beams, even bulldozers weighting tents of tons where so rescued.

From the rationality point of view, the use of cable cranes permits to obtain a better organization of the building yards: in fact the crushing and screening plant, the batching and mixing plant, the platform of the runway for loading the buckets of the cable cranes can be arranged according to organic criteria and in the most appropriate position, in order to rationalize the flow from one to the other plant without caring too much of their distance from the place where the concrete has to be placed.

It becomes also possible to keep the dam's area and the adjacent ones clear from obstructive plants and machinery that might hinder the remaining operations.

It is evident the great advantage of having a system which passes high on top of the dam area, without any interference with the dam working site.

From the economical point of view, the advantages are considerable: even if, and this is not always the case, the initial investment required for the cable cranes can be noticeable higher than that of other usable means.
In fact the economy in operation is such that permits to recover not only the difference in cost, but also to effect large savings.

First of all, passages and handling are reduced: with a small travel.
The concrete is transferred from the batching and mixing plant into the buckets of the cable crane which carry it directly to the casting block, eliminating in this way all the transfers, transshipments and useless and expensive handling necessary with other means.

Cable cranes are able to cast the concrete into the different blocks of the dam, to concentrate the concrete casting in a single area or to alternate different areas

Using other means instead , for feeding the different blocks of the dam, various cranes or derricks are required, plus of course other means for bringing the concrete to them; otherwise such machines must be shifted many times and the construction of the dam or of parts of it has to be stopped in the meantime.

The cablecrane is controlled by a single operator from a cabin positioned in a suitable place, allowing the best view mainly of the bucket loading area and possibly also of the unloading one.

It can operated easily even in case of poor visibility conditions thanks to the special indicator of the position of the bucket, which allows blind approach manoeuvre to the casting point where the final position instruction can possibly be given through radio.

Since the anchorage position of the track ropes are usually placed well outside the dam's area and the position of the ropes is usually quit high above the dam site, the cable cranes are no affected at all by mine volley
On the contrary special precautions are required with other means that stand in the dam area near the mine explosion zone.

By using a cable crane it is possible to schedule and obtain a casting cadence an intensity that permits to exploit in the best way the concrete production and in the same time to be sure that the concrete will be cast in the best conditions, that is : without segregation as often occurs using other means that require repeated handling.

Even if the main duty of a cable crane is concrete transportation , this installation is suitable for many other auxiliary functions like transportation of forms, reinforcing bars, equipment from one yard to an other.

For all this reasons the cable cranes are still up to date and are still widely used for construction of big concrete dams.

Basically the systems used today are not very different from the cable cranes used 20 or 30 years ago.

Although some important features were subject to an evolution, let' have a look at the main ones:

- capacity: there was an evolution both on maximum weight to be transported.

Today is usual to utilize cable crane with a capacity at the hook of buckets of 9 cubic meters capacity, that means about 28 t at the hook.

Up to some years ago the usual capacity was not more of 4 cubic meters.

This evolution was possible with the construction of ropes with higher characteristics and the use of two twins tracks ropes instead of a single track rope.

- speed. there was a considerable increase in the speed of carriage translation and bucket lift.

Now speeds of 7 m/s for the translation and 3 m/s for lift are usual.

The increase was considerable especially as far as translation speed is concerned.

Up to some years ago the translation speed was limited to about 3 m/s.

The increase was possible mainly due to the utilization of better system of slack carriers as the fixed ones used by Agudio and Poma, or other systems as the
" opening " slack carriers .used by PWH.

This type of slack carriers are fixed on the track rope or ropes and allows the carriage to pass trough them at high speed.

One of the main technical problem in a cable crane is in fact how to support the operation ropes (especially the lift rope which is subject to a high variation of tension, depending from the fact that the bucket is full or empty).

These systems are a big improvement from the first slack carriers which used a knot rope system, each carrier having a "hole " of different dimension, being released from the carriage when the appropriate " knot " of the knot rope met the appropriate slack carrier.

I would like to show you a short movie showing the system. The movie refers to the cable cranes of Rules in Spain. These are two radial cable crane with a capacity of 20 t, building a concrete gravity dam for the " Agroman - Auxini" consortium. The total dimension of the dam is about 2 millions cubic meters of concrete.

Also the " automatic " slack carriers, used in the past by many cable crane makers, as Agudio and PWH, were not much effective, although a nice piece of mechanical technology . In that system a mechanical gear on each carrier , actuated by an appropriate rope was moving each carrier at a different speed (lower near the track rope ends and bigger near the carriage) in order to position in the proper way the different carriers. The system was quite clever, but it was never possible to make it work well due to slippage of the operating cable and other practical problems.

- safety systems. It was possible to transfer to the cable cranes all the main safety developments introduced in the last years in passenger transportation.

This applies especially to control systems.It is enough to mention electronic overspeed devices, the control of integrity of mechanical transmission of the winch, maximum torque and maximum torque gradient control and so on.

Of course this is very important, in order first of all of increasing the safety of the equipment (with cable cranes we are not transporting people as with passenger ropeways, but we are usually working on top of many workers), but it is also very important to prevent small accidents which can be a reason for stops decelerating the concrete casting program.

An other improvement is in the system signaling the bucket position. Today the movement of translation and hoisting rope is usually checked by a double system utilizing a mechanical programmer and an electronic one .

Whit this system is possible to send to a monitor all the information of the position of the bucket and even make the operation of the cable crane completely automatic from the concrete loading point to a determined unloading point.

I would also like to mention a new feature used in the parallel cable cranes of Karun III in Iran where an arc dam is being built by the Sabir company using two 9 cubic meters cable cranes.

In parallel cable cranes one technical problem is the fact that the winches have to be on board of one of the mobile cars and the hoisting rope has to be kept in line with the track rope (or ropes).

Since the hoisting rope is moved by a drum winch we have the problem of keeping the hoisting rope alignment with the track rope during the movement of the drum.

The classic solution used so far is to have the axle of the drum parallel to the track rope, deviating the hoisting rope on a pulley which moves with a movement synchronous to the drum rotation.

In this arrangement the pulley has to stand all the pull of the hoisting rope,.

In Karun III a different solution was used: the hoisting drum axle is perpendicular to the track rope axle and the hoisting winch is moved synchronous to the drum rotation, In this way the pull of the hoisting rope is not contrasting the winch movement.

To finish this short talk about cable crane I would like to mention I have developed a few very simple programs to calculate the track ropes condition of cable cranes and the power consumption requirements.

I think there is no time to fully illustrate these programs now. I can juste say a few wordszabout it

The program is written is plain basic and calculates the tensions in the anchored track rope of a cable crane taking in consideration the position of the load, the temperature and so on.

It takes also in consideration the mutual influence of the translation and hoisting rope with the track rope, in the various condition of line charge.

In fact this is perhaps the most interesting part of the calculation , because we have to consider that not all the weight of the hoisting and translation rope goes on the track rope, but only a part of it, the difference being sustained by the hoisting and translation ropes tension directly. The program takes this aspect in account calculating which is the actual sag of the various ropes linked together and which would be the sag of each rope alone.

Finally the program automatically makes a drawing of the track rope lower position compared with the dam crest,

The last portion of the program calculates the power required by the translation winch, calculating the maximum required power and the quadratic average power required by the most critical cycle.

The overhead images shows the way the data are sorted by the program.

Anyone which can be interested in this very simple program or some more which run on excel can contact me directly to have a copy of the same