

SEGMENT DOCUMENTATION

Alex Conacher and Florian Werres discuss current practices and future developments for segment tagging in tunnelling



AS THE INDUSTRY MOVES towards BIM across all phases of construction, suppliers, designers and contractors are still working out all of the potential uses. When it comes to preventative maintenance, a lot depends on knowledge of the structure itself: what exactly has failed, where, when and why? Once this is known, it is easier to predict future failures and act in advance to prevent costly post-failure repairs. To achieve this, as much information as possible about the built tunnel must be recorded and saved for future generations of engineers.

VMT, best known for TBM guidance solutions, also has a segment documentation system (SDS) where barcodes are placed on segments containing information about reinforcement used, concrete composition, tools, and segment dimensions can all be recorded, along with supply chain information that might be useful at a future date.

With this information, if a segment fails or is worn in some way, it is possible to identify similar segments and perform maintenance prior to failure. For example, if it turns out that a number of segments had a bad concrete mix, and you realise that there will be high corrosion on a certain amount of segments, you can trace back to concrete mix design and predict

Above: Segment storage for the Santa Lucia project in Italy. All photos courtesy of Maccaferri

which segments will need maintenance in the next few years and you can do preventative maintenance.

LONG-TERM THINKING

Synthetic barcode labels are useful up to a point, but for longer term recording of segment data, the company is pushing for the use of RFID tags attached to the reinforcement prior to the concrete pour. In the case of the Paris Metro, a plastic marking plate for the RFID tag was chosen. The specification assumes coverage of 60–80mm of concrete, but if there is more than 100mm it might be difficult to read the tag, so it cannot just be thrown into the mould.

“Labels will disappear due to time and the tunnel environment, or even due to TBM activity,” says Florian Werres, head of VMT’s SDS business unit. “Whenever this happens, all of the data is lost. But



with RFID tags, even 50 years down the line you still have the information available.”

At the moment, interest in the RFID system is growing, but the barcodes still have the advantage of not always needing a scanner to read, so until the awareness of the long-term advantages of RFID is more widespread, there will be reluctance from some projects to switch (there are also significant automation advantages to RFID, which will be discussed later). There is, however, nothing to stop a segment factory using barcodes and RFID tags together.

It is possible, as BIM analysis of construction performance becomes more widespread, that segment design under various real-world conditions will be analysed more empirically, and this can be used to learn lessons for future projects.

ACCURATE REPORTING

Regarding the growing enthusiasm for digitalisation and BIM, Werres says, “At the moment a lot of people are talking

Top: Scanning a segment documentation barcode in a storage yard

Above: Building reinforcement ahead of placement in the mould

about this, but there is a tendency for precast factories to be quite traditional. They use paper to record this information in many cases. But with paper it is possible to write down anything you want. The same is true of a basic digitalised system, e.g. an Excel document.

“Our system will control and monitor the quality actively and you cannot easily manipulate the records. We configure/customise the system to match the process chain of the factory that will use the system. And because of this the software will guide you through the process and will actively control each step that you do, and tell you if you do something wrong. And it will not delete the data, just change it. This gives assurance that the quality of the segments is good. Accurate data, not manipulated, is important.”

GROWTH AREAS

The company has supplied 30 projects with its SDS, but just one, the Santa Lucia Tunnel in Italy has opted for the RFID tags. It has averaged a couple of projects a year since it started work on this system nearly a decade ago, but in the last year has had around 10 orders.

“The guidance side of the company is maybe EUR 25M [USD 29M] while SDS is of the order of EUR 1M [USD 1.15M],” says Werres. “Aside from promotion, the reason for this growth is just the trend to digitalisation. People ask for it, it is getting mentioned in the specification of projects, not just in Europe but also places such as Singapore and Canada. You can see it appearing in the tenders.”

In terms of current research and development, Werres is focusing on the evaluation and analysis of production in order to improve output, rather than more documentation. This will allow, for example, the time a worker needs to perform a single process and compare them to other workers, or compare shifts.

“Maybe on a night shift there is one worker cleaning the moulds who holds up the carousel each time. This is hard to identify at the moment, but with more analysis could be possible. And then you could provide targeted training, for example.

“Another thing we want is more visualisation, so if you are sitting in an office in Singapore and production in Malaysia, you have graphs and visualisation of production in real time. Maybe there is a crane defect – you call the guys and tell them to bring out a crane tech before production continues.

“To achieve this we need more interfaces directly from the machine control units and other systems. At the moment we are a quality management and traceability system with a little bit of production planning, but we want to go more in that direction of production planning and management.”

FUTURE HOPES

“In my opinion, we should move into automation. I can see it appearing in Paris or other parts of Europe where labour is very expensive, maybe not in lower wage countries, but in Europe it’s a big thing. Clients are also struggling to hire personnel to these dusty, rough, repetitive jobs.

“In Paris they have started to use robots for some of the work stations and if we want to go further in this direction we need RFID.

“[But it is not necessarily just in the developed world], we have projects are all over. In Egypt we have two systems running and the labour cost is really low, at something like EUR 250-300 [USD 290-350] per month but they still use SDS because there are other benefits, including keeping up quality.

“TBM manufacturers are also looking at automatic segment erection. Fewer people in the tunnel is safer and ultimately a good thing.”