

ROBY 850 ROBY 850 – a semi-automatic drilling robot

Contract No. CV/2012/08
Liantang / Heung Yuen Wai Boundary Control Point Site Formation
and Infrastructure Works – Contract 2

ITA
AITES Chuzhou-Nanjing 7th November 2018

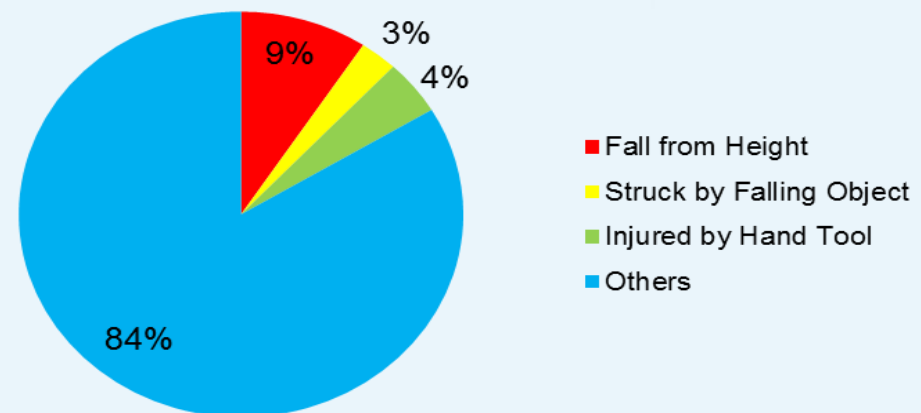




- In Hong Kong, every year there are about 4000 occupational injuries in construction industry and 300 occupational diseases. The highest risks to injuries are “falling from height” (9%), “injured by hand tools” (4%) and “falling objects” (3%).
- With longer and larger tunnel we built, there is definitely increasing demand, for construction workers, to install E&M services, in particularly, drilling anchors and installing permanent utility containment system including cable brackets and cable tray. Current practice of using hand-held equipment to drill hole and install anchors repeatedly, will lead to having working exposed to hazard of “falling from height”, “falling object”, “joint or muscle damage; “misuse of drill” as well as “hazardous dusts”.



**Occupational Injuries in Hong Kong
Construction Industry (2017)**



The Need for Safety and Health

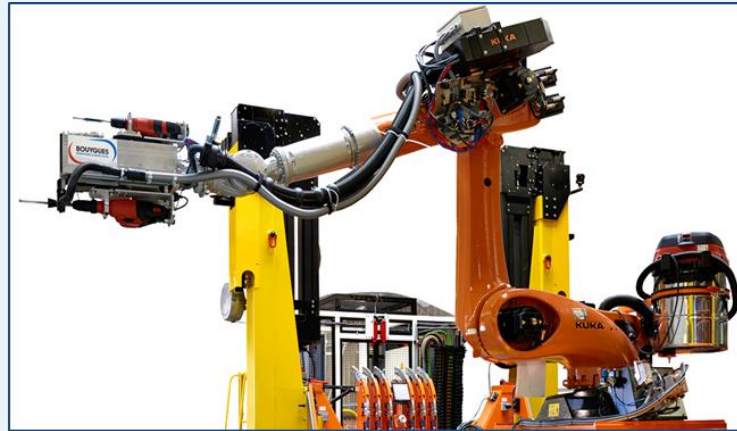


- Current practice requires a surveyor or lineman to set out the anchors holes. Then a worker work on cherry picker or working platform to drill each of the holes repeatedly by using a hand-held drill. The anchors could hence be installed in the holes after holes cleaning. High quantity of anchors requires very frequent change of drill bits by hand.
- Some workers have reported having health issue of “Tennis elbow” or so called lateral epicondylitis, after repeated pushing / pulling of drill.
- Vibration caused by prolonged use of hand held drill can cause nerve, circulatory and joint damage.
- The workers also very often work at height, and are exposed to hazard of falling from height and falling objects.
- The worker is greater risk in use of hand-held drill, because of their likely inexperience and often inadequate safety information, instruction, training and supervision.
- Hazardous dusts are emitted by drilling that does not use water for cooling drilling parts and capturing dust. Concrete dust may carry high levels of silica dust and repeated exposure can cause silicosis, which is a scarring and stiffening of the lungs.

- Over the past 10 year Bouygues and Dragages Hong Kong have sought through research and development to bring new mechanical and automotive skills and tools into the construction industry to enhance productivity and the well-being of workers.
- Adapting expertise from manufacturing to construction sites to remove, reduce or support repetitive, heavy duty or tasks with inherent risks is crucial to ensure our industry progresses in a safe way in the coming years.
- For the past 3 years Bouygues TP R&D teams have worked to develop a specific tool to replace human involvement in this repeated setting- out, drilling and anchors installation by this robotic system which significantly reduces the risks associated with the drilling operation. Through development, this has led to the so called ROBY 850 - Semi-Automatic Drilling Robot.



- ROBY 850 is designed as a semi-automatic drilling robot capable to drill holes and install anchors.
- The robotic arm is installed on a lifting platform.
- The platform is movable along tunnel after being mounted on specific trailer and pulled by dedicated truck.
- The robotic arm length in combining with extension of lifting platform has drilling range of total 8.5m. Hence the model is called “Robot Bouygues in 8.50m”– in short “ROBY 850”.
- It has capacity to complete the work in full process, including setting out, drilling, cleaning holes, and then fetch anchors from anchor magazine, as well as install anchors in drilled holes.
- The machine is in semi-automatic mode, as it is controlled by a pilot for our primary consideration – Safety.

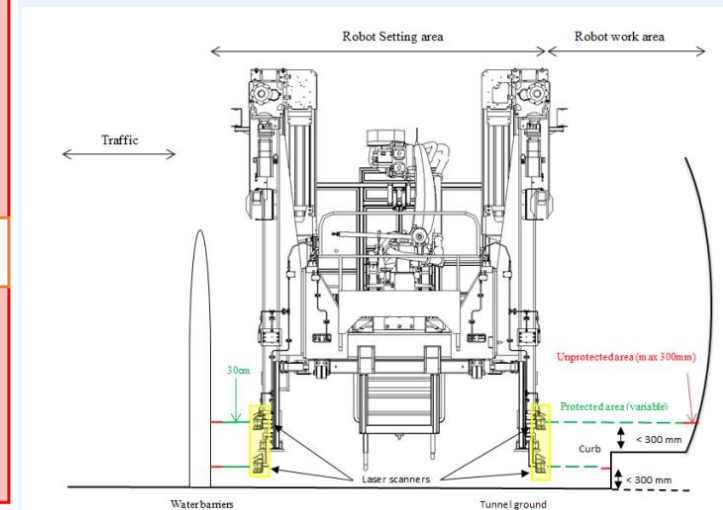
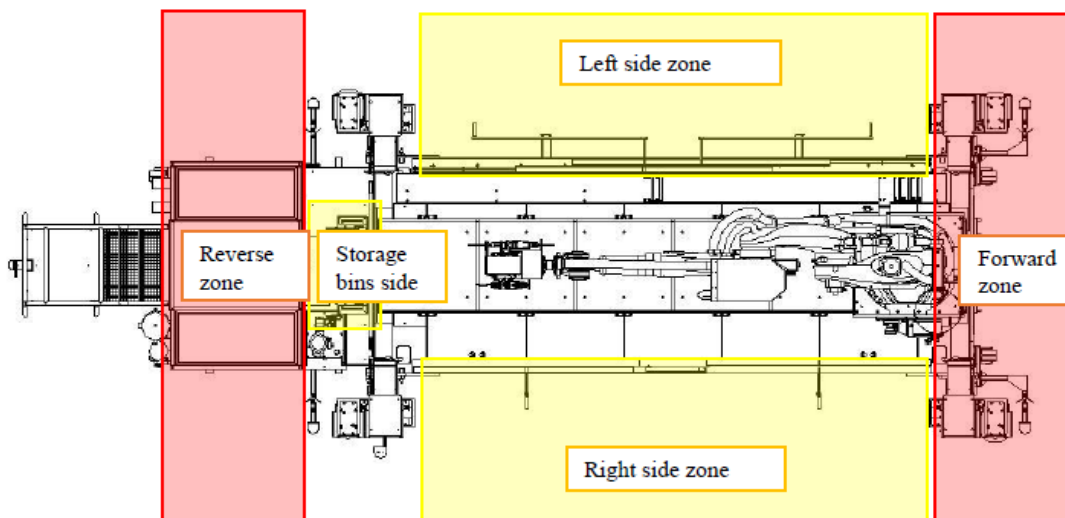
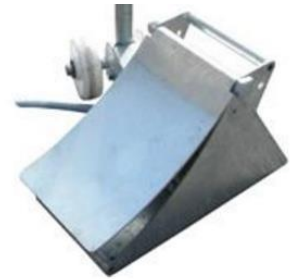




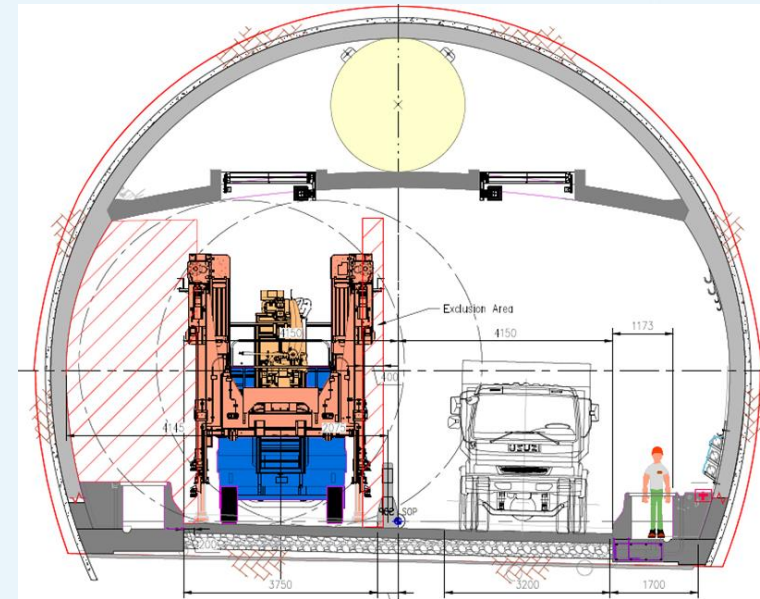
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- Kuka safe working zone
- Area protection with 1.6m high water barriers
- 2D laser screen to protect the area in any platform position
- Siemens safety automaton for sensors as inclinometers, platform hydraulic effector, wheel block, drilling machine consumption control, safe positioning of robot, door access lockers...



- Following laboratory experiment, a ROBY 850 prototype was first in the world utilized in the Liantang / Heung Yuen Wai Boundary Control point and infrastructure Works Contract 2 project in Hong Kong which consists of 9.7km of dual two lane road tunnel including 4.8km of TBM excavation using a large diameter (14.1m) Earth Pressure Balance machine (EPB TBM).
- It was considered quite adapted for the trial as about 200,000 numbers of anchors were foreseen to need installed for cladding and E&M service along this long length tunnel.
- ROBY 850 have completed its mission of first trail successfully in the project and installed over 30,000 numbers anchors semi-automatically in 2017 and 2018.



- There is significant improvement in efficiency of the robotic arms throughout the trail in the project. The daily production rate of cable bracket installation has been increased from of 10m to 40m length of tunnel, even over 60m at the peak. This result is significantly faster than the productivity by using hand-held drill with a team of three on cherry picker. More importantly, it brings much safer working environment to the workers who have been trained as robot's pilots.

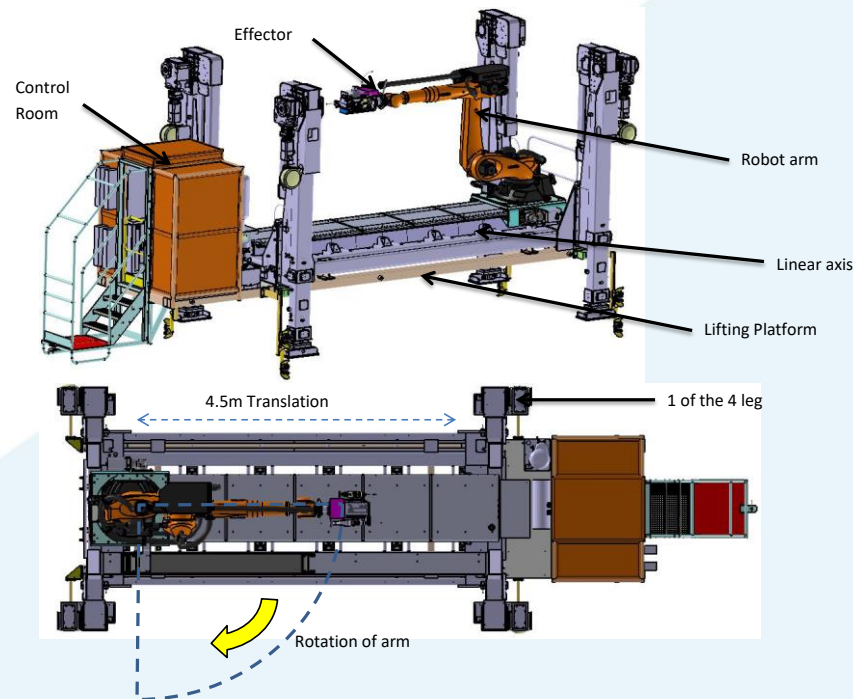


Figure 1: Main Parts of ROBY850

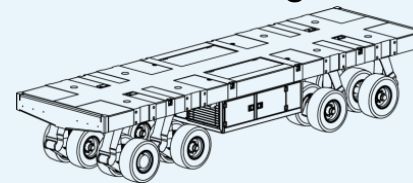
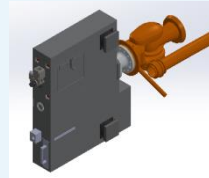
A) Issue related to the project and its organization

- Anchor and tunnel design are essential for the robot : Site/ROBY Team communication to improve
- Spare parts management
- Survey work to clarify
- Access to manage
- Team interaction to lower



B) Improvements related to the machine

- Automatic trailer to facilitate the machine progression
- Localization to improve thanks to master target tracked during trailer move (NCX development)
- Anti-pollution effector
- Generator to install on the trailer
- Robot movements to reduce by embedded anchor storage
- Tunnel adaptation





- The next generation of ROBY robots can easily be seen as the future standard tools for the E&M service and cladding installation in tunnel.
- Bouygues and Dragages are leading the project by sharing and using competences from far beyond the construction and tunnelling industry. By opening our industry to others, ROBY 850 demonstrates that we can exchange and combine ideas and know-how to promote a better and safer tunnelling environment leading to an industry where wellbeing of workers is enriched.



Thank You