# Robotics improve construction – an example in metal inert-gas (MIG) welding of pipes

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## Introduction

The rise of robotics is timely for the construction industry. The present ageing working population in Hong Kong and the less comfortable working condition have deterred the young generation to relay our previous brilliant achievement in the industry. Robotic technology improves quality, productivity and efficiency. There are limitless application of robotics in the construction industry to fill the gap in those labor intensive activities.

In a bid to cope with the huge demand in construction, the Government (2018) have collaborated with the Construction Industry Council in establishing a Construction Innovation and Technology Fund (in HK$1 billion) to encourage a wider adoption of innovative technologies and stimulate the provision of cutting-edge solutions for industry enhancement.

## Robotic arc welding plant – the first of its kind

I have a chance to view the use of robotic technology for pipe welding in Hong Kong. An example of this application happens in the welding of pipes and flanges. The venue I visited was a robotic arc welding plant named the O-Link Limited, situated at San Tin in the New Territories. This process is called Metal Inert-Gas (MIG[1]) welding. Gourd (1995) states that it can be either manual or a merchandised traversing system. The operation includes an arc being established between the end of the electrode and the parent metal at the joint line. The electrode is fed at a constant speed by a governed motor. The arc area and the weld metal are protected by a gas which is chosen to suit the metal being welded. Gibson and Smith (1993) describe the electrode wire aptly. It is a continuous consumable wire electrode fed through a welding gun fitted with a concentric gas nozzle. The arc is struck between the work piece and the wire, which acts as both electrode and filler.

The arc and the weld pool are shelded from atmospheric contamination by passing a suitable gas through the nozzle to form a protective “umbrella” around the welding area. The gases used are 75% argon and 25% carbon dioxide. The plant performs the task of onsite welding on pipes and flanges supplied by clients using robotic arms, starting from setting out the dimensions, to welding, pressure testing and certifying. I was told it is the first of its kind in Hong Kong. The work is a one-stop process which can avoid the stringent site safety requirements.

The process I viewed was the “ductile iron pipe welding by robot”. It was a 150mm diameter ductile iron medium long neck flange, using pipe standard to BS EN 545, K-12 and a ductile iron flange, using flange standard of medium long neck flange to BS EN 545, PN16[2].

## The complete process

There are five main steps in the process. (1) Cutting; (2) Peeling paint and zinc coating; (3) Robotic welding; (4) water pressure test; and (5) Painting and laser labeling.

In the actual process, numerical control machines are employed and in so doing, finally all products with their test results can be traced by the time and data printed or certified. To illustrate the process I am describing (1), (2) and (3) as follows:

(1) The CNC Bandsaw 數控鋸床

Pipes are measured to the required lengths using the pipe conveying feeder. The dimensions are inclusive of the rebate size and the width of the fillet weld. The length of pipe is measured to be 155mm which is pretty short to maneuver manually. The bandsaw is continual and of low temperature. No fluid lubricant is used to preserve water hygiene because any chemical in the liquid lubricant could contaminate the flanged pipes. It was fascinating to see that the cement lining of the ductile iron pipe shows no blurs at its end.

Precise cutting

(2) The CNC Lathe 數控車床 - Flanges are peeled off in the internal diameter of the zinc coating. The large CNC Lathe 大型數控車床 – it removes the paint and zinc coating off the external diameter of the ductile iron pipe.

Scraping the inside of the flange (CNC Lathe)

Peeling the outside of the pipe (large CNC Lathe)

(3) 11-Axis robotic welding system allows the four fillets of weld to be performed. The fillets run in an oval shape along the internal perimeter and external shank of the flanged connections. The shield is using argon and carbon dioxide. During the process excessive dusts, fumes and sparks are removed by the vacuum absorber shrouding over the weld. The mechanical arm is named Vivi which moved swiftly on a semi-autonomous trajectory. The MIG method is versatile that allows the nozzle to navigate in the convex and concave loci along the inside and outside of the flange. Fumes[3] can be hazardous and are immediately removed from the vicinity.

A flexible duct (in blue) to suck the fumes

11-Axis mechanical arm (in white) named “vivi”

## Remarks

Close to the end of the visit I have had a chance to view the finished product awaiting to be dispatched and collected by the clients. I note that the flanged pipes were stacked horizontally to form a neat and leveled platform. It is amazing to see that after several independent and semi-autonomous stages, the products retain their dimensions precisely and standing square and firm. emembering that all of these welded pieces were processed through the numeric controlled machines and welded by the mechanical arm. The dimensions were all the same making them standing identical to each other.

This is the quality and efficiency that technology and innovation are meant to provide. The government is heading for this in order to enhance safety on site. The above is an illustration of what the Development Bureau (2018) has been promoting: despite its acclaim for high efficiency, Hong Kong's construction industry must continue to upgrade through wider adoption of innovative technology to enhance productivity, built quality, environmental performance and site safety. The Construction Industry Council established the Construction Innovation & Technology Application Centre last year, leading the industry to embrace innovation through collecting, exhibiting and experiencing the latest construction technologies and applications. With the advance in technology, many manual construction operations can be performed by machines and robots under the supervision of skilled and knowledgeable construction personnel. I am sure the process similar to the one I viewed will become an example that other construction activities will like to follow. It is crucial that plumbers and decorators shall take these into account when planning their work ahead.

[1] Gourd (1995) defines MIG as Metal Inert-Gas welding which has other names including metal active-gas welding, metal arc gas-shielded welding, gas metal arc welding, semi-automatic welding or CO2 welding.

[2] BSI - BS EN 545: 2010 5.4 & PN16 - Flanged joints as cast, screwed, welded and adjustable. In order to demonstrate their strength and leak tightness in service conditions, flanged joints shall be subjected to a performance test...The test assembly shall comprise two flanged pipes of approximately equal lengths, assembled together by means of a flanged joint; both ends of the test assembly shall be equipped with blank flanges.

[3] Gibson and Smith (1993) point out that during the welding process, good ventilation and fume extraction are required, but care must be taken not to disturb the protective argon gas shroud by too strong a draught. With argon being heavier than air, it can accumulate at a low level in confined spaces, gradually reducing the oxygen level and increasing the risk of suffocation.

## References

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