Solid Wire "MG-55R" for Steel Structure Welding Robots

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The number of steel structure buildings has increased since 2004, with the recovery of the economy, and fabricators are introducing larger numbers of welding robot systems to improve their productivity.

Welding wires for steel structure buildings have evolved from the conventional strength class of 490MPa to the 540MPa class for improved earthquake protection. A solid wire, "MG-55R", was developed as a 540MPa class wire, used for robotic welding with high efficiency. The MG-55R is a solid wire for carbon dioxide gas arc-welding suitable for automated, long and continuous operations, which are unique to robot welding (**Photo 1**).

The following summarizes the features of the MG-55R.

Features

1) Small slag generation with excellent slag removal
   Conventionally, 540MPa class wires generate larger amount of slag, which is difficult to remove, compared to the 490Mpa class wires. The slag remaining on the weld metal surface, which does not cause much of an issue in semi-automatic welding, poses the following obstacles in robotic welding :
   i) The slag disturbs continuous operations and lowers work efficiency, because the slag is difficult to detach and has to be removed frequently.
   ii) Being an insulator, the slag can cause arc start failure.

   In order to solve the above problems, MG-55R has an optimized chemical composition which reduces the amount of slag generated and makes the slag easier to remove (**Figure 1**, **Photo 2**). As a result, the residual amount of slag is reduced to half and the maximum thickness of plate, which can be welded without any slag removal, has been increased from 19mm to 25mm. Furthermore, slag inclusion defect has been reduced with the reduced amount of slag.

Photo 1 "ARCMAN" robot welding system and "MG-55R" wire

2) Deep penetration characteristic
   The developed wire converges more arc and, as a result, has a deeper penetration compared to conventional wires (**Photo 3**). Kobe Steel's "ARCMAN" robot system has a capability of automatically correcting the welding direction and thus preventing penetration failure. Combined with the deeply penetrating wire, the system can further ensure the soundness of the welded joints.

3) Superior mechanical properties of the weld metal
   "MG-55R" has higher strength and energy absorption compared to the conventional 490MPa wires.(**Figure 2**) The wire allows a large heat input and high interpass temperature welding condition, enabling higher welding efficiency and performance compared to 490MPa class wires. **Table 1** and **Photo 4** show examples of mechanical properties and penetration profiles of welded metal joints.
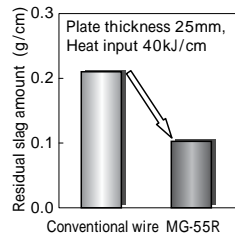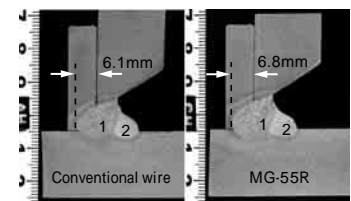

Fig. 1 Amounts of slag generated

Photo 3 Comparison of penetration depth

Photo 2 Comparison of slag detachability (Flat position welding, Plate thickness 16mm, Cooled to room temperature)
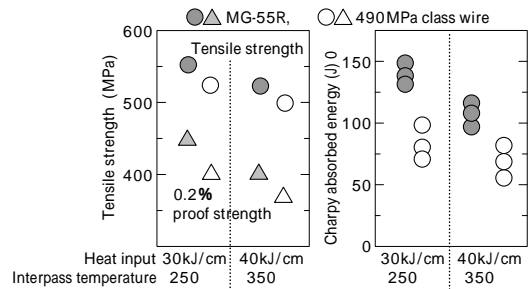

Fig. 2 Comparison in mechanical properties between MG-55R and 490MPa class wire
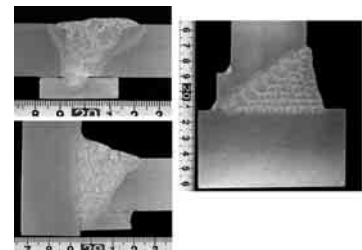
Table 1 Mechanical properties of weld metal by MG-55R using the ARCMAN steel structure welding robot

No.	Joint	Position	Thickness (mm)	Tensile properties				Absorbed energy	
				0.2 proof strength MPa	Tensile strength MPa	Elongation	Reduction of area	νE₀ J	Avg.
	Diaphragm / Beam flange	Flat	19	450	553	31	73	118, 104, 98	107
	Diaphragm / square pipe circumference	Flat	25	472	565	30	72	110, 106, 102	106
	Skin plate of column / Beam flange	Horizontal	45	496	582	29	70	134, 146, 129	136

(Sorts of steels   Square pipe   BCP325   Diaphragm   Skin plate of column   Beam flange   SN490C)

Photo 4 Cross sectional profile