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A twin roll caster to cast wire-inserted composite strip

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Abstract: A wire-inserted composite strip was cast using a downward melt-drag twin roll caster. The downward melt-drag twin roll caster was easily modified to a twin roll caster for the composite strip by simply attaching a coil of wire. Wire of either 0.3-mm and 0.6-mm diameter could be inserted continuously both inside and at the surface of the strip. The insertion of wire did not affect the castability of the strip. At a suitable roll speed, no void formed between the wire and the strip. The wire-inserted strip could be rolled without defect between the wire and the strip. Draft of the wire diameter was almost same as that of the strip after rolling. The wire and the strip reacted at the some condition. However, the reacting layer was very thin.

Keywords: Roll casting, Roll caster, Composite

1. INTRODUCTION

A twin roll caster can cast strip directly from melt. Therefore, the twin roll caster has several advantages. First of all, the twin roll caster is a very simple process. Also, the twin roll caster has the advantages of process saving and energy saving, and low equipment cost. However, there are few processes that utilize the twin roll caster. In this study, the twin roll caster was used to fabricate composite material. Using the twin roll caster, a large-sized (i.e., long) composite sheet material could be made continuously. This verifies the substantial process saving and energy saving that can be realized by the twin roll caster. It should be noted, however, that in the conventional twin roll caster for aluminium alloys, the insertion of wire between the two rolls is difficult. A downward melt-drag twin roll caster was used in the present study, because the wire can be inserted between the rolls [1]. As the first step of our current research on the casting of a wire-inserted composite strip using the twin roll caster, we investigated the effects of roll speed and wire diameter.

2. EXPERIMENTAL CONDITIONS

The experimental conditions are shown in Table 1. The diameter of the lower roll was smaller than that of the upper roll in order to set the coil of wire. Copper rolls were used in order to increase the cooling rate and the casting speed of the strip. The wire was set at the roll bite before casting, as shown in Fig.1. Because the wire was dragged with the strip, it did not need to be fed from the coil. To insert the wire in this process, the only special equipment required was the coil of wire. In this study, we did not coat or pre-heat the wire in order to improve the wetting between the wire and the melt. We used Al-12mass%Si, which is very easy to roll cast. The strip could be cast continuously at speeds from 10 m/min to 30 m/min.

Table 1.
Experimental conditions

roll	copper, diameter 300 mm, width 100 mm, no lubricant
roll speed	10, 20, 30 m/min
nozzle	width 30 mm, depth of channel 1.8 mm
strip (matrix)	Al-12mass%Si
melt temperature	650 ℃
wire (mild steel)	diameter 0.3, 0.6 mm

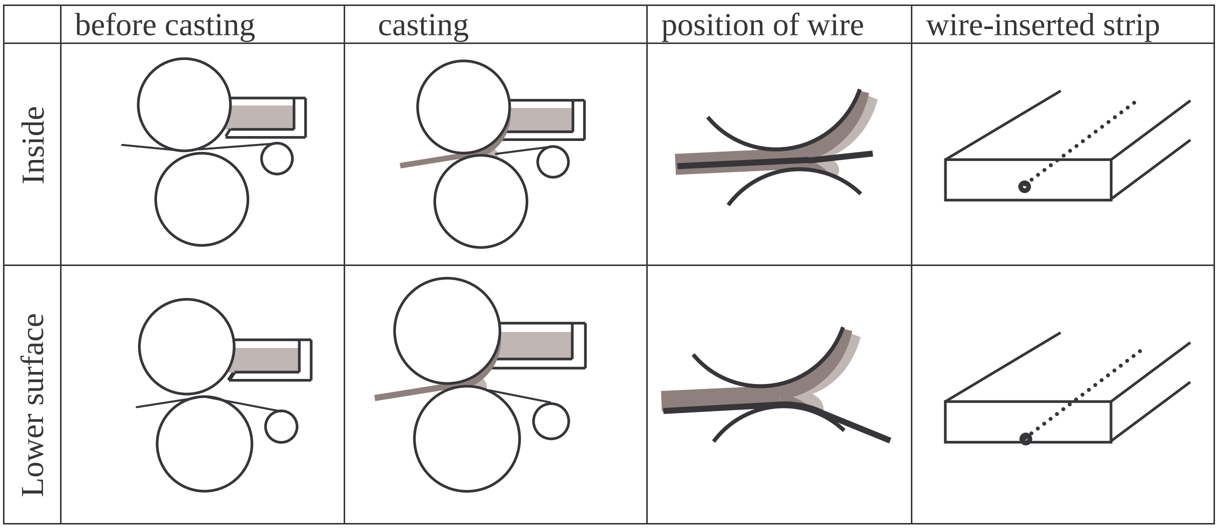


Figure.1 Schematic illustration of showing the position of the wire-coil and wire when the wire is inserted at lower surface of the strip

3. RESULT ANDDISCUSSIONS

The solidified strip could draw the wire into the roll bite without feeding equipment. The wire-inserted strip could be cast continuously, and there was no difference between the strip casting of melt only and the strip casting with the inserted wire. In other words, the insertion of the wire did not affect the casting. Cross-sections of the strip with the wire inserted inside are shown in Fig.2. Wires of 0.3-mm and 0.6-mm diameter could be inserted inside the strip. No void formed around the wire for conditions when the wire was 0.3 mm in diameter and the roll speed was slower than 20 m/min, or when the wire was 0.6 mm in diameter and the roll speed was slower than 10 m/min. There was a tendency toward more reliable casting of the wire-inserted composite strip when the wire was thin and the roll speed was slow. The explanation is as follows. The size of the puddle became smaller as the roll speed became faster. Therefore, the contact time between the melt and the wire became shorter. As a result, the wetting between the melt and the wire worsened, and the void formed. When the diameter of the wire was large, the temperature rose more slowly. As a result, the wetting between the melt and the wire worsened, and the void formed.

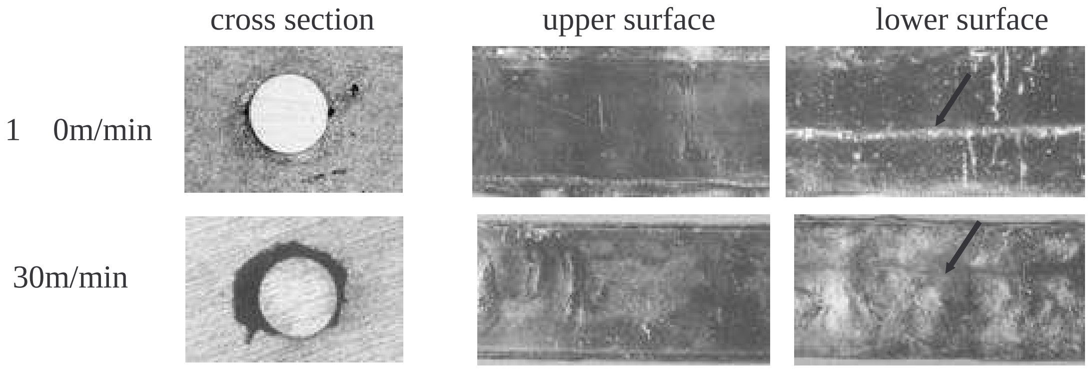


Figure 2. Cross section and surfaces of wire-inserted strips. The wire was inserted at inside of the strip. Diameter of wire wasφ0.6mm.

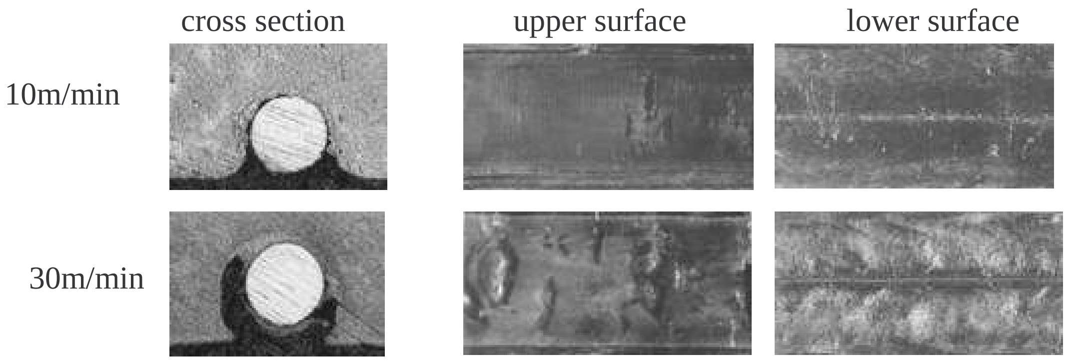


Figure 3. Cross section and surfaces of wire-inserted strips. The wire was inserted at lower surface of the strip. Diameter of wire isφ0.6mm.

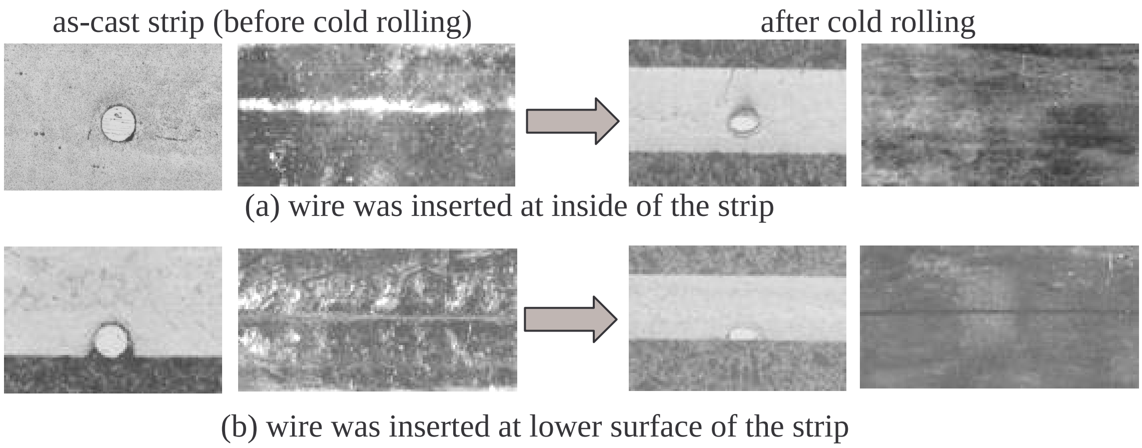
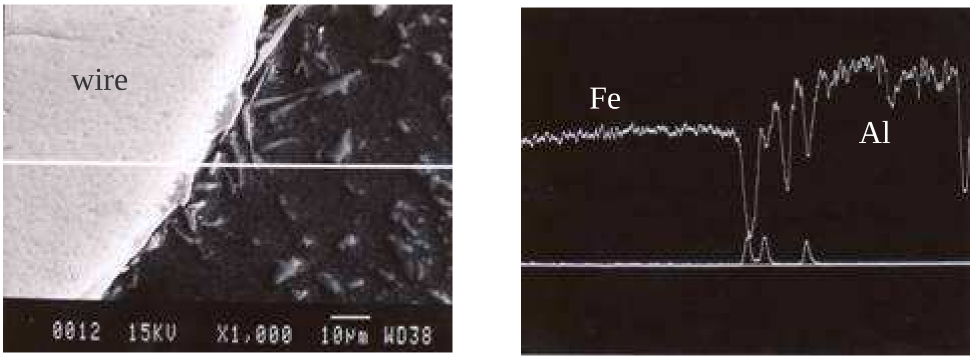


Figure 4. Cold rolling of wire-inserted strips. Cross sections and lower surfaces of the strips are shown. Diameter of wire isφ0.3mm.

The upper and lower surfaces of the strip are shown in Figure 2, too. In this figure, only one wire was inserted, and the wire was inserted inside. The insertion of the wire did not affect the upper surface. However, the insertion of the wire did affect the lower surface. The position of the wire was close to the position of the defect. Figure 3 shows cross-sections and surfaces of the strip with the 0.6-mm-diameter wire inserted at the lower surface of the strip. As in the case where the wire was inserted inside, there was a tendency to form a smaller void at a slower roll speed. The lower surface around the wire insertion did not show any significant effects from the insertion. Figure 4 shows the ability to roll the strip with the wire inserted. If the void did not exist around the wire before rolling, the void did not form after rolling. If the void existed before rolling, the void became smaller after rolling. The reduction of the wire diameter in the draft of the strip thickness was almost the same as the reduction of the strip. The surface and thickness distribution were improved by the rolling.

Figure 5 shows the result of a line analysis around the wire. There was a very thin reaction area around the wire. The aluminum alloy might solidify before reaction in the area between the melt and the wire.



(a) SEM image (b) line analysis

Figure 5. Line analysis of the wire-inserted strip at around the wire .

5. CONCLUSIONS

A composite strip could be cast with an inserted wire by using a downward melt-drag twin roll caster. The wire could be inserted both inside and at the surface of the strip. The insertion position of the wire was controlled by the position of the coil. The insertion of wire did not affect the casting of the strip. The effect of roll speed on the void around the wire was investigated. The void became larger as the roll speed became faster. The diameter of the wire also affected the void around the wire. The void became larger as the diameter of the wire became larger. This strip could be rolled, and the diameter of the wire was reduced by the same draft.

REFERENCES

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