

Development of Ground Coil Type of PLG for Maglev

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Abstract

Ground coils used in the superconducting maglev system are required to reduce their cost because of a huge number thereof. On the other hand, since they are used outdoors for a long period of time, they should also have high reliability. We are currently developing a ground coil for practical use of the system hauling the functions of Propulsion, Levitation and Guidance (PLG coil) to reduce the cost of construction.

Here, we report the following contents.

- The summary of the ground coil type of PLG and the other items of the system.
- An essence concerning the development of the ground coil of PLG, which we have promoted till now, and how we installed a ground coil of PLG on a guide way.
- As a result of our effects, we confirmed that we could lay a high voltage cable without any problems.

1 Types of the ground coil

The ground coil for Maglev was called Type of normal flux levitation, and laid on Miyazaki Maglev Test Track in the 1980s at first. With respect to this type of ground coil, coils which gave a vehicle levitation force were laid on the ground (levitation coil) and coils which gave a vehicle driving force were installed on the sidewall of the guide way (propulsion coil). (Figure 1.) As for the guidance of the vehicle, propulsion coils were connected with a null flux cable. Sidewall levitation was devised and adopted both on Miyazaki test line and on Yamanashi test line afterwards in the 1990s (Figure 2.). As for the guidance function, at first null flux cables were connected to propulsion coils in the same way as ever, afterwards the guidance function was ensured by connecting levitation coils mutually by null flux cables. In this way, two layers of two kinds of coils came to be installed on a sidewall. Because demanded functions are different, between propulsion coil and levitation coil, the structure and the specifications are also largely different between them. Type of PLG coil has been developed in order to integrate these two kinds of coils so as to function as one kind of coil.



Figure 1. Section of normal flux levitation
(Miyazaki test line)



Figure 2. Section of side wall levitation
(Miyazaki test line)

2 Summary of ground coil type of PLG⁽¹⁾

Type of PLG coil is the ground coil such that levitation force, propulsion force and guidance force can be generated by letting a promotion electric current flow into the side wall levitation coil and by connecting a couple of facing coils by a null flux cable at the same time. A basic constitution is shown in Figure.3. Because propulsion, levitation, and guidance can be functionalized with the same ground coil, it is called the combined Propulsion, Levitation and Guidance ground coil (PLG coil). A large cost reduction can be anticipated by the reduction of the coil amount by realizing three functions with one coil (Figure 4). The appearance of the ground coil is shown in Figure 5.

However, type of PLG coil has a lot the point that should be settled. These for example, high voltage is applied because all connection cables including the null flux line are connected to a power supply for drive, and the ground coils to which high voltage is applied are installed on the ground and exposed to sun light and outdoor environment on a guide way.

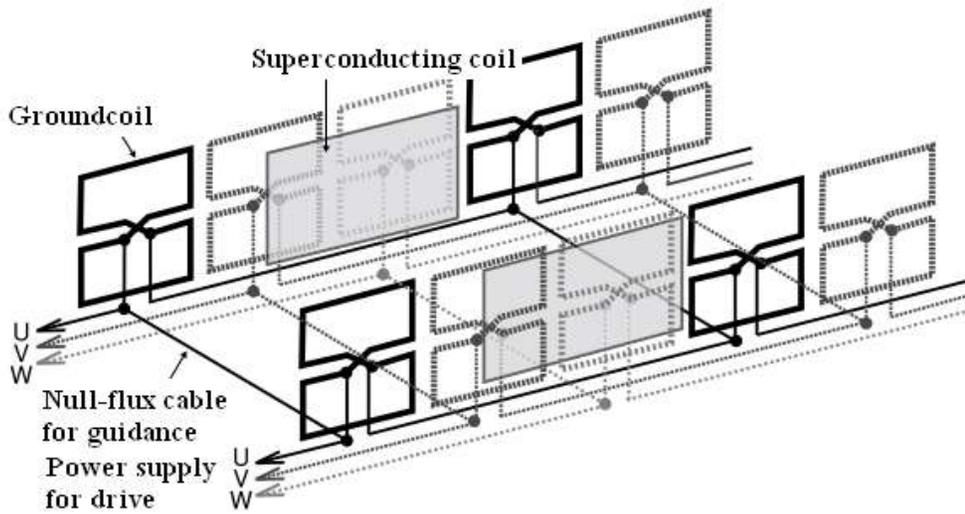


Figure 3. Outline of ground coil type of PLG

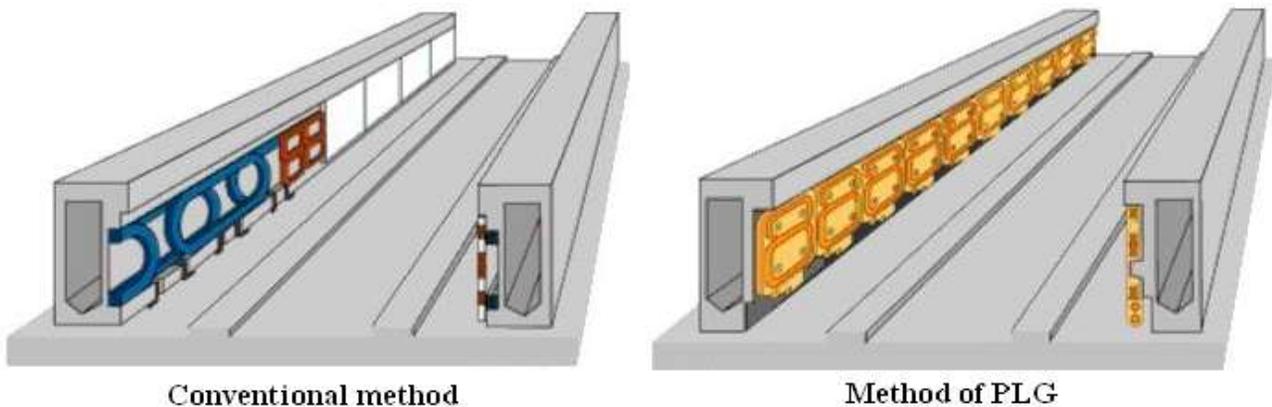


Figure 4. Comparison of the guide way constitution



Figure 5. Photo of ground coil type of PLG

3 Development and inspection of ground coil type of PLG

Here, we introduce the essence of the development and the inspection which were exerted in late years.

3.1 Development of the protective layer and Impact test⁽²⁾

In the case of the conventional ground coil, levitation and guidance coils are installed on the running surface of the roadbed and has the structure not to be affected directly from external shocks(Figure 4. The right side) however, because the surface of the type of PLG coils are exposed to sunlight and outdoor environment, the coils have been examined with respect to the measures for external shocks. (Figure 4. The left side) As a result,

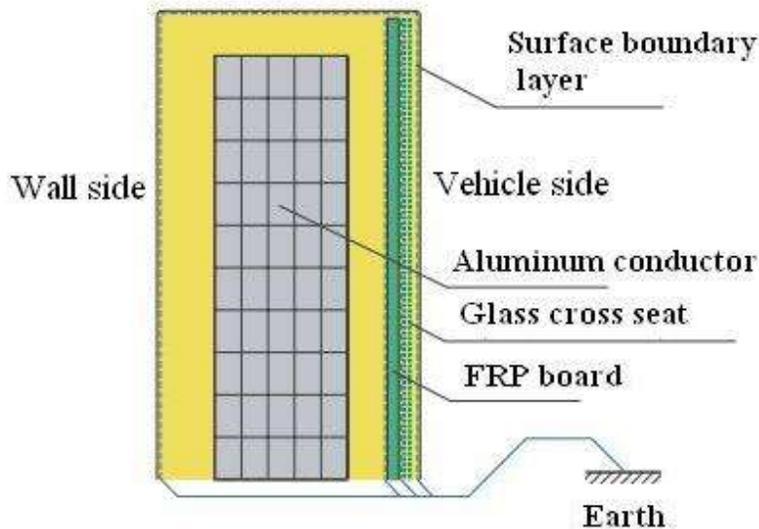


Figure 6. Cross section of the protection layer (PLG coil)

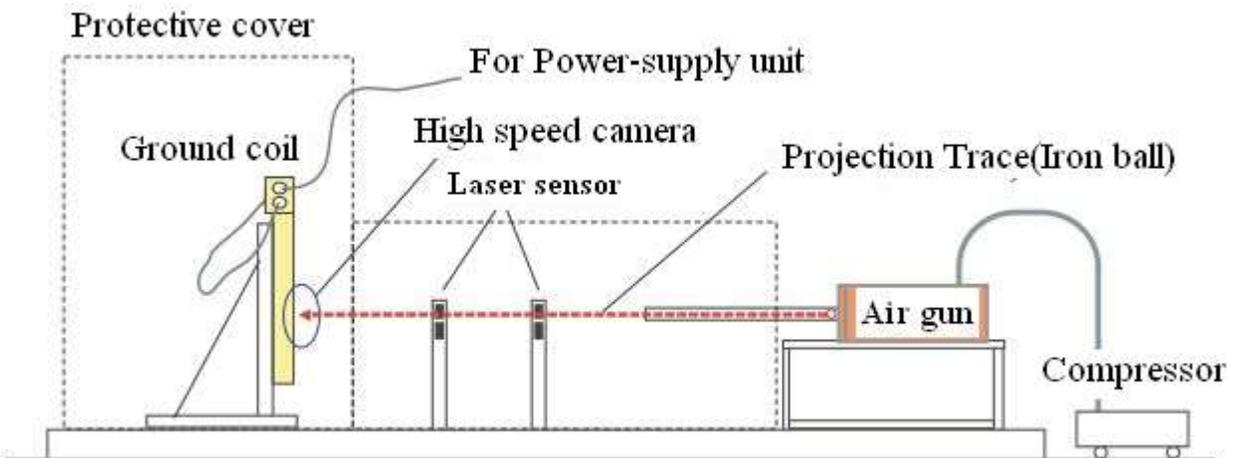


Figure 7. Configuration of the impact test device

we produced a coil that has the structure to absorb a shock with an FRP board which was molded together with glass cross seat by epoxy resin at the time of coil molding, and was used as the surface protection of coil type of PLG. We show its constitution in Figure.6. To this ground coil, we shot an iron ball by compressed air with the launching machine (Figure 7.) called the air gun, and examined the destruction

situation. As a result, it has been confirmed that in comparison with the ground coil without the protective layer, the ground coil with the protective layer has approximately twice times layer shock strength, the smaller area of the crack outbreak, the shorter crack length (Figure 8.), and the shallower destruction depth of the mold resin. Therefore, we confirmed the superiority of applying a protective layer.

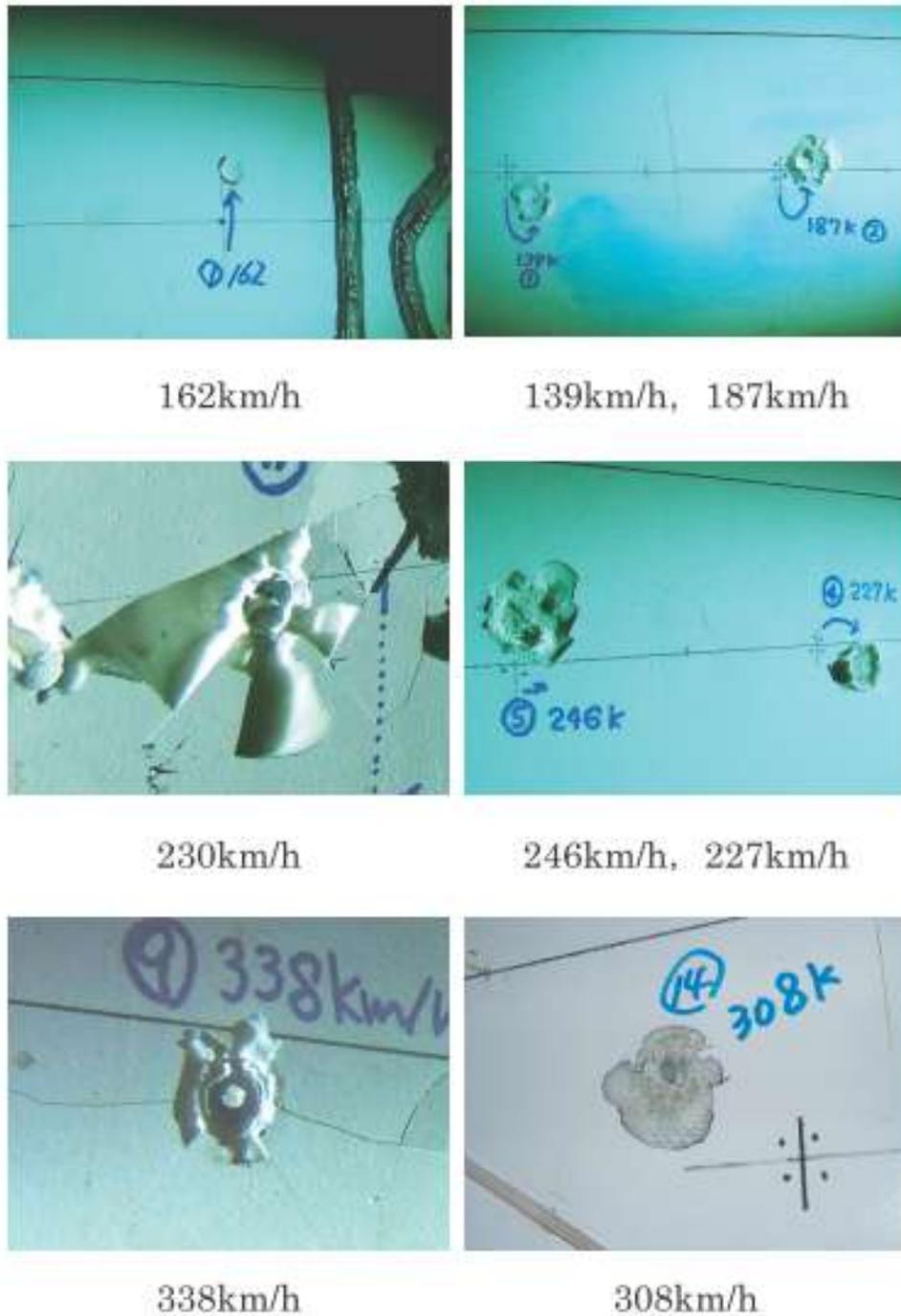


Figure 8. The destruction situation of the ground coil surface

3.2 Inspection of easiness of construction

Compared to the conventional methods, the null flux cable of the ground coil type of PLG has high electric voltage, according by the diameter of the cable and the bend radius of the cable becomes lager. Therefore, the easiness of construction of this type of coil must be carefully examined. Then we constructed the model guide way of the actual size (Figure 9.and Figure 10), and performed inspection of construction easiness including laying and the connection cable construction and confirmed its construction characteristics and easiness.

As a result, it has been confirmed that by increasing the diameter of the null flux duct line, and devising an opening shape like the one shown in Figure 11, we can execute construction of the ground coil type of PLG in the same way as the conventional ground coil. In particular, it has been confirmed that the cap which protects a connector part, the wire cable for drawing out and the null flux duct line of which diameter is increased as shown in Figure 12 contribute to easiness of construction effectively.



Figure 9. Guide way model (Undertaking construction)



Figure 10. Guide way model (Completion)

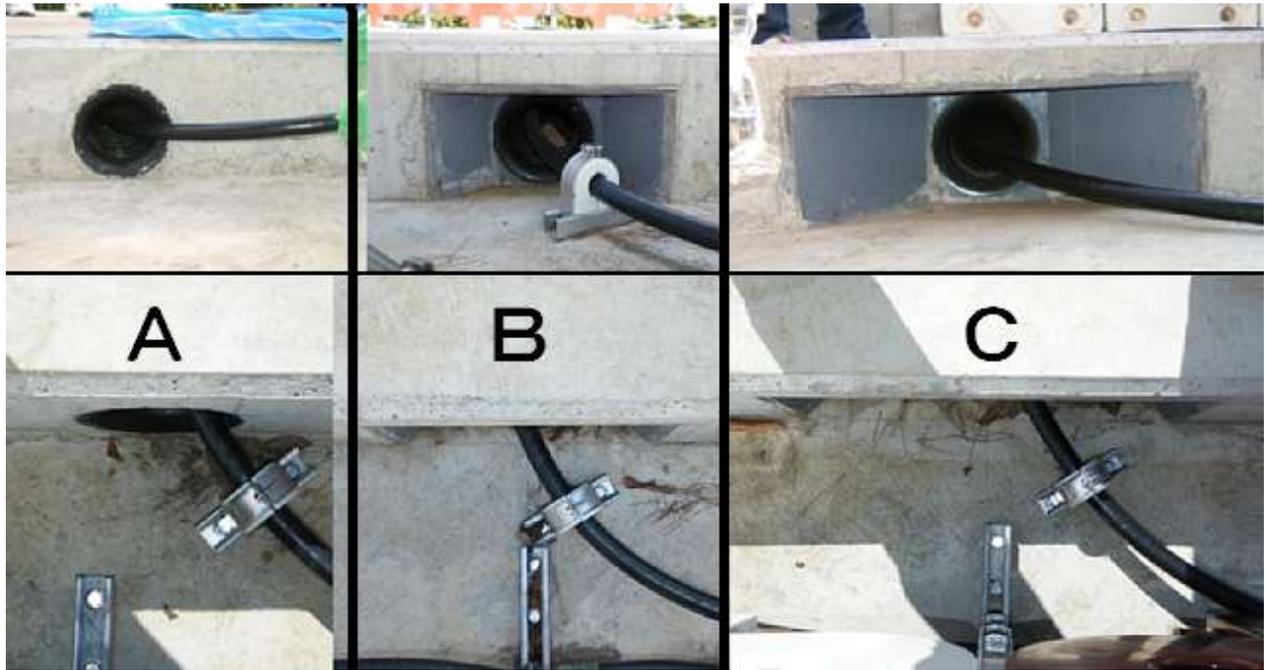


Figure 11. Null flux opening shape



Figure 12. Terminal part protective cover and the use situation

4 Conclusion

We have promoted the development of the ground coil type of PLG in order to reduce cost by the coil amount reduction until now. We show below the result obtained by the impact test.

(1) It has been recognized that a form of the destruction is different depending on the condition whether or not, these exists protection layer, it has been also recognized that the coil with the protective layer is superior to the one without it.

(2) We have confirmed that shock strength of the coil with the protective layer is almost twice larger than that of the coil without the protective layer.

We show below a result provided by inspection of easiness of construction.

(1) In the case of the guide way structure of the beam type that simulates the actual construction, it has been confirmed that, the laying of the connection cable is possible without having a big structure change.

- (2) Regarding a null flux duct line, it has been confirmed that we can have enough construction easiness and can ensure the sufficient bend radius of the cable by using a duct slightly bigger than the conventional one, and by devising a suitable opening shape.
- (3) We have confirmed that the protection metal fittings cover which serves as protection and drawing out of connection part contributes effectively to the easiness of cable laying.
- (4) By these inspections, we have confirmed that when the ground coil type of PLG, is adopted, its construction easiness can be ensued.

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