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APPLICATION OF JACKET PACK ANCHOR (JP ANCHOR)

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ABSTRACT

Jacket Pack Anchor(JP Anchor) is applied the irregular layer that general ground anchor is difficult to be applied such as soft layer(SPT-N values of less than 20) or gravel layer that grout lost. It makes sure of the pullout resistance required in these layers by the certain grout bulb formation and expansion effect. Thereby, Jacket Pack Anchor that is a new concept makes possible the construction improving and the cost saving in the excavation site.

From the field test results, it was observed that the pullout resistance of Jacket Pack Anchor was about 84% greater than that of general ground anchor, and plastic deformation of Jacket Pack Anchor compared to that of general ground anchor was about 35% at the same load cycle. Especially, it was showed that the increase of resistance over 200% and plastic deformation was about 17% in gravel layer.

This method has been applied mainly in the soft reclaimed soil and marine deposit areas of Incheon and Pusan etc. or in the loose layer of urban waste landfill. From the result of these cases, its usefulness has been proved because of ground displacement and building damage with little during the excavation work.

Therefore, we propose strongly to try Jacket Pack Anchor in the past difficult layer from this paper. Also, we are hoping to take the full advantage of ground anchor that is secure enough workspace to minimize disturbance of excavation or underground structure can improve work efficiency, using Jacket Pack Anchor in the excavation site.

INTRODUCTION

Jacket Pack Anchor(JP Anchor) is produced by wrapping Geosynthetics that has the flexibility to withstand the pressure of more than 1kg/cm^2 at the fixed anchor length. It was developed to prevent the injection grout loss and to increase the pullout resistance of General Ground Anchor.

Therefore, Jacket Pack Anchor is applied the irregular layer that general ground anchor is difficult to be applied such as soft layer(SPT-N values of less than 20) or gravel layer that grout lost. It makes sure of the pullout resistance required in these layers by the certain grout bulb formation and expansion effect.

Thereby, Jacket Pack Anchor that is a new concept makes possible the construction improving and the cost saving in the excavation site. This method has been applied mainly in the soft reclaimed soil and marine deposit areas of Incheon and Pusan etc. or in the loose layer of urban waste landfill. From the result of these cases, its usefulness has been proved because of ground displacement and building damage with little during the excavation work.

So, we propose strongly to try Jacket Pack Anchor in the past difficult layer from this paper. Also, we are hoping to take the full advantage of ground anchor that is secure enough workspace to minimize disturbance of excavation or underground structure can improve work efficiency, using Jacket Pack Anchor in the excavation site.

CHARACTERISTICS OF JACKET PACK ANCHOR

Formation of Jacket Pack Anchor

Grout milk is injected into the jacket pack to make the certain grout bulb of Jacket Pack Anchor. The formation of the certain grout bulb of Jacket Pack Anchor increases the diameter of grout bulb, ground strength and confining pressure between anchor grout and soil. Formation of Jacket Pack Anchor is as shown in *fig.1*.

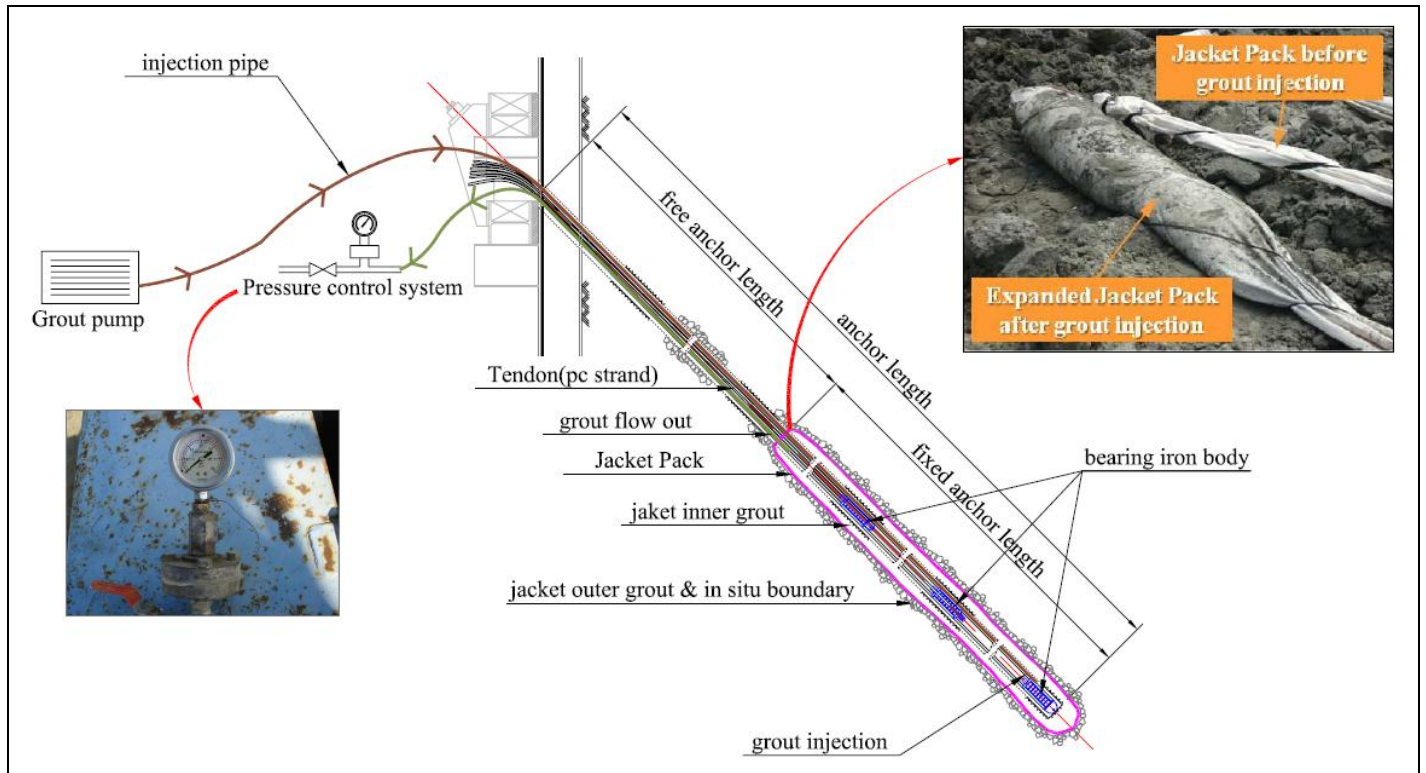


Fig. 1. Formation of Jacket Pack Anchor

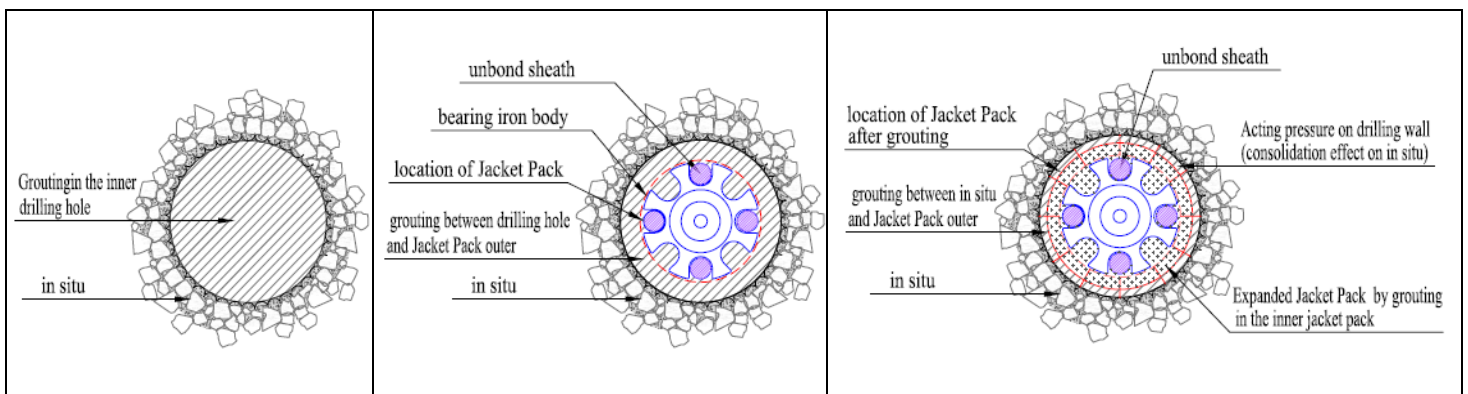
Jacket Pack Anchor is produced by wrapping Geosynthetics that has the flexibility to withstand the pressure of more than $1\text{kg}/\text{cm}^2$ at the fixed anchor length. It was developed to prevent the injection grout loss and to increase the pullout resistance of General Ground Anchor

Pullout resistance Mechanism of Jacket Pack Anchor

As shown in fig.2, Jacket Pack Anchor supports the load acting on the anchor using friction between anchor grout and in situ ground which is received the expansion effect by grout injection. To construct Jacket Pack Anchor is as shown in

Fig.2. (a) and (b), at first, drilled until location of anchor setting, and then, inserted Jacket Pack Anchor after primary pressurized grout injection. Next, as shown in Fig.2. (c), expanded the jacket pack and in situ ground by secondary pressurized grout injection inside the jacket pack.

These expansion effect of jacket pack brings increasing strength by the consolidation of the surrounding soft soil from pressuring on the outside grout and in situ ground at right angles. This strength increase is also able to increase the frictional force between anchor grout and in situ ground and the pullout resistance of Jacket Pack Anchor.



(a)Grouting after drilling

(b)Jacket Pack Anchor insertion

(c)Grouting in the inner Jacket Pack

Fig. 2. Mechanism of Pullout resistance of Jacket Pack Anchor

In addition, Jacket Pack Anchor can be minimized the grout loss in the soil with large voids because grout becomes the closure into jacket pack. For these reasons, Jacket Pack Anchor compared to General Ground Anchor is possible to

cost saving, construction period shortening, workability improving and ground movement minimizing. As shown in Fig.3, we could see this fact from the digged anchor body after Jacket Pack Anchor constructed



Shape (1)

Shape (2)

Fig. 3. Photo of fixed anchor body of Jacket Pack Anchor

Comparison between Jacket Pack Anchor and General Ground Anchor

Comparison between Jacket Pack Anchor and General Ground Anchor is as shown in Table.1.

Table 1. Comparison between Jacket Pack Anchor and General Ground Anchor

Items	General Ground Anchor (GGA)	Jacket Pack Anchor (JPA)	Remarks
main formation	Tendon + Grout	Tendon + Grout + Jacket Pack	
setting layer	<ul style="list-style-type: none"> ·Good soil layers such as sand($N \geq 20$) and clay($N \geq 7$ or $qu \geq 200\text{kN/m}^2$) ·As grout is lost, the certain bulb formation is difficult in the boulder or gravel layers with large voids ·When Grouting in the soft silty clay layer, tension crack will occur. So, it is difficult to establish due to lack of friction. 	<ul style="list-style-type: none"> Reliable setting is not only good soil layers, but also special soil layers as follows, because the loss of the grout is not larger and tension crack does not occur. In addition to its durability is increased. ·soft layers (reclaimed soil, marine deposit areas) ·sand & gravel layer with large voids ·boulder layer or fractured rock ·confined aquifer ·waste landfill 	
pullout resistance	·100%	<ul style="list-style-type: none"> ·average 184% ·gravel layer 200% 	-Results of the field test in Incheon areas (2008)
plastic deformation	·100%	<ul style="list-style-type: none"> ·average 35% ·gravel layer 17% 	-Results of the field test in Incheon areas (2008)

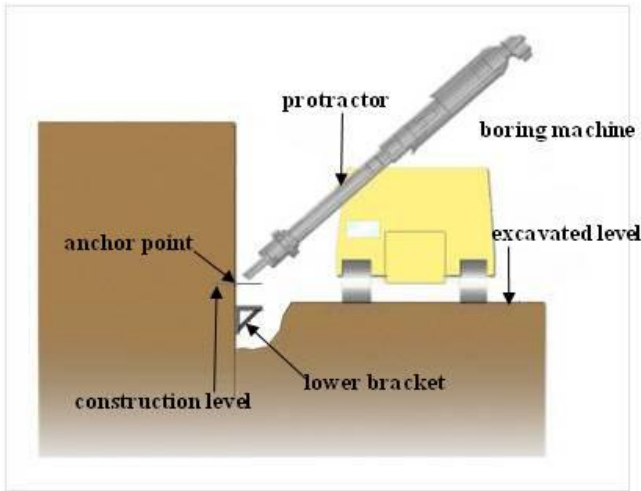
APPLICATION OF JACKET PACK ANCHOR

Construction sequence of Jacket Pack Anchor

Construction sequence of Jacket Pack Anchor is as follows and as shown in fig.4.

1) drilling

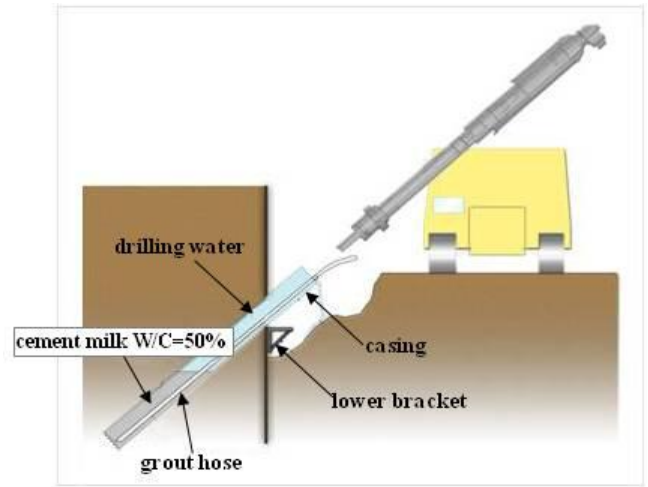
: Washer drilling carried out by all casing method.
Check the fixed layer by slime to match with boring log



- 1) drilling
- 2) Casing washing & Grouting performance
- 3) Jacket Pack Tendon insertion
- 4) Pullout of Casing fixed part
- 5) Grouting at Inner of Jacket Pack Tendon
- 6) Pressurized grout injection performance
- 7) Casing pullout
- 8) Prestressing and Setting

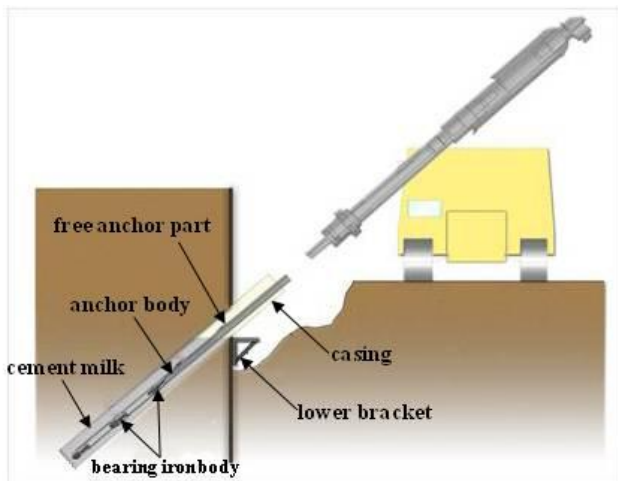
2) Casing washing & Grouting performance

: Grouting until cement milk flow out over casing



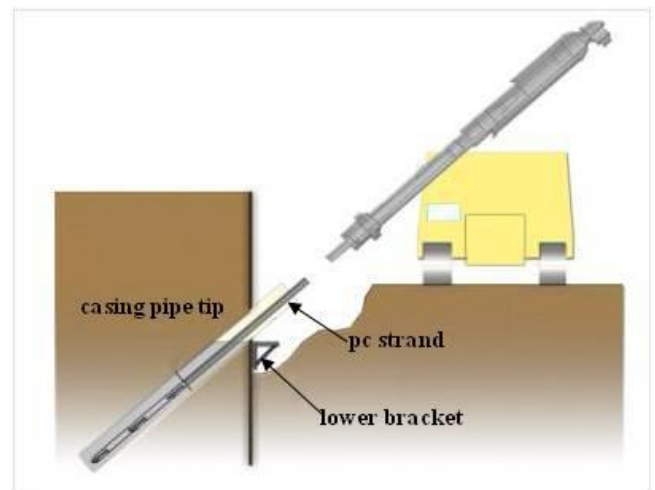
3) Jacket Pack Tendon insertion

: Insertion Tendon wrapping bearing iron body with Jacket Pack after grouting

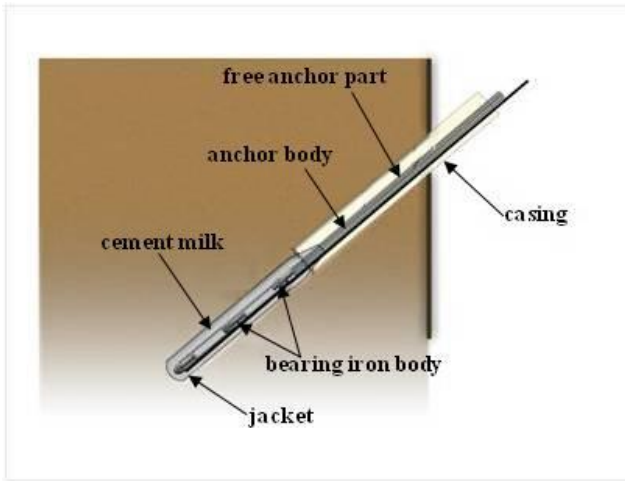


4) Pullout of Casing fixed part

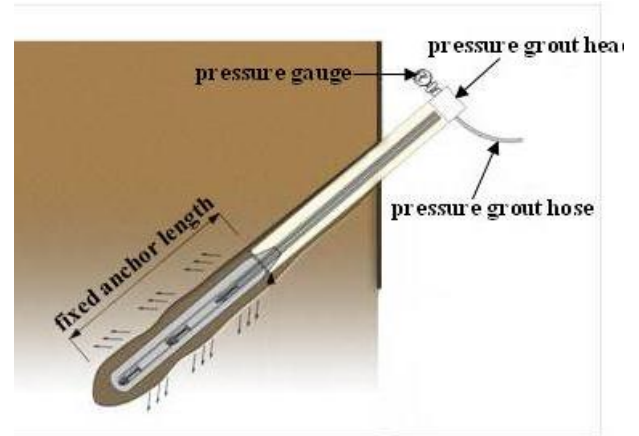
: Pullout Casing fixed part after Tendon insertion



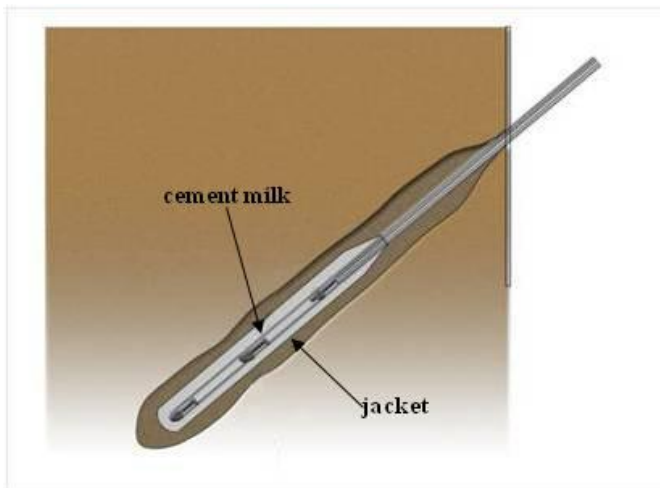
5) Grouting performance of Inner Jacket Pack Tendon
: Increasing pullout resistance by inner grouting and primary pressurized grout injection in fixed anchor part



6) Pressurized grout injection performance
: Pressurized grout injection carried out in fixed anchor part



7) Casing pullout
: Grouting until over flow after pullout the free anchor part of casing



8) Prestressing and Setting
: Setting with hydraulic pressure after check the design load of bearing iron body and cure the anchor body

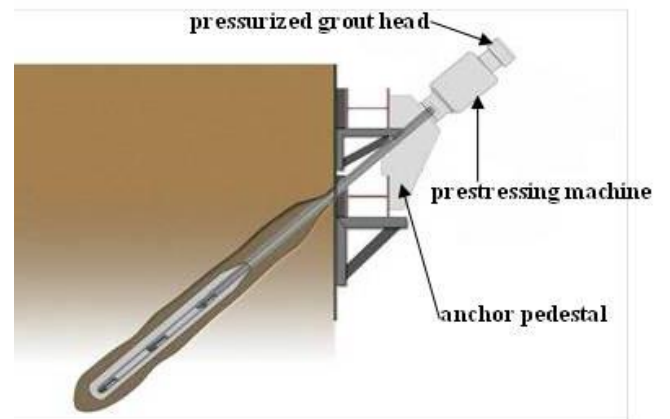


Fig. 4. Construction sequence of Jacket Pack Anchor

Applicability of Jacket Pack Anchor

Applicability of Jacket Pack Anchor is as shown in Table.2.

Table. 2. Applicability of Jacket Pack Anchor

Year	Location	Description	Ground water level	Setting layer	Applicability
2011	Pangyo	·Depth of excavation 6.1 ~ 6.9m ·H-Pile+timber+JPA(c.t.c 1.8m) 1 ~ 2 level (※JPA=Jacket Pack Anchor)	GL-9.0~ -12.0m	clayey, sandy, gravel layers (Landfill)	As landfill areas with large voids are formed, grout leakage is severe. So, change from GGA to JPA.
2010	Inchon	·Area of excavation 12,244m ² ·Depth of excavation 11.9m (Basement 2) ·H-Pile+SCW(2rows)+JPA (c.t.c 0.9m) 4 ~ 5 level (※SCW=Soil Cement Wall)	GL-3.2 ~ -7.6m	clayey silt (N=1 ~ 13)	In the soft reclaimed soil and marine deposit areas, change from Strut support structure to JPA.
2010	Inchon	·Area of excavation 26,172m ² ·Depth of excavation 9.7m (Basement 2) ·H-Pile+SCW+JPA (c.t.c 1.8 ~ 2.7m) 3 ~ 5 level	GL-7.3m	sandy silt (N=5 ~ 12)	In the soft deposit areas, construction is applied to JPA safely.
2010	Inchon	·Area of excavation 26,770m ² ·Depth of excavation 9.7m (Basement 2) ·H-Pile+SCW+JPA (c.t.c 0.9 ~ 1.8m) 3 ~ 5 level	GL-3.3m	sandy silt (N=8 ~ 13)	In the soft deposit areas, construction is applied to JPA safely.
2008	Pusan	·Area of excavation 39,037m ² ·Depth of excavation 22.6m (Basement 5) ·D-Wall+JPA(c.t.c 1.5m) 9 level (※D-Wall=Diaphragm-Wall)	GL-4.2m	boulder layer (marine deposit areas)	In the boulder layer, change from Jet grouting ground improvement anchor which was failed to secure the required pullout resistance to JPA.
2008	Seoul	·Area of excavation 36,732m ² ·Depth of excavation 9.3m (Basement 2) ·H-Pile+SCW+JPA 2 level +GGA 1 level (※GGA=General Ground Anchor)	GL-5.6m	silty sand (N=6 ~ 21)	In the soft layer adjacent to the old housing of downtown, change from Raker support structure to JPA. So, prevent resident complaints.
2007	Inchon	·Area of excavation 19,961m ² ·Depth of excavation 7.3m (Basement 2) ·H-Pile+SCW+JPA(c.t.c 2.7m) 1 ~ 4 level	GL-5.8m	sandy silt (N=8 ~ 11)	In the soft reclaimed soil and marine deposit areas, change from Strut support structure to JPA.
2007	Inchon	·Area of excavation 35,584m ² ·Depth of excavation 12.0m (Basement 2) ·H-Pile+SCW+JPA(c.t.c 2.7m) 4 ~ 5 level	GL-4.5 ~ -4.8m	clayey silt (N=0 ~ 9)	In the soft deposit areas, construction is applied to JPA safely.

2007	Pusan	·Area of excavation 28,145m ² ·Depth of excavation 23.0m (Basement 5) ·D-Wall+JPA 2 level +GGA 4 ~ 6 level	GL-0.9 ~-10.3m	silty sand (N=6 ~ 49)	In the same place, JPA and GGA are applied to the soft upper layer and the stiff lower layer, respectively. So, construction workability and period are improved.
2006	Inchon	·Area of excavation 94,290m ² ·Depth of excavation 11.7m (Basement 2) ·H-Pile+SCW+JPA(c.t.c 2.7m) 3 level+GGA 1 level	GL-3.2m	sandy silt (N=4 ~ 23)	In the soft layer, change from Jet grouting ground improvement anchor to JPA for cost saving and period shortening.
2005	Pusan	·Area of excavation 13,960m ² ·Depth of excavation 22.0m (Basement 5) ·D-Wall+JPA(c.t.c 1.8m) 3 level +GGA 3 ~ 4 level	GL-1.5 ~-3.4m	clayey gravel layer	In the compound layers with clayey gravel, JPA is securely applied.
2004	Seoul	·Area of excavation 6,069m ² ·Depth of excavation 9.2m (Basement 2) ·H-Pile+SCW+JPA 3 level	GL-12.6m	waste landfill (N=4 ~ 7)	In the waste landfill adjacent to the housing of downtown, change from Strut support structure to JPA. So, construction workability and period are improved without resident complaints.
2003	Pusan	·Area of excavation 13,070m ² ·Depth of excavation 17.5m (Basement 3) ·D-Wall+JPA(c.t.c1 ~ 2m) 4 level	GL-1.8 ~-2.1m	boulder layer (marine deposit areas)	In the most landfill with boulder layer, JPA is securely applied.
2003	Seoul	·Area of excavation 1,650m ² ·Depth of excavation 9.0m (Basement 2) ·H-Pile+lagging+JPA 3 level	GL-10.0m	fractured rock	In the fractured rock areas adjacent to Han River, construction is applied to JPA safely.

CONCLUSIONS

We could know the following facts through the development process and field application of Jacket Pack Anchor (JP Anchor).

- 1) Jacket Pack Anchor can be installed in the difficult soil layers where General Ground Anchor can not be installed. Thereby, in the excavation site, this method is able to cost saving, construction period shortening and workability improving.
- 2) From the field test results, it was observed that the pullout resistance of Jacket Pack Anchor was about 84% greater than that of General Ground Anchor, and plastic deformation of Jacket Pack Anchor compared to that of General Ground Anchor was about 35% at the same load cycle. Especially, it was showed that the increase of resistance over 200% and plastic deformation was about 17% in gravel layer.

- 3) This method has been applied mainly in the soft reclaimed soil and marine deposit areas of Inchon and Pusan etc. or in the loose layer of urban waste landfill in south korea almost ten years from 2003. From the result of these cases, its usefulness has been proved because of ground displacement and building damage with little during the excavation work.
- 4) Therefore, in the excavation site, we propose strongly to try Jacket Pack Anchor in the past difficult layers in order to take the full advantage of ground anchor that is secure enough workspace to minimize disturbance of excavation or underground structure can improve work efficiency.

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