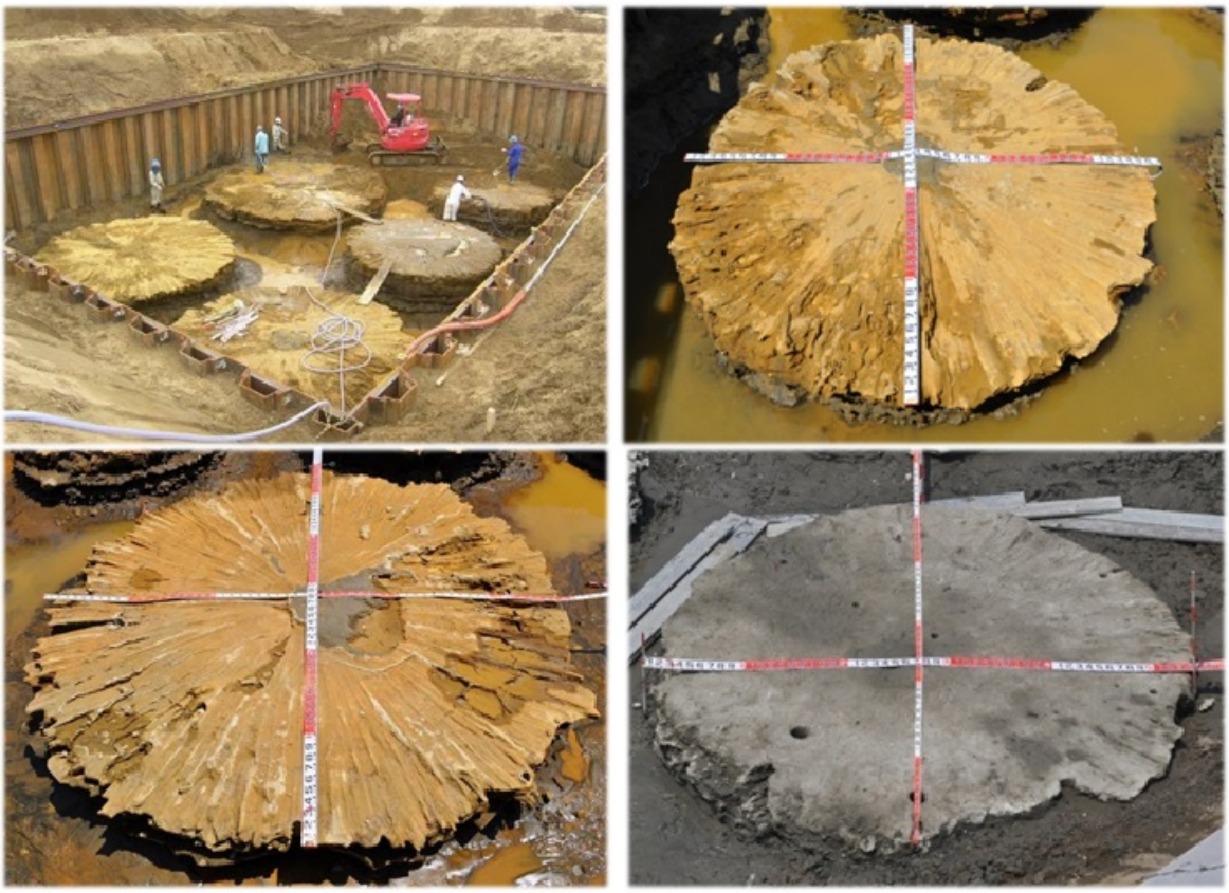
SANSHIN CORPORATION

V-JET Technology - Innovative Jet Grouting

Efficient Installation of Large Diameter Jet Grout Column



Hazard

Earthquake Tsunami Land Slide Storm Surge Flood

Solution Purpose

Prevention & Mitigation Recovery

Solution Theme

Infrastructure Technology Building Technology

Technology Subject

River & Basin Dam & Reservoir Coast Sabo Road Railways Airport Port Essential Utilities Urban Resilience Improvement on Existing Building

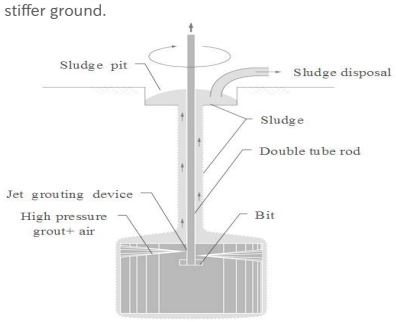
Advantages

Innovative Injection device demonstrates a state-of-the-art jet grout technology. V-JET technology provides large column up to 5.5m in diameter at drastically fast installation rate. Reliable quality of V-JET technology improves the existing ground under facilities of river dykes, sea coasts, ports & harvors and airports and mitigates liquefaction potential.

Solution Illustrated

Jet Grout Technology is commonly applied to mitigate soft ground worldwide. V-JET categorized in this field installs large diameter soil-cement column at fast rate, utilizing erosion by high-pressured binder fluid with compressed air.

The injection device called to the Monitor is specialized double nozzles on opposite side of the monitor. The monitor assists to drastic erosion and mixing resulting to larger column diameter and faster installation than other technology even in harder and stiffer ground.



V-JET system has several option in column diameter and gives the best solution in ground treatment to the project requirement.

Type	Grout flow rate	Machinery	Diameter
V1	180 L/min	Small	2.0m, 2.5m
V2	360 L/min	Middle	3.5m, 4.0m
V3	540 L/min	Large	5.0m, 5.5m

Type	V1		V2		V3	
Grout Pressure (MPa)	35		35		35	
Grout Flow Rate (L/min)	180		360		540	
Effective Column Diameter (m) per Soil Property						
Sandy soil N≦50 Clayey soil N≦3	2.0	2.5	3.5	4.0	5.0	5.5
Sandy soil 50＜N≦100 Clayey soil 3＜N≦5	1.8	2.3	3.2	3.6	4.5	5.0
Sandy soil 100＜N≦150 Clayey soil 5<N≦7	1.6	2.0	2.8	3.2	4.0	4.4
Lift Rate (min/m)	7	11	10	14	14	18

Column Strength	Soil Type	Unconfined Compressive Strength qu (MN/m²)	Shear Strength c (MN/m²)	Elastic Modulus E (MN/m²)	Adhesive Strength f (MN/m²)
Ordinary strength	Sandy soil	3.0	0.5	300	1/3c
	Clayey soil	1.0	0.3	100	
Middle strength	Sandy soil	2.0	0.4	200	
Low strength	Sandy soil	1.0	0.2	100	

Background

Upgrade of existing revetment along river needs to renovation of the revetments or to mitigate foundation performance.

For example, wider revetment or additional foundation pile installation will come as countermeasures. However, such options do not meet requirements in urban area.

Furthermore, soft and loose ground under revetment will cause serious liquefaction and failure during

and after earthquake.
Such soft and loose ground shall be removed and replaced to stable soil after demolishing of existing revetments and dykes.

Exposition of the Solution

VJET technologies install injection monitor with small diameter drilling. Existing revetment and other structures will allow small drilling with small rig. Large diameter jet grout column of VJET compensates essential performance of the existing foundation piles and mitigate the ground against to failure during and after earthquake. Excellent injection performance guarantees reliable quality of column even in decomposed rock ground, where conventional jet grout never cover required specification.
In case of liquefaction countermeasure, lattice alignment of soil cement column is commonly designed in order to save cost of soil cement column. VJET technology clearly contributes to establish the lattice alignment due to large diameter column and reliable performance of column wall based on column stiffness and cut-off property.

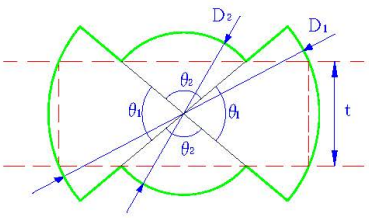
What is Multi Fan Technology?

Multi Fan Technology is an innovative jet grout technique characterized by combination of fan shape columns. The special device for column installation realizes the combined jet grout column consisting of smaller and larger diameter.

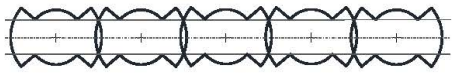
The special shape of Multi Fan Technology provide the best application in lattice alignment and wall alignment of soil improvement because the technology drastically reduces waste material and project cost.

Multi Fan Technology has been developed on V-JET knowhow and utilizes high reliability and many job experiences on V-JET. Specialties in injection mechanics and control devices provide the unique shaped column.

Excavated Multi Fan column



Basic Dimension of Multi Fan column



Wall Alignment using Multi Fan columns

Wall Alignment using conventional jet gout columns

Recently V-JET technology has developed Multi Fan technology having unique shape column, which combines smaller and larger diameter fans. Multi Fan contributes to reduction of wastes and cost in particular alignment like to wall and lattice alignment.

Achievements of Examples

Application of Lattice Alignment against to Liquefaction

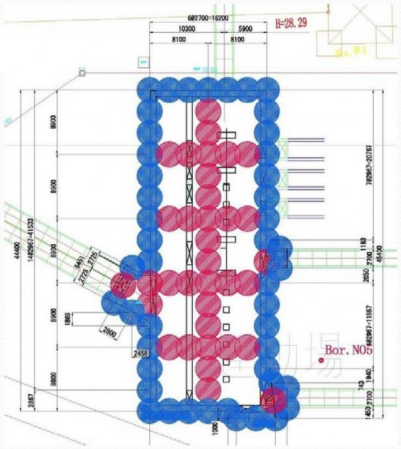
Job reference

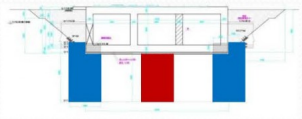
Seismic reinforcement

Summary of the construction

	Quantity / Specification
Soil	Sandy Soil SPT-N≦40
Column Diameter	φ3,500mm
Column No	82
Installation	501.06m

Ground plan





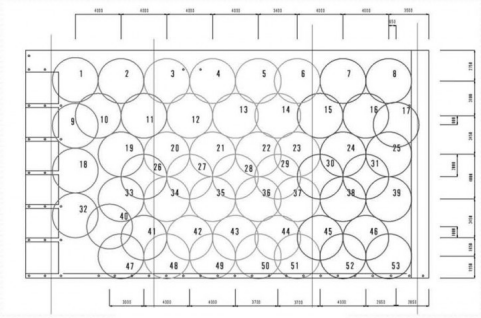
Application for Mitigation of Ground Stiffness to Earthquake

Job reference

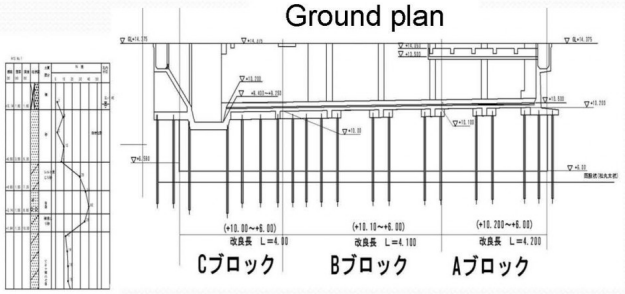
Seismic reinforcement

Summary of the construction

Soil	Sand(N≦10)
Diameter	VE2 φ4,000mm
Number	53
Extension of columns	213.1m



Ground plan



Cross section

Application to Decomposed Granite in Hong Kong

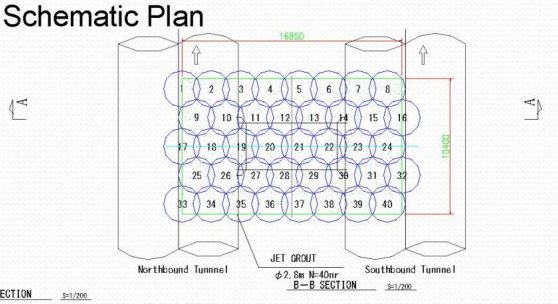
Job reference

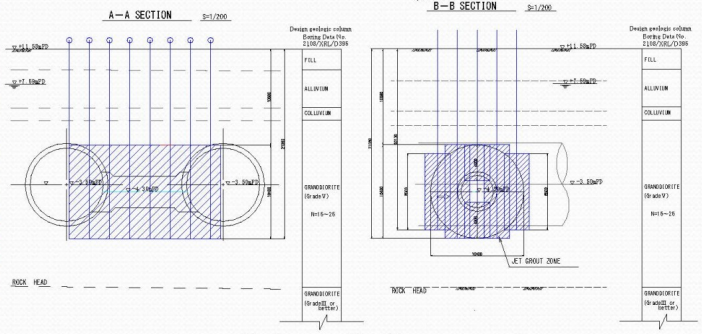
TBM Work (Cross Passage Adit), Hong Kong

Summary of the construction

Soil	Decomposed Rock (N<30)
Diameter	V2 φ2,800mm
Number	40
Column Length	385.6m

Schematic Plan





Schematic Cross section

Application to Soft Ground in Taiwan

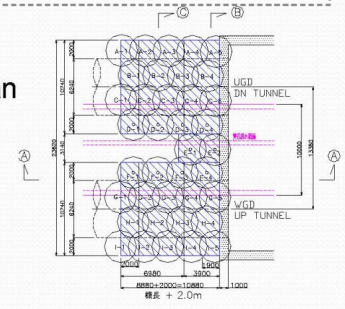
Job reference

TBM Work (Recovering), Taipei

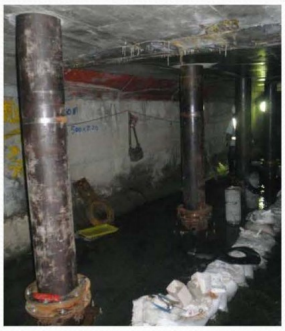
Summary of the construction

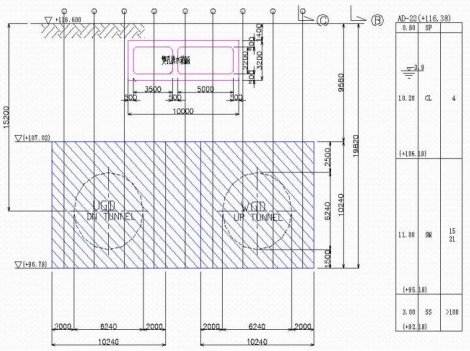
Soil	Sand (N<25) and Clay (N<3)
Diameter	V2 φ3,500mm
Number	38
Extension of columns	389m

Schematic Plan



Schematic Cross section





Other References

Technical Materials
JET GROUT Technical Document;Japan Jet Grout Association (Japanese Edition)
V-JET Technical and Costing Document;V-JET Association (Japanese Edition)T

Papers

H. J. Liao et al., 2013, Performance of V-Jet method for arrival of shield tunneling machine
/_upload/member/105/files/Geotec_Hanoi-2013_2-06_V-Jet.pdf
T. Shinsaka and J. Yamazaki, 2013, Development of high-speed type jet grouting method
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