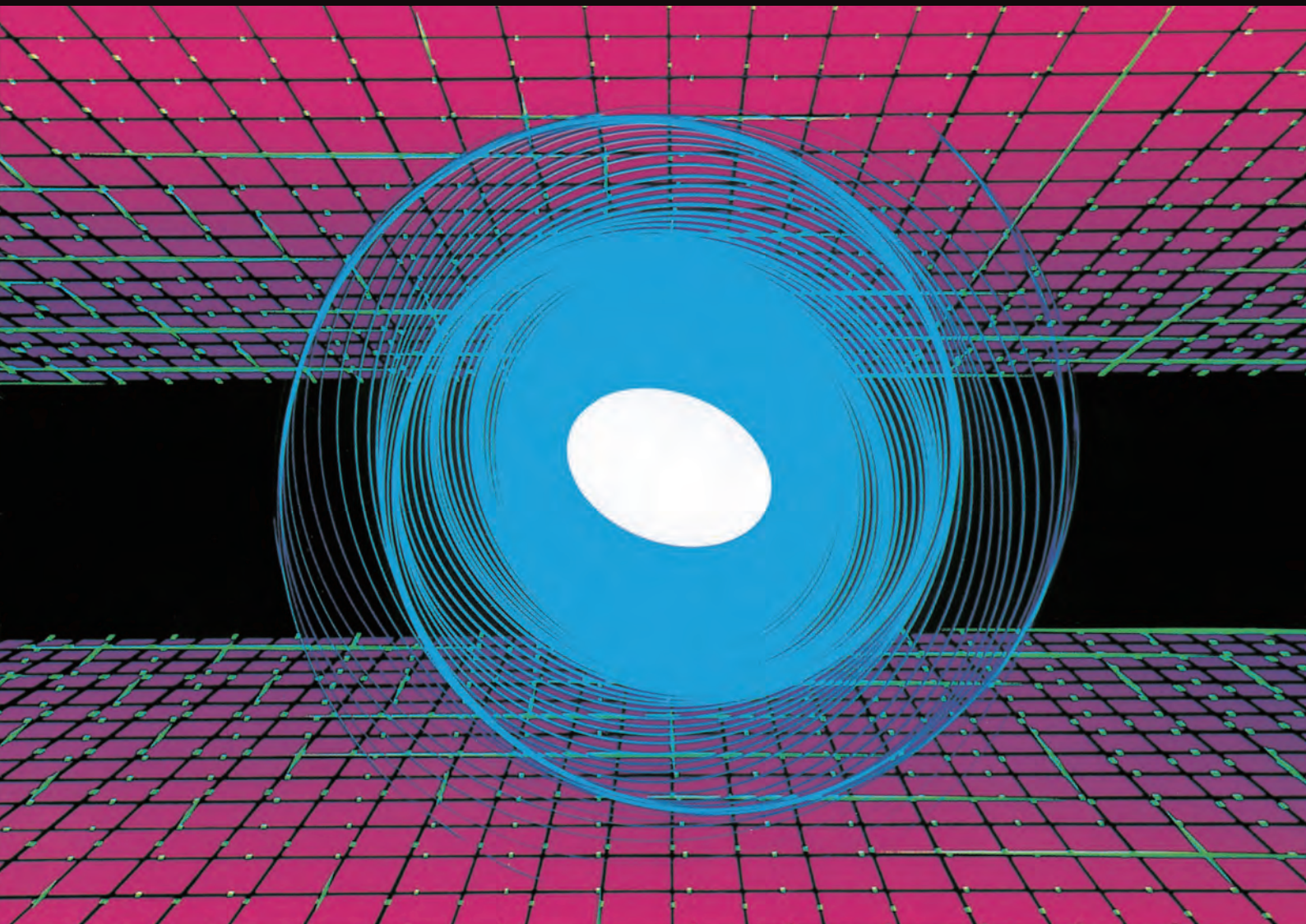


Cement Deep Mixing



Cement Deep Mixing - An excellent ground imp Excels in both marine and on-land ap



The Cement Deep Mixing (CDM) method is a technique to chemically solidify and strengthen soft ground by in-situ mixing of the soil with cement slurry.

For many years this high quality, environment friendly, low cost ground improvement technology has become the most popular ground improvement method.

The CDM method is often superior to other methods in a wide range of ground improvement applications such as prevention of embankment instability and settlement, improving ground stability for construction projects, countermeasures against liquefaction, and reinforcement of ground to improve earthquake-response of superstructures.

The Cement Deep Mixing Association is a consortium of private firms including general contractors, marine works contractors, and foundation works contractors.

Its function is to promote and improve the CDM method. The CDM Association has managed to introduce the method for use in numerous successful soil improvement projects throughout not only Japan but also many foreign countries; and consequently the use of CDM continues to increase steadily.

Improvement system utilizing cement-water slurry - applications

Advantages of the CDM method

1

Assures achievement of required strength

2

Shortens the construction period

3

Prevents settlement

4

Improves earthquake resistance

5

Prevents pollution and leachate of contaminate

6

Has wide applicabilities

7

Enables reliable quality control

8

Uses resources beneficially

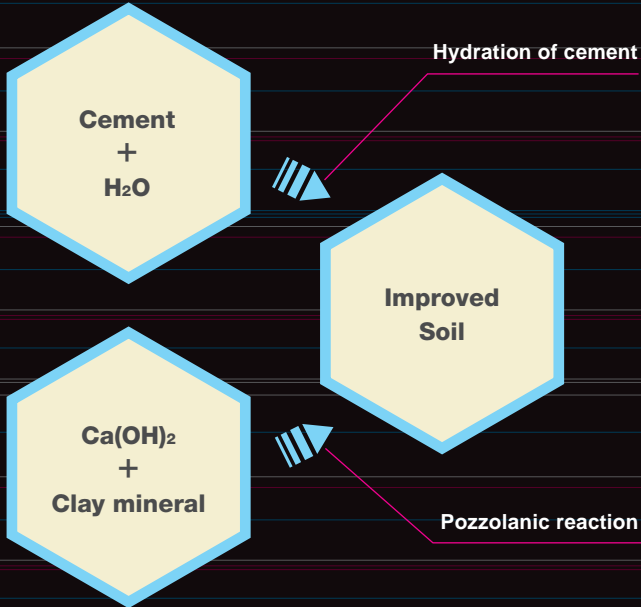
9

Lowers construction costs

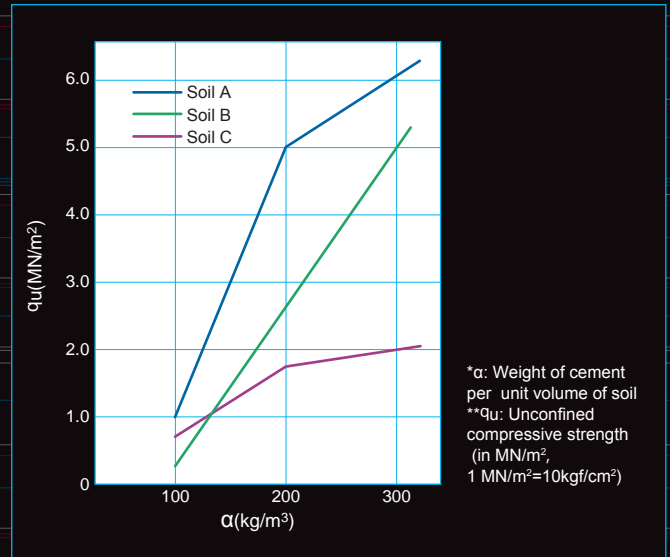
Principle of deep mixing

Cement Deep Mixing

Cement Deep Mixing (CDM) is a method for improving the ground to a prescribed strength by mixing cement slurry with the soft soil in situ. Generally, the cement used is either ordinary portland cement or a mixture of portland cement and blast-furnace slag. The cement alone creates cementitious materials through hydration; and, although the reaction differs with the soil type, the calcium hydroxide liberated from the cement also undergoes a pozzolanic reaction with the soil to create cementitious materials. As the mixture ages, these cementitious materials gradually fill the void space between the soil particles, which results in higher strength and lower volume compressibility of soil.

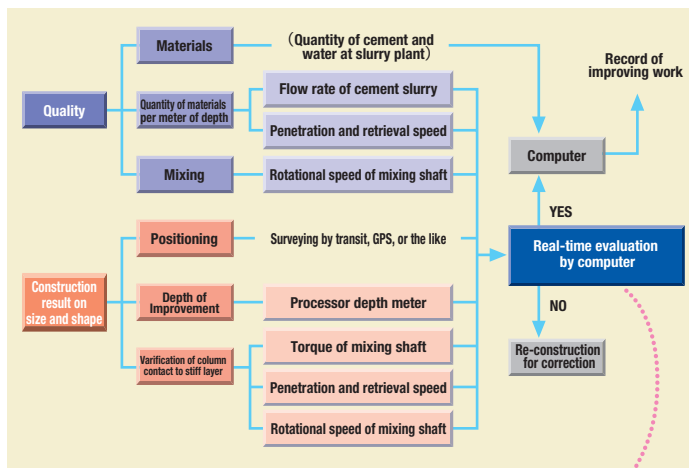


Relation between cement ratio and strength (at 4 weeks)

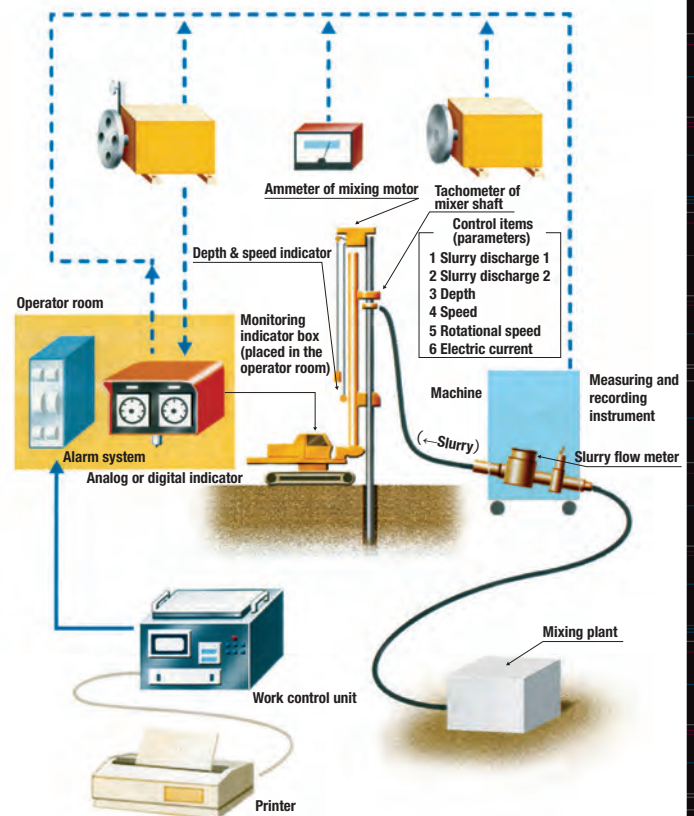


CDM quality Control System

The CDM machine is equipped with a quality control system, which enables the real-time monitoring and control of high quality execution and insures reliable treated soil columns.

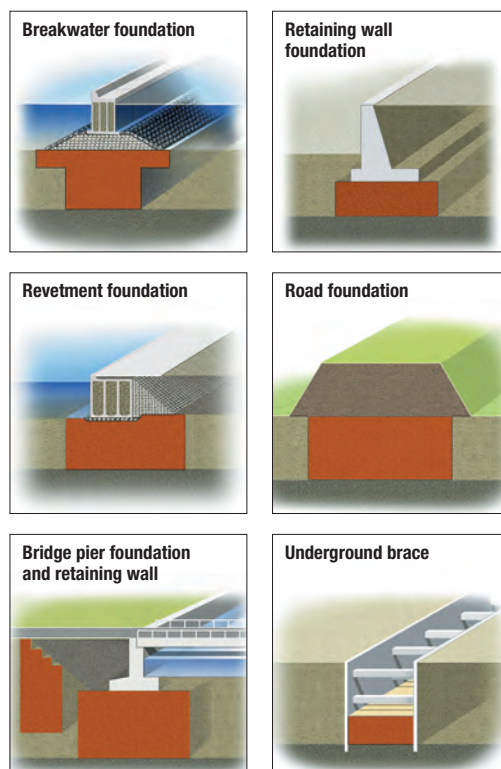
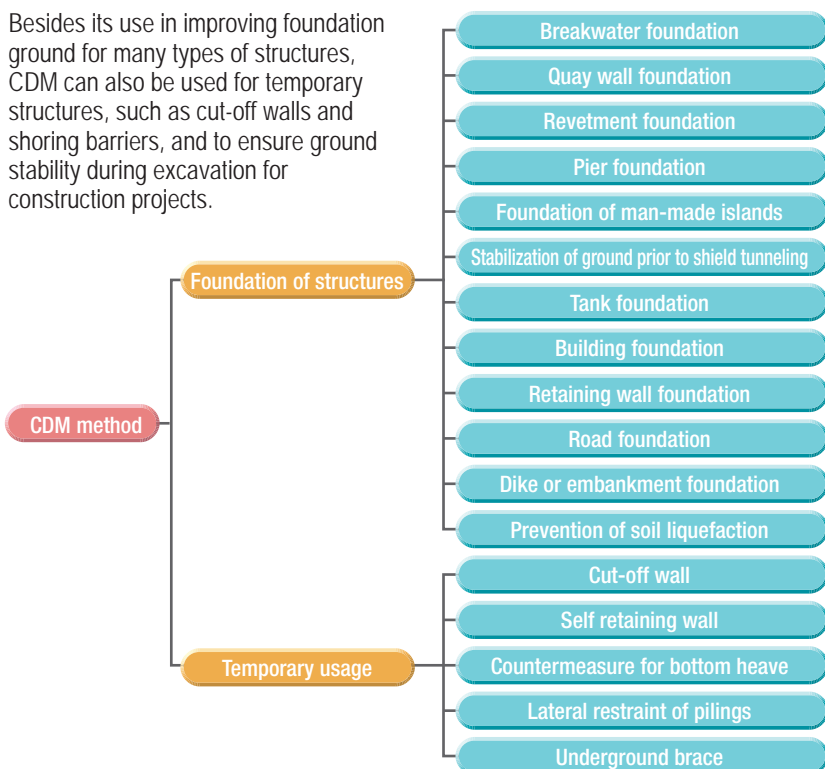


Work control monitor screen

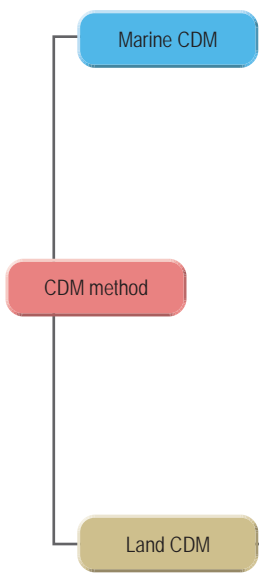


Application of CDM

Besides its use in improving foundation ground for many types of structures, CDM can also be used for temporary structures, such as cut-off walls and shoring barriers, and to ensure ground stability during excavation for construction projects.



System tree of CDM method



Class	Maximum depth (Underwater)	Number of special barges
2.2m ²	-40m	5
4.6m ²	-60m	6
5.7m ²	-70m	5

Method name	Shaft type	Diameter of mixing blade	Improved area	Depth of improvement	Number of machines
Standard CDM method	Dual-shaft	φ1,000mm	1.5m ²	45m	134
CDM-Mega method	Dual shaft	φ1,200mm	2.17m ²	40m	118
		φ1,300mm	2.56m ²	30m	
CDM-LODIC method	Dual shaft	φ1,000mm	1.5m ²	40m	48
		φ1,200mm	2.17m ²	40m	
		φ1,300mm	2.56m ²	30m	
CDM-Land4 method	Dual shaft x 2	φ1,600mm	2.01m ²	30m	3
		φ1,000mm	3.0m ²	40m	
		φ1,200mm	4.34m ²	30m	
CDM-Column method	Dual shaft	φ1,300mm	5.11m ²	20m	4
		φ1,500mm	3.5m ²	30m	
CDM-Lemniscate method	Triple shaft	φ1,600mm	4.34m ²	30m	26
		φ1,000mm	2.19m ²	30m	
		φ1,200mm	3.21m ²	30m	
CDM-Single shaft method	Single shaft	φ1,300mm	3.79m ²	30m	-
		φ800~1,200mm	0.5~1.13m ²	10m	
CDM-FLOAT method	Dual shaft	φ1,000~1,600mm	0.78~2.01m ²	30m	-
		φ1,000mm	1.5m ²	25m	-
		φ1,200mm	2.17m ²	25m	-
		φ1,300mm	2.56m ²	25m	-

SPECIFICATION OF ORDINARY CDM and CDM-Mega PROCESSES

Cement Deep Mixing

To meet the demands of larger projects, the CDM Association has developed a large-scale CDM process, CDM-Mega. The CDM-Mega process has inherited the various merits and features of the standard dual-shaft system (1000 mm diameter X 2 columns) but the diameter of the mixing blades is increased to 1200-1300mm. CDM-Mega can reduce the cost of a project in terms of both time and money.

1

Reduction of construction term

2

Cost reduction

Features

3

Enriched options for construction



Specifications of CDM machines

Diameter of mixing blade	Component	up to 10m deep	up to 20m deep	up to 30m deep	up to 40m deep
φ1000mm X 2	Deep mixing machine	45 kW X 2 Leader length: 20 m Hoisting: 25 t to 27 t	50 to 60 kW X 2 Leader length: 30 m Hoisting: 35 t to 37 t	75 to 90 kW X 2 Leader length: 40 m Hoisting: 50 t to 55 t	90 kW X 2 Leader length: 50 m Hoisting: 50 t to 55t
	Engine power generator	250 kVA 100 kVA	300 kVA 125 kVA	450 kVA 125 kVA	450 kVA 125 kVA
	Cement slurry plant	10 m ³ /h	20 m ³ /h	20 m ³ /h	20 m ³ /h
	Backhoe	0.6 m ³	0.6 m ³	0.6 m ³	0.6 m ³

Specifications of CDM-Mega

Diameter of mixing blade	Component	up to 10m deep	up to 20m deep	up to 30m deep	Remarks
φ1200 mm X 2	Deep mixing machine	75 to 90kW X 2 Leader length: 20 m Hoisting: 37 t to 40 t	90kW X 2 Leader length: 30 m Hoisting: 50 t to 55 t	90 to 110 kW X 2 Leader length: 40m Hoisting: 70 t to 75 t	
	Engine power generator	450 kVA 200 kVA	600 kVA 200 kVA	600 kVA 200 kVA	for mixing motor for slurry plant
	Cement slurry plant	40 m ³ /h	40 m ³ /h	40 m ³ /h	
	Backhoe	0.6 m ³	0.6 m ³	0.6 m ³	
φ1300 mm X 2	Deep mixing machine	90 kW X 2 Leader length: 20 m Hoisting: 50 t to 55 t	90 to 110 kW X 2 Leader length: 30 m Hoisting: 60 t to 65 t		
	Engine power generator	600 kVA 200 kVA	600 kVA 200 kVA		for mixing motor for slurry plant
	Cement slurry plant	40 m ³ /h	40 m ³ /h		
	Backhoe	0.6 m ³	0.6 m ³		

Column shapes

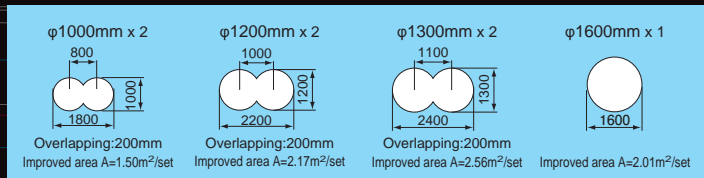
Cross-section	Example of pile arrangement in group column type		
	group column type	block type	block type
φ1200mm X 2 2.17m ² /set Overlapping:200mm			
φ1300mm X 2 2.56m ² /set Overlapping:200mm			

CDM-LODIC is one of the cement deep mixing methods which gives minimal impact on the surrounding environment and existing structures.

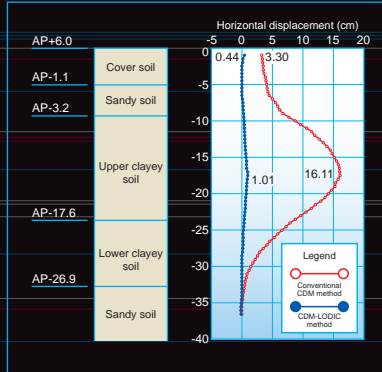
The standard Cement Deep Mixing (CDM) method has gained wide popularity because it causes less displacement than other ground improvement methods. CDM-LODIC uses auger screws on the upper part of the mixing shafts to discharge a volume of soil equal to the amount of cement slurry that is injected, enabling the work without influencing the surrounding ground and structures. It has been adopted in a considerable volume throughout Japan (7.8million m³ as of 2014). Standard CDM-LODIC machines are dual shaft and equipped with mixing blades with 1000 mm diameter. In order to meet demands of larger deep mixed columns, dual shaft LODICs with ϕ 1200mm, ϕ 1300mm and single shaft ϕ 1600mm are available. The method may use continuous, intermittent, or propeller type auger screws.

Reliability is guaranteed with the use of the execution control system to monitor and regulate the volume of soil extracted.

Improved form of CDM-LODIC method



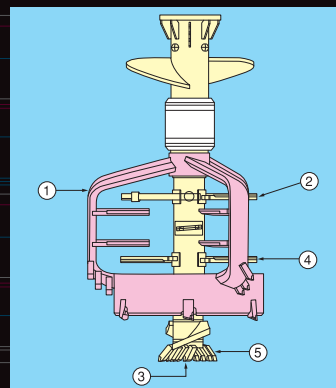
Ground Displacement Measurement



CDM-Column

The CDM-Column method, which creates larger diameter stabilized-soil column, is a deep mixing method with two rotating shafts. It is characterized by a sophisticated mixing tool comprising outer larger diameter blade (1500 mm) and inner smaller blade rotating in opposite directions. Compared with the conventional method, the machine can be applied to a harder ground. It improves the production rate, reducing work period. The sophisticated mixing tool and the execution control system provide stabilized soil with uniform quality.

Mixing blades of the CDM-Column



- ① Outer mixing blade
- ② Inner mixing blade
- ③ First outlet for cement slurry
- ④ Second outlet for cement slurry
- ⑤ Excavation head (Option: Available for harder ground)

Specifications of mixing machine

Model		TEM-200-2L			
Electric motor		75kwX4/6pX2 motors			
		Rod rotation number (r.p.m)	Drilling torque (Ton-m)	Rotation number on casing (r.p.m)	Drilling torque (Ton-m)
50Hz	4P	28.5	2.56	19.6	3.71
	6P	19.0	3.84	13.1	5.57
60Hz	4P	34.2	2.13	23.6	3.09
	6P	22.7	3.20	15.7	4.64
Upper auger weight		Approx. 6.5Ton			
Lower auger weight		Approx. 10.5Ton			
Upper chuck drawing force resistance		Approx. 30Ton			
Lower chuck drawing force resistance		Approx. 40Ton			
Swivel caliber		11/2BX11/2BX2 swivels (Swivel equipment with 2 fluids injection)			
Gross weight of attachments		Approx. 43.1Ton			



CDM-Land4

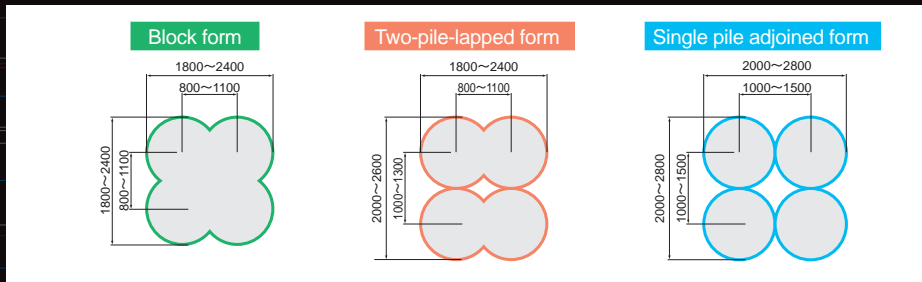
Cement Deep Mixing

CDM-Land4 uses four shafts operating simultaneously, which greatly increases capacity and reduces construction costs in comparison with the standard dual-shaft CDM machines. This four shaft simultaneous operation also increases the mixing efficiency and consequently offers higher-quality soil improvement.

Improved area

CDM-Land4 machine	Diameter of mixing blade	Φ1000X4 shafts	Φ1200X4 shafts	Φ1300X4 shafts
Maximum penetration depth (GL)		40m	30m	20m
Improved area	Block form	2.83m ² /set	4.21m ² /set	5.00m ² /set
	Two-pile-lapped form	3.00m ² /set	4.34m ² /set	5.11m ² /set
	Single pile adjoined form	3.14m ² /set	4.52m ² /set	5.31m ² /set

Improved form



CDM-Lemni 2/3

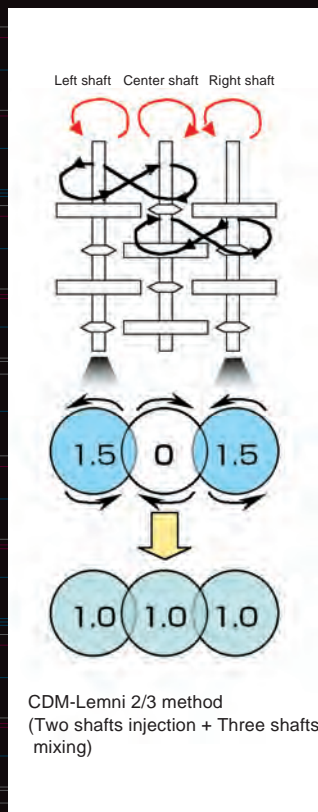
(Triple-shaft type deep mixing method)

Cement Deep Mixing

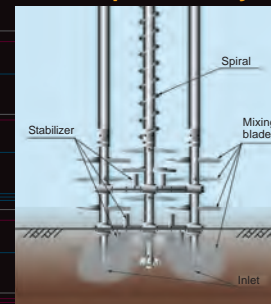
Efficient soil stabilization by the triple-shaft type machine with larger diameter mixing blades.

"CDM-Lemni 2/3 method" is a method to improve soft ground efficiently by means of triple shaft machine equipped with mixing blades with diameter ranging from 1000 to 1300 mm. The triple shaft machine enables soil-binder mixture to flow among the three shafts in lemniscate by pouring the cement slurry from the tips of outer two shafts rotating in the same direction while the central shaft rotates in the opposite direction. The triple shaft machine ensures the uniform and strong improved ground. The method can reduce the cost of a project drastically in terms of both time and money compared with the conventional method.

Concept of mixing by CDM-Lemni 2/3 method



Received a technical development award of 2006 from Japan Society of Civil Engineers

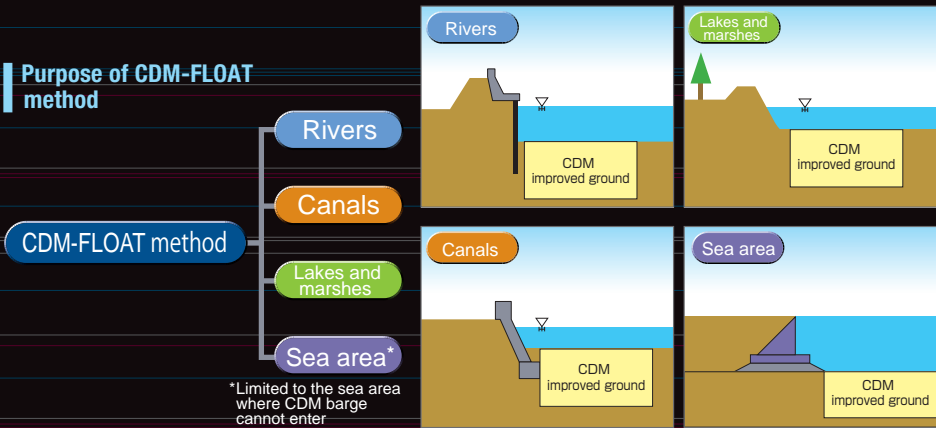


Improved form of CDM-Lemni 2/3 method

Diameter of mixing blade	Φ1000X3 shafts	Φ1200X3 shafts	Φ1300X3 shafts
Form			
Improved area	2.19m ² /set	3.21m ² /set	3.79m ² /set

CDM-FLOAT method is developed to carry out ground improvement at the shallow water such as estuary and in-land waters.

The method employs standard CDM machine for on-land use being mounted on a pontoon with spud. For the accurate determination of the depth of improvement, correction of elevation against changing water level is necessary. CDM-FLOAT utilizes a system management device with a tide level managing function (CDM-FLOAT system), which automatically correct the elevation during work and record the machine's tip depth for the reporting purpose.

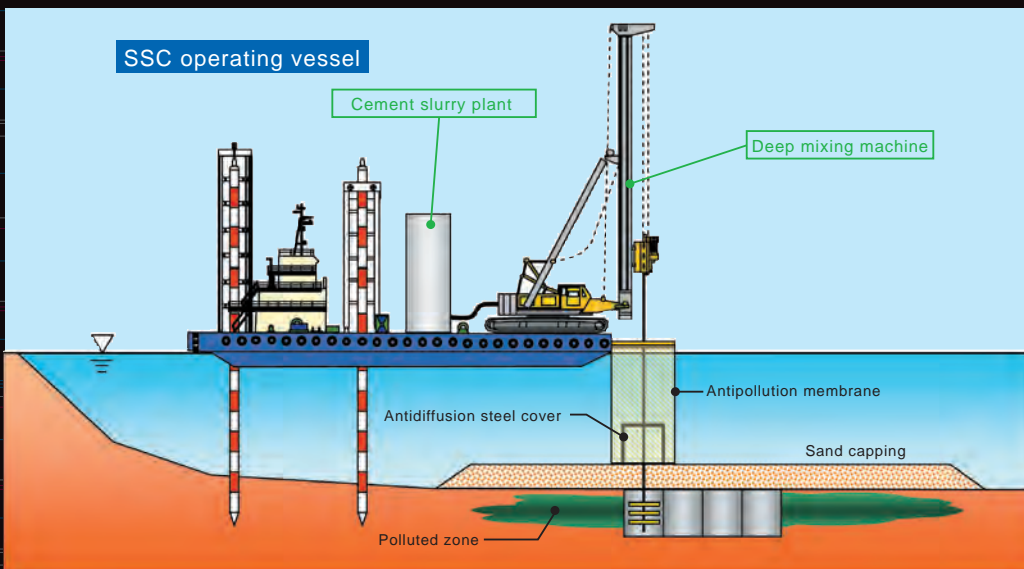


CDM-SSC

(In-Situ solidification of contaminated sediment under water)

This is a method to solidify and stabilize the contaminated soil piled up on the bottom of harbors, rivers, lakes and marshes, etc. without affecting the quality of water around.

CDM-SSC method provides multiple preventive measures against the diffusion of contaminants, which include the placement of sand cap on the sediment, a steel hood covering mixing shafts, and silt fences around the deep mixing machine.



SSC stands for Stabilization & Solidification of Contaminated soil (Method).



Antipollution membrane (Overall view of membrane)



Antidiffusion steel cover

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Cement Deep Mixing



Cement Deep Mixing Method - in situ mixing of soil with cement slurry - is a patented process.





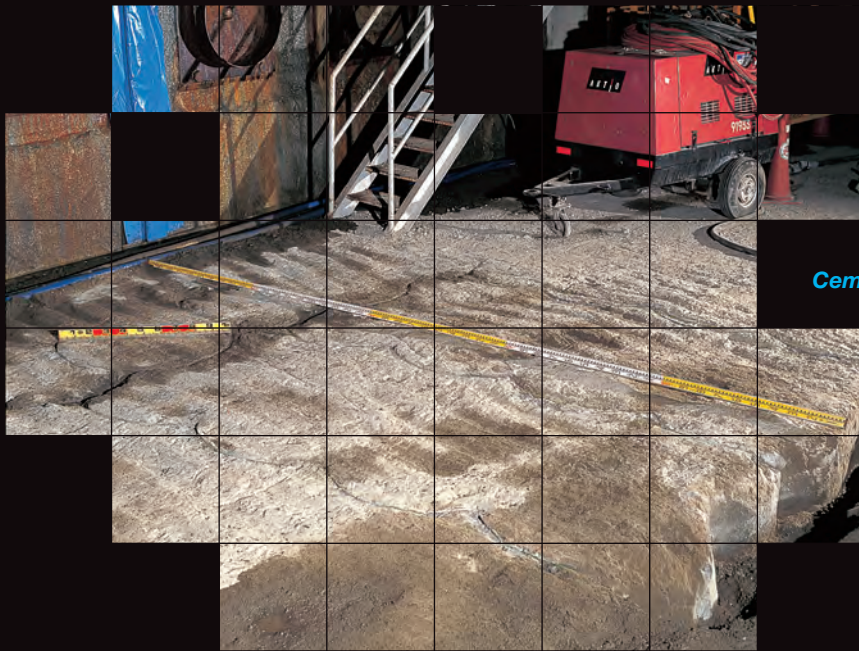
Cement Deep Mixing Association Headquarters

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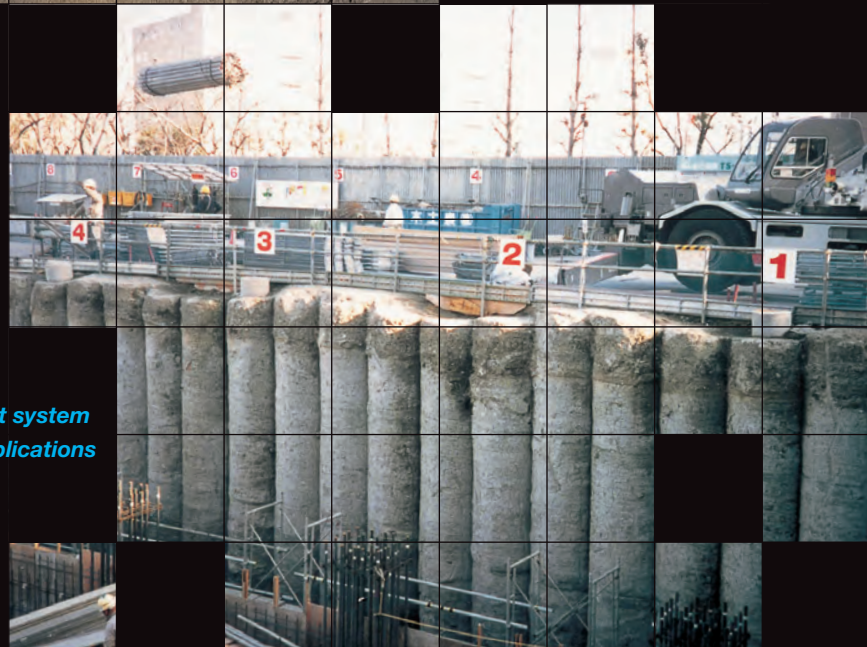
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Cement Deep Mixing Association



*An excellent ground improvement system
Excels in both marine and on-land applications*

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