

The most powerful and advanced diaphragm wall trencher series developed through the world's greatest construction records of submersible motordrills forwarded to meet the highest technical requirements generated on the largest square measure construction demand per nation.

TONE ELECTRO·MILL DRILL

*TONE Model EMX-320
Electro·Mill Drill*

2.8 m wide and 120 m deep World's greatest diaphragm walls are under construction from man-made island in Trans-Tokyo Bay Highway Project with 4 sets of TONE EMX-320 drills.



TOA-TONE BORING CO., LTD.

TONE ELECTRO-MILL DRILL

Features of TONE Electro-Mill Drill

1. Full section cutting mechanism:

Since ring cutters are interposed between a pair of drum cutters, its drillhead mechanism eliminates uncut sections. This direct cutting mechanism of entire cross section without the necessity of supplementary treatment for uncut section is particularly advantageous to drill harder material as rocks.

2. Submersible motor drive system:

By use of submersible electric motors and special design of transmission mechanism, power loss is less than that of a hydraulic drive system and ground equipment for drive can be more compact. Due to the nature of electric drive principle, drive power can be increased to 150 % of rated output of the power.

3. Lower position of reverse inlet:

Utilizing ring cutter arrangement, reverse inlet position can be located to the lower level of drum cutters enabling prompt removal of cuttings after excavation.

4. Greater range of trenching width of diaphragm wall:

Model EMX-150:	650 — 1,500 mm (25.59 — 59.06 in.)
Model EMX-240:	1,200 — 2,400 mm (47.24 — 94.49 in.)
Model EMX-320:	2,000 — 3,200 mm (78.74 — 125.98 in.)

5. Greater capacity of trenching depth:

All models of EMX series drills are capable of trenching to the maximum depth of 150 m.

6. Application to large rectangular section pile:

By single cut, a large section pile can be constructed with the following maximum dimensions.

Model EMX-150:	650 × 3,200 mm (25.59 × 125.98 in.)
Model EMX-240:	2,400 × 2,400 mm (94.49 × 94.49 in.)
Model EMX-320:	3,200 × 3,200 mm (125.98 × 125.98 in.)

7. Overlapping cut on concreted preceding panels:

Since overlapped cutting on adjacent concreted panels can be done, nuisance joint process needed for conventional system can be simplified and water tight effect at joint section is high.

8. Trapezoidal cutting section:

For construction of ring shaped diaphragm wall alignment, EMX series drill can install special drillhead with trapezoidal cutting section to form multi-sided plane.

9. High degree control system for trenching accuracy:

Being equipped with a deflection indicator and remote controlled deflection corrector for two directions of forward to rear and left to right, the highest degree of trenching accuracy is attainable.

10. Pressure balancing system:

Being equipped with longtime experienced pressure balancing mechanism ensuring constant equalization of internal hydraulic pressure to correspond with increasing outer hydrostatic pressure, the drill is protected from ingress of pressurized mud water, free from necessity of flushing of tainted hydraulic oil.

11. Scraper for cohesive soil excavation:

Installed scraper enables effective excavation through cohesive soil scraping off sticking cuttings.

12. Operations under restricted headroom and confine space:

When situation demands, the height and dimensions of gantry can be made further shortened enabling the trenching operation under restricted headroom and confined space.

13. Connection free operation of hoses:

As an option, the hose reel can be employed to avoid frequent connection of reverse hoses enabling faster trenching operation and saving man power.



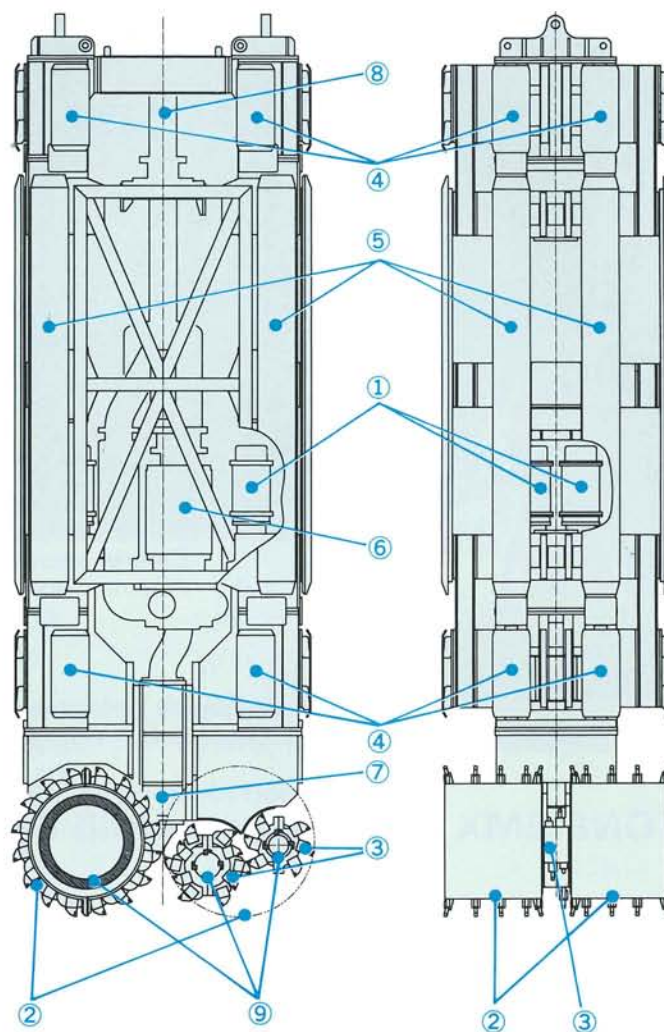
*Crawler crane suspended Electro-Mill Drill
(Kajima Corporation)*

*Derrick suspended Electro-Mill Drill
(Shimizu Construction Co., Ltd.)*

Specifications of TONE EMX Series Electro-Mill Drill

Model		EMX-150	EMX-240	EMX-320	
Trenching section	Width	(mm)	650 — 1,500	1,200 — 2,000	2,000 — 3,000
		(in)	25.59 — 59.06	47.24 — 94.49	78.74 — 125.98
	Length	(mm)	3,200	2,400	3,200
		(ft)	10.50	7.87	10.50
Trenching depth		(m)	150	150	150
		(ft)	492	492	492
Power unit:		Type;	Oil immerse type submersible electric motor		
		Output (kw) and nos.;			
			22 x 4	22 x 4	37 x 4
Drill head rotation speed (rpm.):		Drum cutter;	9.1	12.4	7.8
		Ring cutter;	30.7	24.2	14.8
		Ring cutter;	30.7	25.5	15.7
Torque:		(t-m)	7.0	5.1	13.5
Reverse inlet		(mm)	150	200	250
		(in)	6	8	10
Submersible sand pump			Inverter control type		
Discharge capacity;		(m³/min.)	6	8	12
		(ft³/min.)	211	282	424
Total head;		(m)	30	20	16
		(ft)	98	65	52
Power unit;		(KW)	75	75	75
Motordrill weight;		(t)	30 at 1,500 mm	34 at 2,400 mm	55 at 3,200 mm
Motordrill height;		(m)	8.2	7.2	7.2
		(ft)	26.9	23.6	23.6

Structural Scheme of TONE Electro-Mill Drill



Name of Components: TONE Electro-Mill Drill

Symbol No.	Component	Quantity
1,	Submersible electric motor for drum cutters and ring cutters	2 sets each on left and right sides (Total 4)
2,	Drum cutter	2 sets each on left and right sides (Total 4)
3,	Ring cutter	2 sets each on left and right sides (Total 4)
4,	Adjustable guide	2 units each on front and rear sides/upper and lower positions on both sides (Total 16)
5,	Fixed guide	2 pieces each on front and rear sides/ left and right side faces (Total 8)
6,	Submersible pump	1
7,	Reverse inlet	1 position
8,	Reverse pipe	1
9,	Shock absorber for drum cutter and ring cutter	1 each

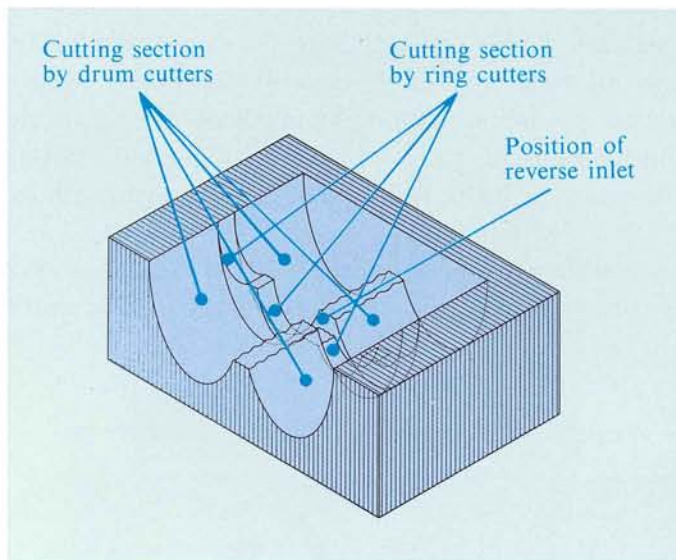
State of drilling section at trench bottom

Since excavation is carried out by combination of drum cutters and ring cutters, there is no section to be left without the pass of drill heads. Where ground formation is hard, this mechanism provides great advantage to attain high drilling speeds.

In addition, since the reverse inlet is located at lower position nearby the mid level of drum cutters, cuttings can be removed promptly after drilling without remaining cuttings at hole bottom which may disturb its essential trenching function.

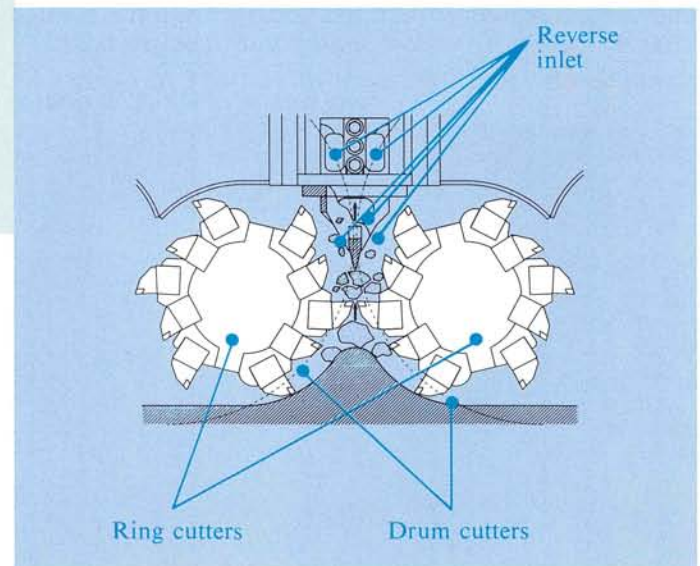


Drillhead consist of 4 drum cutters and 4 ring cutters.

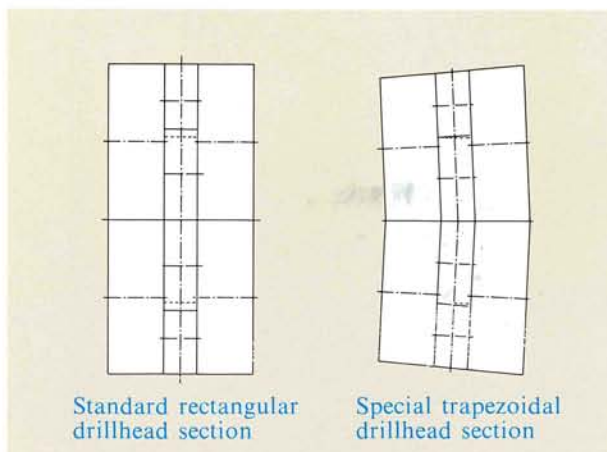


Boulder crushing mechanism

Large gravels or rock fragments approached nearby the reverse inlet can be crushed into small enough pieces to pass through reverse line by means of crushing plate installed at reverse inlet and cutting tooth of ring cutters, choking in the reverse line can be prevented.



Drill-head Section



The World Largest Diaphragm Wall Construction in Trans-Tokyo Bay Highway Project under construction with 4 sets of EMX-320 Drills



Aerial view of Kawasaki man-made island with anchored barges for stabilizing solution and concrete plant.

To form cylindrical retaining structure, the world's largest scale diaphragm wall with the dimensions of 2.8 m in width and 120 m in depth are under construction by 4 sets of TONE Electro-Mill Drills, Model EMX-320. The diaphragm wall is designed to function as perimeter earth retaining wall during inside excavation to specified depth of 70 m below sea level and functions as a part of structure for shield shaft to be constructed in reverse lining method. As the wall will eventually function as structural permanent wall, its accuracy is specified as 70 mm for its all portions from top to the bottom, i.e. approx. 1/1,700.

The scale of the diaphragm wall in this project as well as specified degree of accuracy are the greatest among all diaphragm walls ever constructed in Japan where the construction quantity, scope of dimension in width and depth, degree of required accuracy are the greatest in the world.

Two sets of EMX-320 drills are in operation in sight along circular guide walls.





Prior to main diaphragm wall construction, real size diaphragm wall construction test was conducted by the project owner, Trans-Tokyo Bay Highway Corporation as the formal program in 1988.

The dimensions of diaphragm wall completed the real size test operation are 2.8 m in width and 136 m in depth. Major subjects to ascertain its feasibility are trenching capability with specified dimensions and accuracy, installation of gigantic reinforcing cage, enormous concrete placement solving excessive heat of hydration etc.

The real size test operation was executed by the joint venture of general contractors consisting of Kajima Corporation, Shimizu Construction Co., Ltd. Taisei Corporation, Ohbayashi-Gumi Ltd., Hazama-Gumi Ltd. and Maeda Construction Co., Ltd.

Through this test operation, TONE Electro-Mill Drill, Model EMX-320 distinctly proved its capability to satisfy questioned technical requirements and its feasibility of building unprecedented scale diaphragm walls was affirmed.

Real size test operation for 2.8 m wide and 136 m deep diaphragm wall construction conducted on the land prior to main construction.



EMX-320 Drill in operation along circular diaphragm wall alignment.



General view of ring shaped island with 3 units of EMX-320 drills in sight.

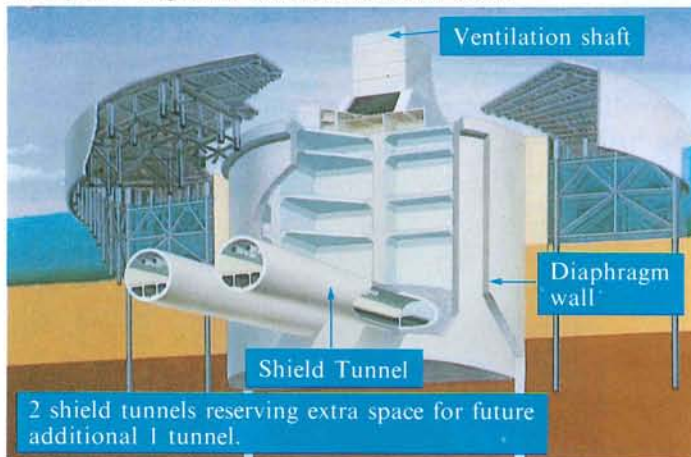
View of crane suspended
Kajima EMX-320 drill.



For main construction, the dimensions of diaphragm wall are eventually decided as 2.8 m in width and 119 m in depth from the surface of man-made island. To form cylindrical diaphragm wall structure, panels are programmed to consist of 28 preceding panels of 3.2 m long and 28 succeeding panels of 7.8 m long. The construction of diaphragm walls was commenced in March 1992 with 4 sets of TONE model EMX-320 Electro-Mill Drills and as of early May, 1992, all of preceding panels are completed. Specified accuracy of 70 mm for the depth of 119 m is sufficiently attained.

This state shows that TONE EMX series drills completely established the status of the most advanced diaphragm walling equipment for 3 m class wide and 100 m to 150 m class deep ultra-large diaphragm wall construction with proven attainability of 1/2,000 to 1/3,000 class accuracy.

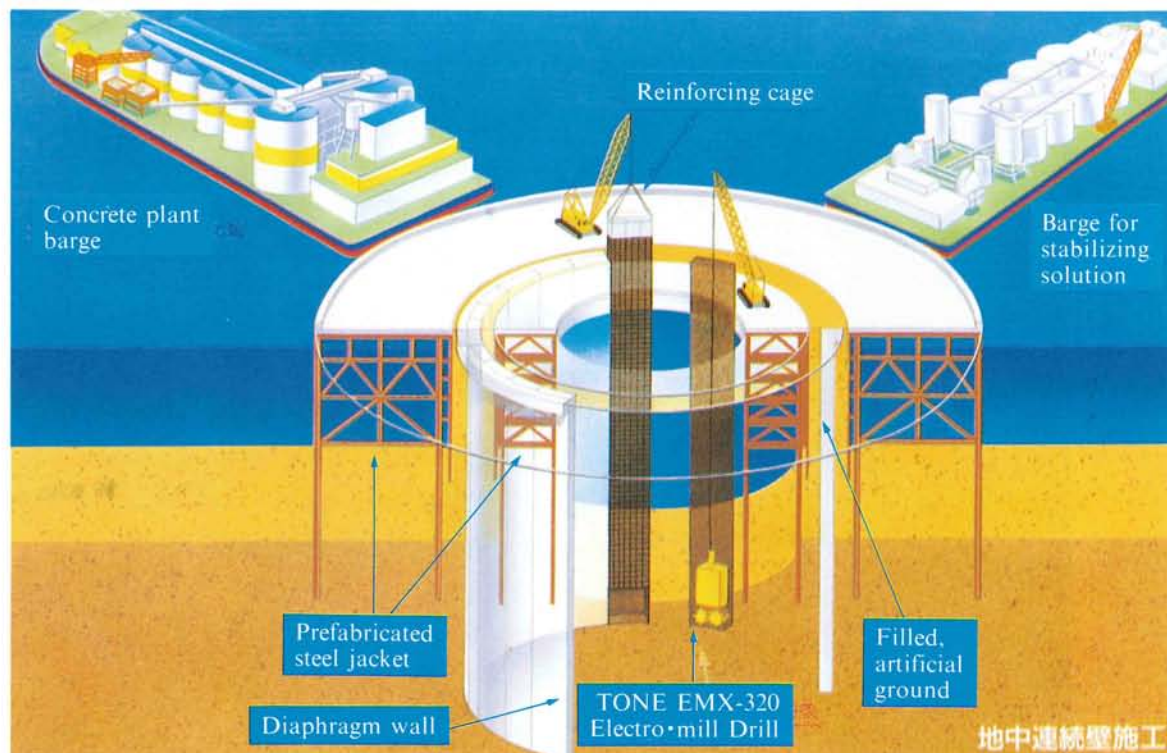
Conceptional Diagram of Kawasaki Man-made Island.



Diaphragm wall construction

After installation of prefabricated steel jackets, the space between inner and outer jacket was filled with sandy soil to form artificial ground. Diaphragm walls of 2.8 m wide and 119 m deep panels are constructed by trenching through this ground to underlain formation with TONE EMX-320 Drills in the order of preceding 28 panels followed by succeeding 28 panels.

For accomplishment of specified highest degree of accuracy as 70 mm at the depth of 119 m, laser beam utilized system was developed and applied.



Conceptional Diagram of Diaphragm wall construction.

地中連続壁施工