SK Piles Sdn. Bhd. (1054130-V)

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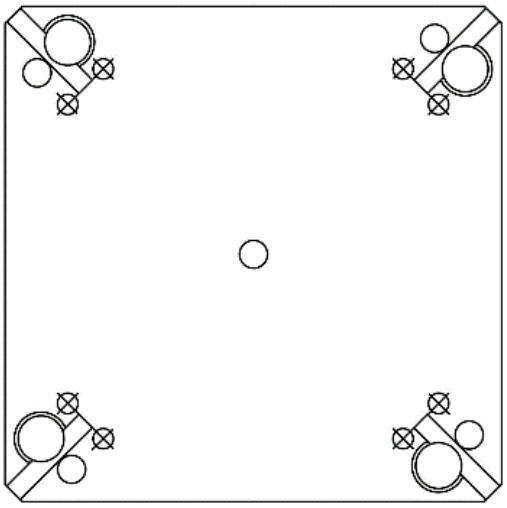
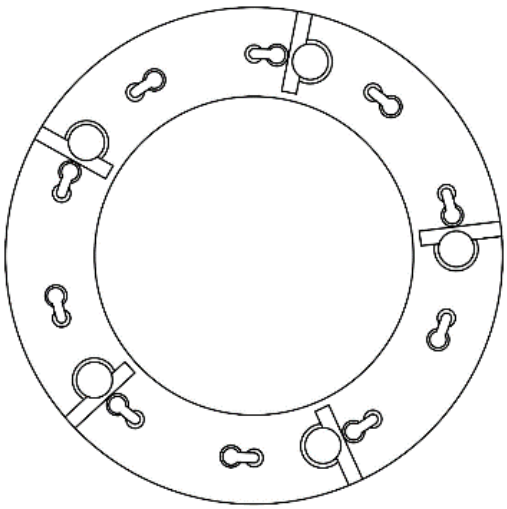
K-Lock

PILE MECHANICAL JOINT WITH GROOVED LOCKING
PROTUBERANCE/PROTUBERANCES FOR EASY LOCKING PIN/PINS INSTALLATION
&
PILE MECHANICAL JOINT WITH IMPROVED GROOVED LOCKING
PROTUBERANCE/PROTUBERANCES





Patent Abstract

A pile mechanical locking mechanism with screwed-on grooved locking protuberance/protuberances, that by virtue of the flex of the non-welded, screwed-on grooved protuberance/protuberances and by the locking pin/pins having a small amount of contact with the grooved protuberance/protuberances, enables easy to install locking pin/pins even with the existence of typical debris from the piling stage or even when dimensional tolerances of the pile's joint plates are not ideal due to manufacturing error or damage from external forces. The mechanical locking mechanism, being open or exposed in nature, enables debris to be easily cleaned away and visual inspection of any possible physical obstructions to successful locking pin/pins installations can be conducted easily.

~Simply the best mechanical joint for piles~

✓ TENSION CAPACITY

- Enables the pile joint to have consistent tensile capabilities/capacities due to the precision machining manufacturing method (CNC Machining) adopted.
- Optimum performance due to the careful selection of materials for the locking components, chosen for their long-established market use.
- Comes in **a few sizes**:
  - **K-Lock Std** (for 12mm thick joint plate)
  - **K-Lock Pro** (for 15mm thick joint plate)
  - **K-Lock Customised** (for special applications)
- K-Lock Std has a tensile capacity of 15 tonnes; K-Lock Pro has a tensile capacity of 20 tonnes.
- When the locking pin is hammered into the K-Lock, there is some **compressive prestress** (between the joint plates) generated, which is extremely beneficial in **reducing the amount of gap** (between the joint plates) generated under any tensile forces.

✓ BENDING MOMENT CAPACITY

- The bending moment capacity is dependent on the tensile capacity of which K-Lock mechanism used.15 tonnes for K-Lock Std; 20 tonnes for K-Lock Pro.
- The bending moment capacity of the pile joint will have no more than 5mm of a gap at the edge perimeter of the pile joint when 2 times the cracking moment is applied.
- At the cracking moment, the K-Lock will **not have any perceivable gap** between the pile's joint plates.

✓ SHEAR CAPACITY

- The shear capacity of a K-Lock joint plate will always **exceed** the shear capacity of the pile
- Each individual K-Lock mechanism will have two high-strength steel bolts and one high-strength steel pin resisting any shearing forces,
- The total combined cross-sectional area of all the K-Lock mushroom bolts and pins will **exceed** the total cross-sectional area of all the reinforcement anchoring the joint plate to the pile.

✓ TORSIONAL CAPACITY

- All the high-strength steel mushroom bolts and pins are placed along the interface between the two K-Lock joint plates.
- Relative to the centroid of a K-Lock joint plate, all the high-strength steel mushroom bolts and pins are located and orientated in a manner such that there will be **optimum torsional strength** provided.
- In general, any K-Lock joint will have a torsional capacity exceeding the torsional capacity of the pile body, ensuring that the K-Lock joint will be the **last to fail** under torsional forces.

✓ AXIAL COMPRESSION CAPACITY

- Designed to accommodate large axial compression forces.
- Components are made from high-strength steel and are also heat treated to provide a good balance between **toughness and strength**.
- Designed to enable stress transfer via the flat surface on the bolt head in the event of high axial compressive forces on the pile point.
- Locking pins' grooves machined on the mild steel joint plates are designed to enable the axial compressive stress transfer through the K-Lock joint without any loss.

✓ OTHER BENEFICIAL FEATURES

- The K-Lock system is very **easy to use** and **does not need any expensive or specialized equipment**.
- When the locking pin is hammered/installed, the movement of the locking pin will rotate the mushroom bolts tighter (clockwise direction). This provides **additional assurance** that the K-Lock is executed properly even in the instance where the mushroom bolts may be inadequately tightened.
- The K-Lock system is **designed for use in the open construction site** where there may be soil or other debris contaminating the joint surfaces. Only **moderate cleaning** of the system is necessary to enable optimum execution of the K-Lock system.
- Compared to welded joints, the K-Lock system is **much faster** to execute properly as well as providing **consistent performance**.
- Once screwed/bolted in place, the K-Lock mushroom bolts are designed to be **virtually indestructible**, making it suitable to handle the rigours of any piling worksite.
- Once the locking pins are hammered in place, the mushroom bolts are secured and **will not loosen**. In addition, the locking pins **prevent the mushroom bolts from unscrewing** due to the locking pins being secured in place via the machined pin grooves on the joint plates.
- The K-Lock system generates **absolutely no heat**. (Conventionally welded pile jointing systems damage the concrete of the pile and when the welding heat is too high, it damages and warps the steel joint components.)

MANUFACTURING METHOD

FOR SQUARE PILES

1. K-Lock joint plates are manufactured using CNC machining.
2. The anchorage bars are high-strength studs (threaded rods) bolted to the joint plates.
3. The steel skirting/collars are flat steel strips welded along the perimeter.
4. Both the mushroom bolts and locking pins are made from high-strength heat-treated steel.

FOR SPUN PILES

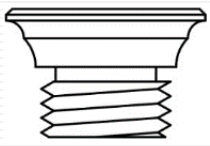
1. The joint plates are made from mild steel and the K-Lock sections are CNC machined carefully.
2. The joint plates are attached to the spun pile via enlarged button heads of the main longitudinal reinforcement being secured to specially machined seating areas/cavities on the joint plates.
3. The steel skirting/collars are flat steel strips welded along the perimeter.
4. Both the mushroom bolts and locking pins are made from high-strength heat-treated steel.

TESTING COMPLIANCE

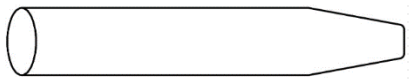
The K-Lock mechanical joint system has been tested in accordance with the load requirements of MS 1314: 2004.

For high load requirements, the number of K-Locks may be increased to provide greater strength. The performance of a K-Lock joint depends on the number of individual K-Lock mechanisms specified/designed.

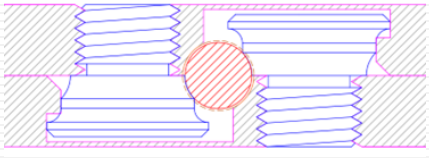
For non-destructive pile integrity tests (such as PDA and or PIT tests) done onto any pile points with the K-Lock system, please note that there will generally be improved integrity results at the pile joints (when compared to conventional welded joints) given that the K-Lock system has some prestress at the joints and the K-Lock system generates no heat thereby preventing any warping of steel causing integrity issues as with conventional welded joints. However, it is important to be aware that any pile joint will experience some strain during load and therefore significant or extreme loads may induce some strain which may be reflected in any integrity test. In simpler terms, while a K-Lock mechanical joint performs better in integrity tests (compared to conventional welded joints), any pile joint system is not infinitely strong, and all will exhibit some strain under high stresses.



Mushroom Bolt



Locking Pin



Comparisons of Attributes Between the K-Lock Pile Joint and Welded Pile Joint

K-Lock	WELDING
SPEED	**SPEED**
Fast & easy to execute.	Very slow if executed properly.
STRENGTH	**STRENGTH**
Consistent & strong.	Inconsistent, highly dependent on equipment & welder skill.
TEMPERATURE	**TEMPERATURE**
Does not increase concrete/joint temperature.	Extremely high temperature, damaging concrete & warping steel.
CONSISTENCY	**CONSISTENCY**
Consistent due to CNC manufacturing.	Very inconsistent due to welders & site conditions.
COST	**COST**
Comparable to welding with additional significant project savings.	No savings in speed & welding errors results in cost implications.
PDA, PIT & MLT TESTS	**PDA, PIT & MLT TESTS**
The K-Lock system incorporates an amount of prestress when assembled making for improved test results especially with regards of pile point integrity.	Welding is highly inconsistent & high temperatures damage concrete and warps steel joints resulting in an increased probability of bad test results, especially with regard to pile point integrity.
  	  

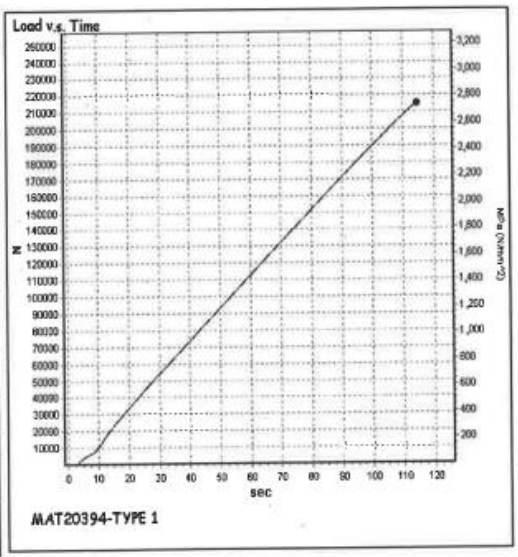
Tension Test Result for 15mm Thick Plate (**K-Lock Pro**)

Report No. : BSEN/TS/22/R6400-1
Job No. : MAT/20394

Test Results of Tensile Strength Test of Bolts
BS EN ISO 6892-1: 2019 / ISO 6892-1: 2019

Sample Reference*		15mm Plate Type 1
Sample Grade*		N/A
Heat No.*		N/A
Source of Sample*		
Nominal Diameter*	(mm)	15
Length of Specimen	(mm)	N/A
Mass	(g)	16583
Yield Force	(kN)	N/A
Yield Strength, R_e	(N/mm^2)	N/A
Max Load, F_m	(kN)	215.1
Tensile Strength, R_m	(N/mm^2)	N/A
Ratio R_m/R_e		N/A
Elongation after fracture, A	%	N/A
Remarks		Tensile Failure at Mechanical Lock

* As indicated by client



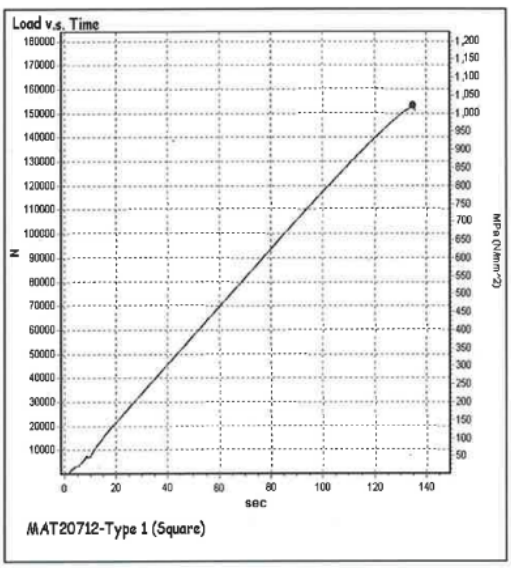
Tension Test Result for 12mm Thick Plate (**K-Lock Std**)

Report No. : BSEN/TS/22/R6535
Job No. : MAT/20712

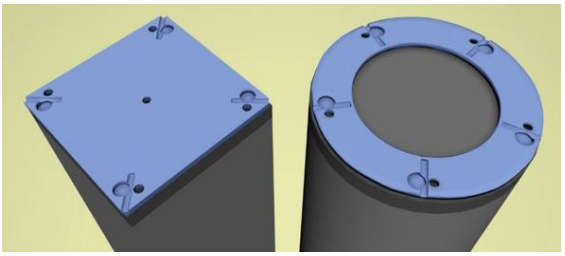
Test Results of Tensile Strength Test of Bolts
BS EN ISO 6892-1: 2019 / ISO 6892-1: 2019

Sample Reference*		K-Lock Type 1 (Square)
Sample Grade*		N/A
Heat No.*		N/A
Source of Sample*		
Diameter of Sample		Type 1
Length of Specimen	(mm)	615
Mass	(g)	15985
Yield Force	(kN)	N/A
Yield Strength, R_e	(N/mm^2)	N/A
Max Load, F_m	(kN)	153.4
Tensile Strength, R_m	(N/mm^2)	N/A
Ratio R_m/R_e		N/A
Elongation after fracture, A	%	N/A
Remarks		Tensile Failure at Mechanical Lock

* As indicated by client



K-Lock Images



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