

## SECTION - STONE COLUMNS

### PART 1 GENERAL

#### 1.1 OBJECTIVE OF TREATMENT

- A. Treatment shall provide a required minimum bearing capacity, shall restrict total and differential settlements to acceptable magnitudes under the proposed structural loading and shall provide acceptable long-term performance of the treated ground.

#### 1.2 METHOD OF TREATMENT

- A. The ground treatment shall be carried out by penetrating the ground with a large poker vibrator and forming continuous dense columns of stone from the maximum depth of penetration up to the ground surface. The method of treatment and plant employed shall be suitable to achieve the depth of treatment and the proper formation of stone columns required to meet the particular design in the prevailing ground and ground water conditions. The treatment shall be carried out in a safe manner. Account shall be taken of concurrent site activities and all plant movement necessary to properly carry out the vibro works.

### PART 2 SITE INVESTIGATION

#### 2.1 PROVISION

- A. Site investigation information provided to the Vibro Designer shall be adequate to characterize the ground to be treated, including made ground, and provide all physical and geotechnical properties required for stone column design.
- B. All factual site investigation information and all interpretative reports relevant to the design of the vibro ground treatment works, including assessments of any soil contamination, shall be made available to the Vibro Designer and to the Specialist Contractor at the contracting stage.

#### 2.2 HAZARD ASSESSMENT

- A. All information relevant to the safe implementation of the proposed vibro works, including the location of all known buried and over-site services and the nature, proximity and condition of adjacent structures, shall be made available to the Vibro Designer and to the Specialist Contractor at the contracting stage.

#### 2.3 ADDITIONAL INVESTIGATION

- A. Where information that is reasonably required for the design of effective vibro works is absent, timely additional site investigation shall be carried out.

PART 3 GROUND CONDITIONS

3.1 DESIGN

- A. The design shall state the specific technical objective of the treatment, shall quantify target performance and shall describe the manner in which treatment will improve the particular ground conditions.

3.2 SUITABILITY FOR TREATMENT

- A. The information on ground conditions shall be assessed to determine its suitability for treatment. Ground unsuitable for treatment by vibro stone columns shall include any conditions which do not allow the proper formation of stone columns or which would prevent the specified performance requirement being achieved.

PART 4 TREATMENT METHODS

4.1 GENERAL

- A. The appropriate method of installation shall be determined with due regard to ground and ground water conditions. Columns shall be formed without the inclusion of unsuitable material that could prevent or inhibit full particle contact and interlocking of stone particles.

4.2 METHOD OF INSTALLATION

- A. The method of installation and plant type shall be stated. Changes to specified installation procedures, for example where new information about ground conditions becomes available, shall be agreed by the Vibro Designer.
- B. The dry top-feed process shall only be used where ground conditions allow the proper formation of a continuous stone column when stone is added from the ground surface.
- C. Where ground conditions prevent proper column construction using the dry top-feed process, a dry bottom-feed process can be used. The bottom-feed poker shall not be removed from the ground during column construction.
- D. Where the wet top-feed process is used the poker shall be kept in the hole during column formation while allowing stone feed via the annular space between the poker and the surrounding ground.

PART 5 DESIGN

5.1 BASIS OF DESIGN

A. Performance Evaluation

1. Estimates of post-treatment load bearing capacity and settlement of the treated ground shall be provided. These shall comply with specified requirements for the nature, extent and magnitude of the load application and stated tolerances for post-construction movements provided by the designer of the supported structure.

B. Changes in ground level

1. Proposed changes in ground level subsequent to the installation of stone columns shall be specified prior to the vibro design stage and the effect this may have on the treatment shall be evaluated.

5.2 TREATMENT LAYOUT

- A. The design shall demonstrate by calculation that the spacing and layout of stone columns fulfills the requirements for minimum bearing capacity and total and differential settlement criteria for the structure to be supported and its foundation system. The layout and spacing of columns shall be clearly shown and numbered for reference on contract drawings and neither the spacing nor location shall be varied without the prior agreement of the Vibro Designer.

5.3 TREATMENT DEPTH

A. TECHNICAL CRITERIA

1. The technical criteria on which treatment depth is decided shall be stated.

B. FULL DEPTH TREATMENT

1. In full-depth treatment the poker shall penetrate to a competent stratum identified from the site investigation and the depth shall be stated for each column or group of columns in contract records.

C. PARTIAL DEPTH

1. For partial-depth treatment, the design shall demonstrate by calculation that the depth of the treatment is adequate to improve the depth of ground loaded by the particular foundation system in order to fulfill the requirements for adequate bearing capacity and differential settlement criteria for the structure to be supported. The risk of movement

occurring below the depth of treatment shall be assessed. The design treatment depths shall be indicated on working drawings.

## PART 6 MATERIALS

### 6.1 MATERIAL STABILITY

- A. Material used to form the stone columns shall be hard and chemically inert so as to remain stable during column construction and working life in the anticipated ground water conditions.

### 6.2 MATERIAL GRADING

- A. Material shall be used with a grading appropriate for compaction to form a dense column fully interlocked with the surrounding ground. Material shall be compatible with the vibro plant used and flow freely within bottom- and through-feed delivery systems without arching, which may block these systems.

### 6.3 SUPPLY AND STORAGE

- A. The material used to form the stone columns shall be specified. Changes in specification or supply of the material used to form the stone columns shall be notified and agreed by the Vibro Designer prior to use. The material shall be stored so as to remain fit for purpose.

## PART 7 EXECUTION OF TREATMENT

### 7.1 COMPLIANCE

- A. Work shall be carried out to written procedures to ensure compliance with the specification.

### 7.2 PRE-TREATMENT

#### A. WORKING PLATFORM

- 1. Working platforms shall be designed, prepared and maintained in a manner suitable for the safe movement and working of the vibro plant. Material used to provide working platforms shall be granular, suitable for the ground conditions on which it is placed and shall not prevent poker penetration.

#### B. WORKING LEVELS

- 1. Site working levels for the treatment shall be provided and maintained throughout the duration of the vibro works.

C. NEAR-SURFACE OBSTRUCTIONS

1. Where near-surface obstructions occur they shall be broken out prior to the commencement of the vibro works and the resulting voids filled with granular material that can be penetrated and compacted by the vibrating poker.

D. SETTING OUT

1. Setting out shall be carried out from established grid lines maintained for the duration of the vibro works. Immediately before treatment, each stone column position shall be clearly marked with a suitable identifiable pin or marker. All stone columns shall be carefully set out to the plan position shown on the contract layout drawings for the vibro works.

E. PRE-BORING

1. In ground conditions where pre-boring is deemed necessary it shall be carried out by a method and to a sequence agreed by the Vibro Designer.

7.3 TREATMENT

A. LOCATION TOLERANCE

1. Stone columns shall be installed within 6 inches of the position shown on the contract layout drawings for the vibro works.

B. VERTICALITY

1. Stone columns shall be constructed as near vertical as possible. The poker shall not deviate by more than 1 in 20 during column formation.

C. DEPTH VARIATIONS

1. Any variations in depth of stone columns due to site conditions not anticipated in the design shall be reported immediately to the Vibro Designer who shall advise on any action to be taken.

D. REMOVAL OF OBSTRUCTIONS

1. Unforeseen obstructions encountered below ground level shall be reported immediately. The Vibro Designer shall agree whether or not the obstruction is to be removed. Where it is decided to remove the obstruction, the void shall be backfilled with granular material.

E. STONE QUANTITIES

1. Significant variations in the quantity of stone used in forming columns of the same length shall be reported immediately to the Vibro Designer.

F. CONTAMINATION OF STONE COLUMN

1. Care shall be taken to ensure lumps of spoil are not allowed to fall into the hole.

G. COMPATION CLOSE TO GROUND SURFACE

1. The formation level for structural foundations or new earthworks shall be a minimum of 24 inches below the level from which treatment was carried out. Where this is not possible, or for floor slabs or widespread loads, re-grading or rolling shall be carried out before foundation construction.

7.4 RECORDS

- A. Daily records of the treatment process shall be kept and signed copies of these records submitted as required by the contract. The records shall show:

- (a) stone column reference
- (b) the date and time of column construction
- (c) method of treatment and plant type
- (d) depth of penetration at each stone column location
- (e) quantity of stone used in each stone column
- (f) presence of ground heave (plus estimate if detected)
- (g) vibrator power consumption
  - during penetration
  - during stone compaction
- (h) obstructions and delays
- (i) any unforeseen conditions encountered

PART 8 TESTING

8.1 GENERAL

- A. The Vibro Designer shall state the type and frequency of testing which is compatible with requirements for quality control and performance of treatment.

8.2 QUALITY CONTROL

- A. Suitable tests shall be carried out to ensure consistency in workmanship. The test method, frequency of testing and criteria for acceptance should be agreed prior to the commencement of the treatment.

- B. Column plate load tests shall be carried out using a nominal 24 inches diameter plate placed concentrically on individual columns, loaded in increments with the settlement of the plate measured against a stable reference beam

### 8.3 PERFORMANCE TESTING

#### A. OBJECTIVES

- 1. Suitable test methods shall be used to verify that the vibro stone column treatment has achieved pre-determined criteria set out in the contract documents. Testing shall be appropriate for the amount of treatment, variability of ground conditions, type of foundation, depth of ground loaded and any other relevant factors.

#### B. LOAD TESTS

- 1. Where required, large-scale load tests shall be carried out.
- 2. Large plate load tests shall be carried out by loading a rigid plate or cast in-situ concrete pad large enough to span one or more columns and the intervening ground.

### 8.4 REPORTING

- A. The number and types of tests and their locations and depth shall be recorded. Signed copies of these records and the test results shall be submitted as required by the contract.