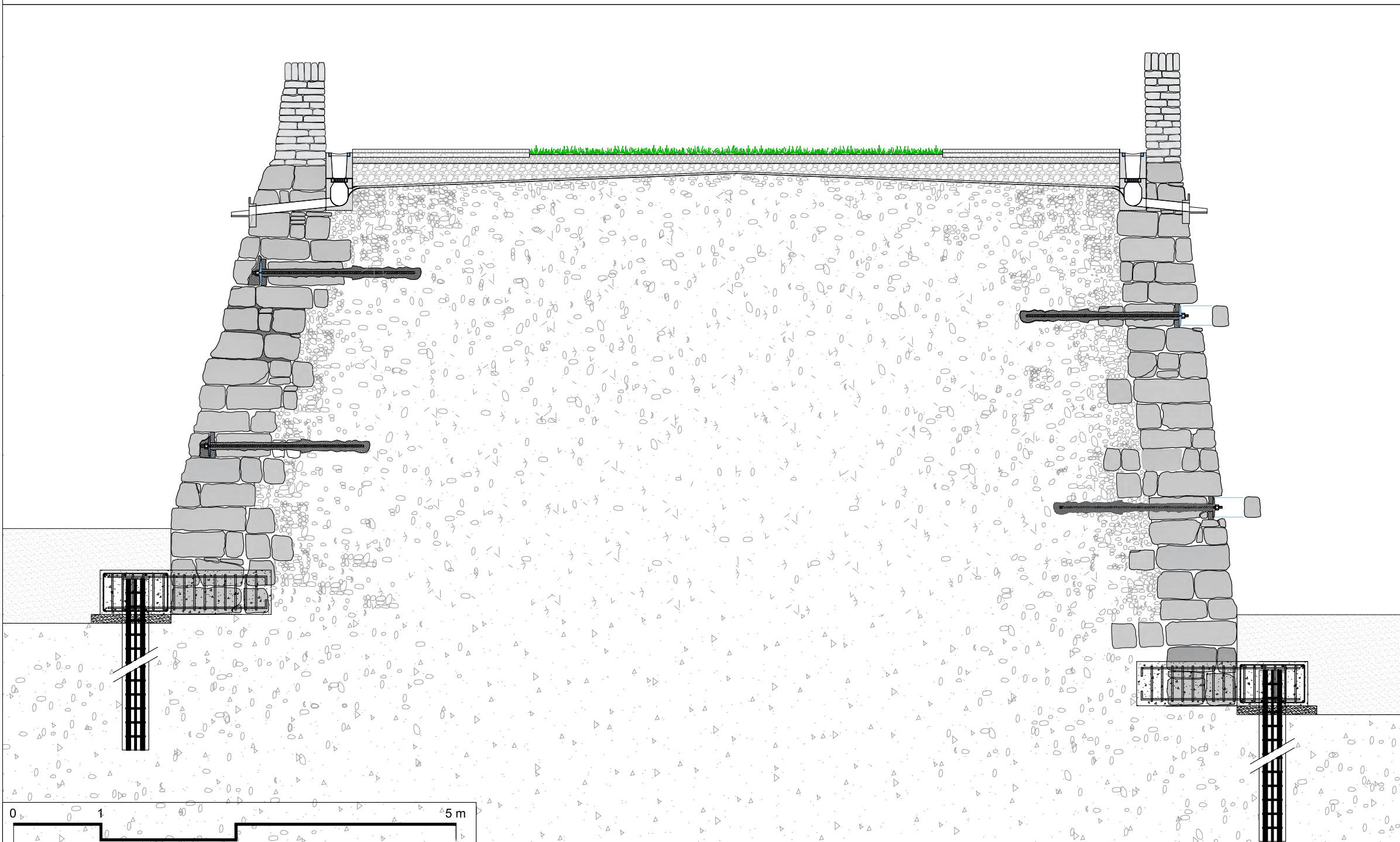
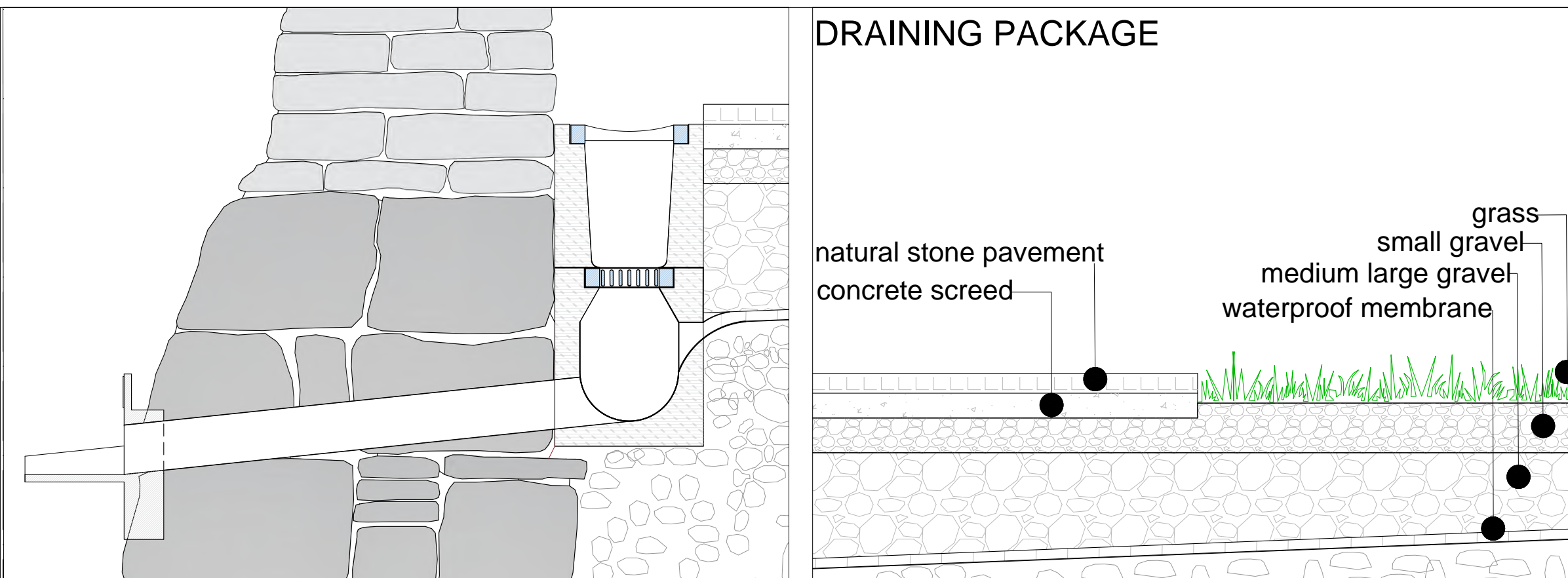


INTERVENTION OF REARRANGEMENT AND OPTIMIZATION OF THE DRAINAGE AND RAINWATER COLLECTION SYSTEM AT THE LEVEL OF THE SUMMIT RAMPART WALKWAY.

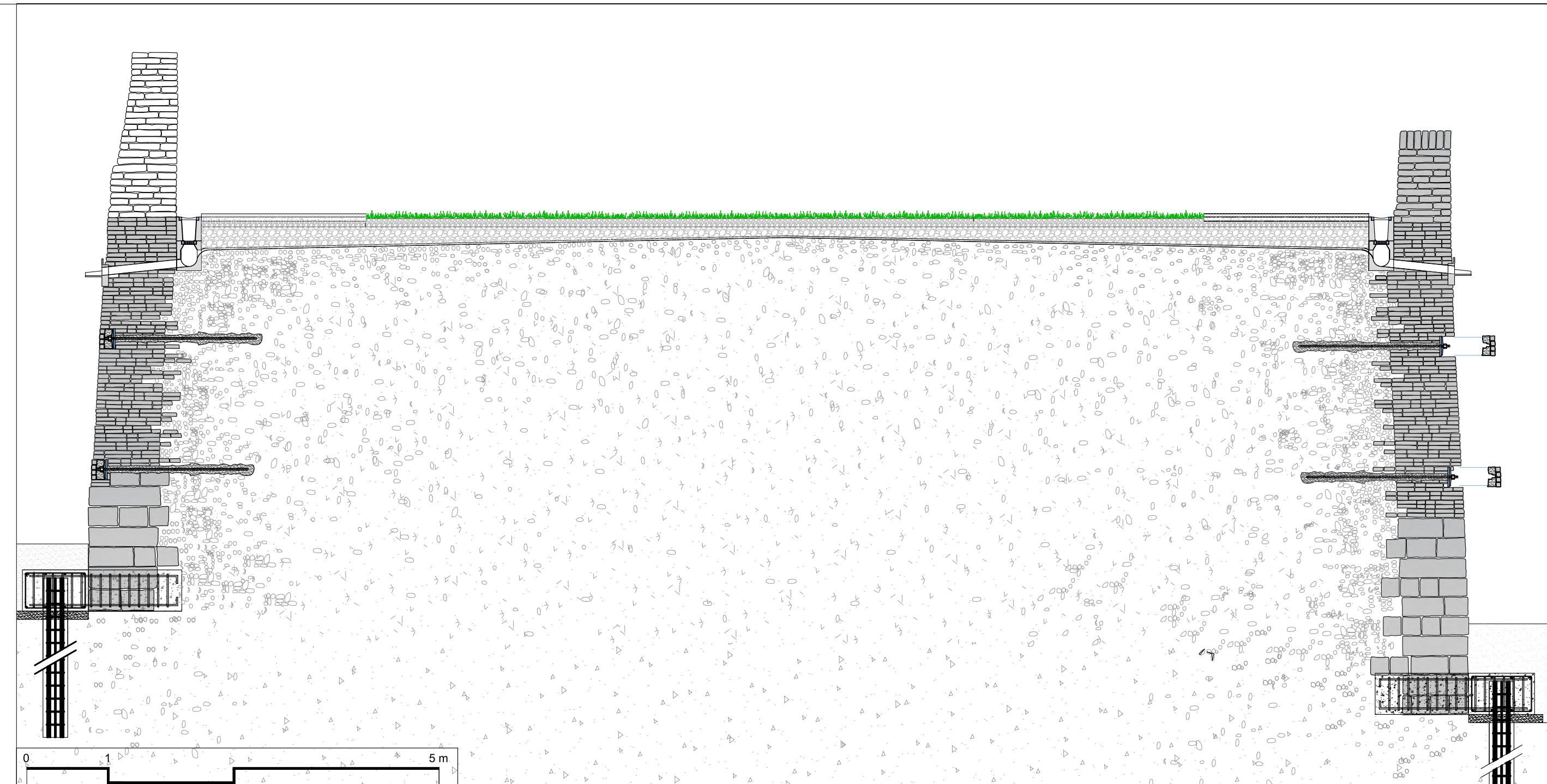
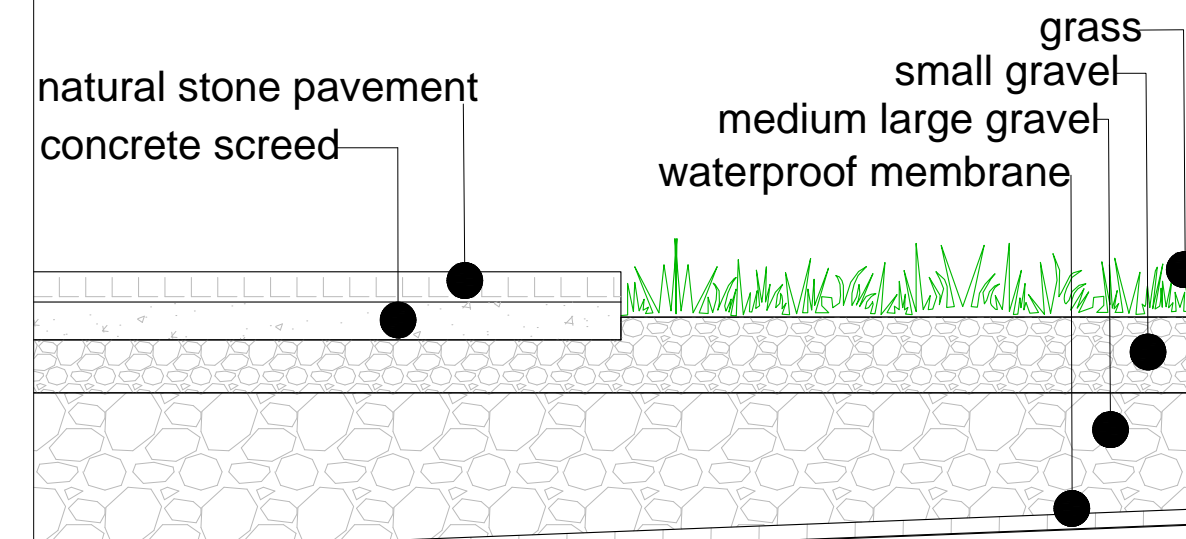
SUZHOU'S CITY WALLS. INTERVENTION STRATEGIES FOR CONSOLIDATION, STRENGTHENING AND SAFEGUARDING



The intervention described above will prevent in the future that the quantity of water coming from the meteoric leachate not only can accumulate in the intermediate levels of the embankment, before intercepting clay layers that prevent it from spreading to the lower layers, but also that it continue to filter towards the foundation layers (if the clayey layers were positioned more at the bottom) constituting a sliding surface which, as the analyzes have shown, would cause the ruinous collapse of the wall in its entire development for the inevitable triggering of such a kinematical mechanism.

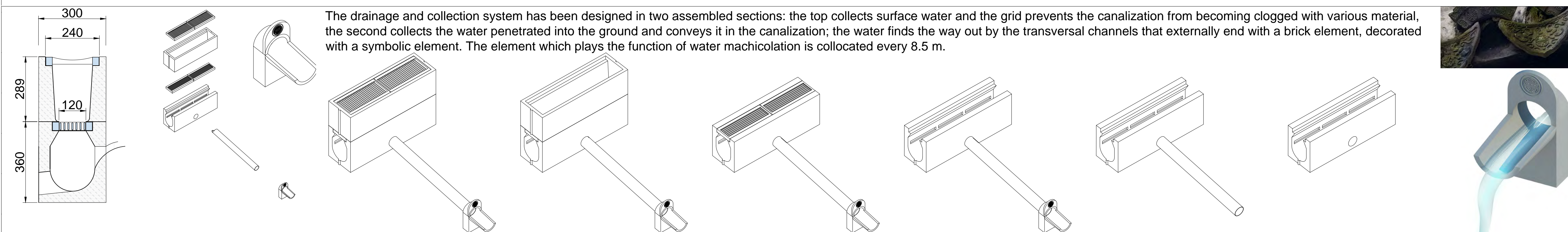
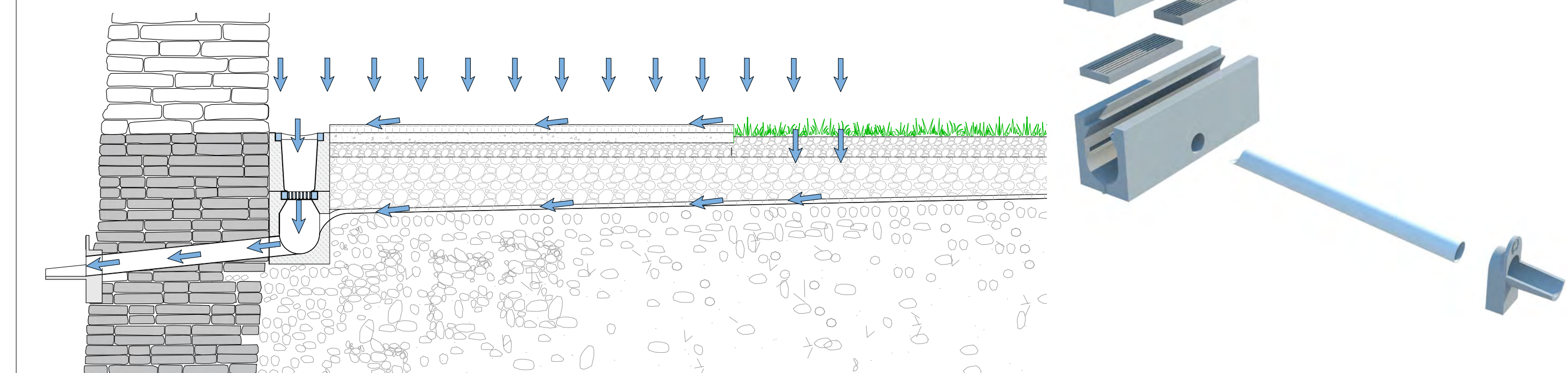


DRAINING PACKAGE



DRAINAGE SYSTEM COLLECT AND CHANNEL RAINWATER execution mode

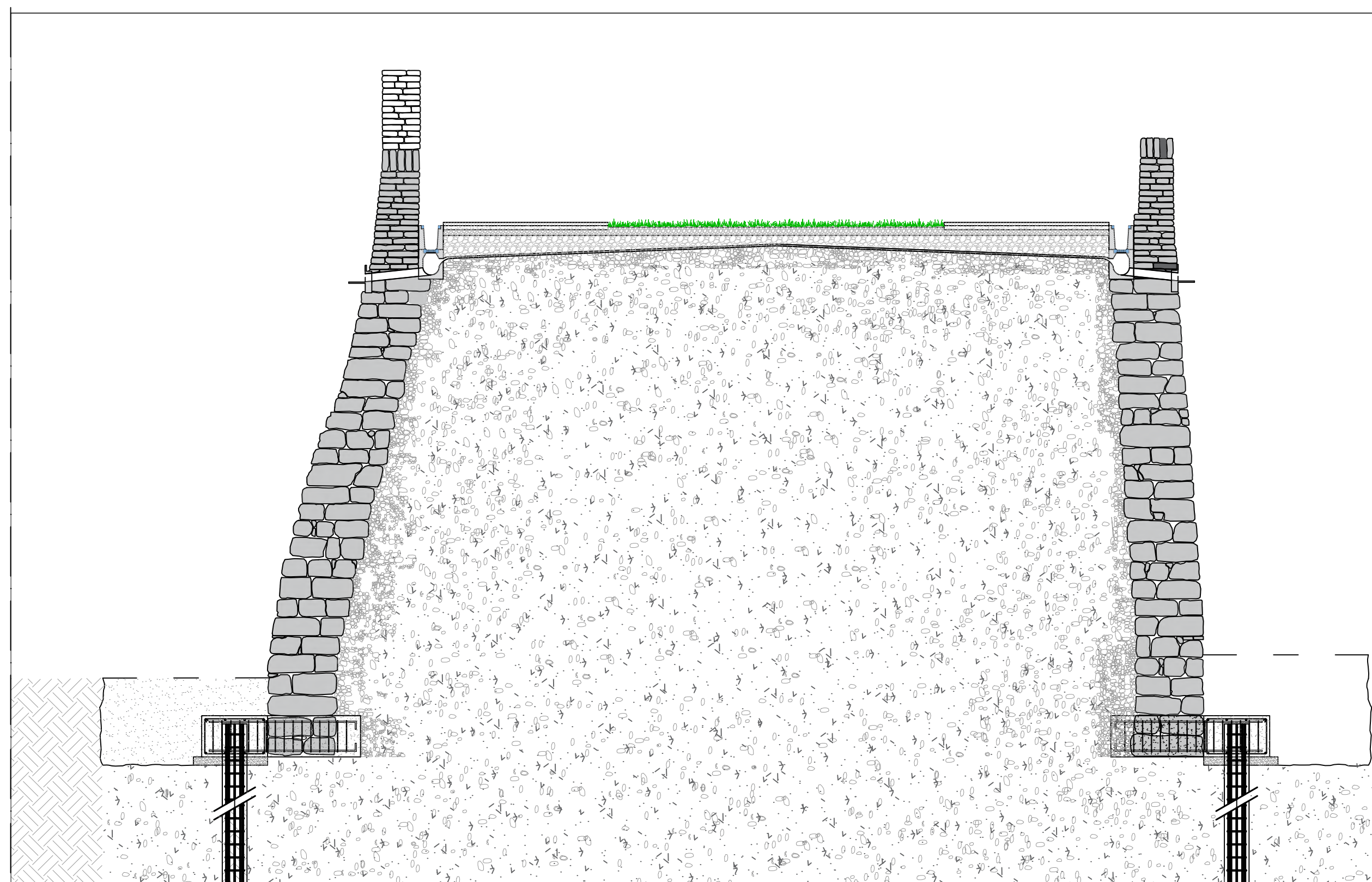
- removal of the first level of soil for a height of about 0.6 m;
- constitution of a draining package consisting, from top to bottom, of stabilized soil, graveled layer, mat in draining geo-mat, geo-composed in waterproof membrane, arranged according to suitable slopes, able to convey the leachate of rainwater towards side wells with two collection levels;
- distribution in drainage tube for disposal in special drains.



The drainage and collection system has been designed in two assembled sections: the top collects surface water and the grid prevents the canalization from becoming clogged with various material, the second collects the water penetrated into the ground and conveys it in the canalization; the water finds the way out by the transversal channels that externally end with a brick element, decorated with a symbolic element. The element which plays the function of water machicolation is collocated every 8.5 m.

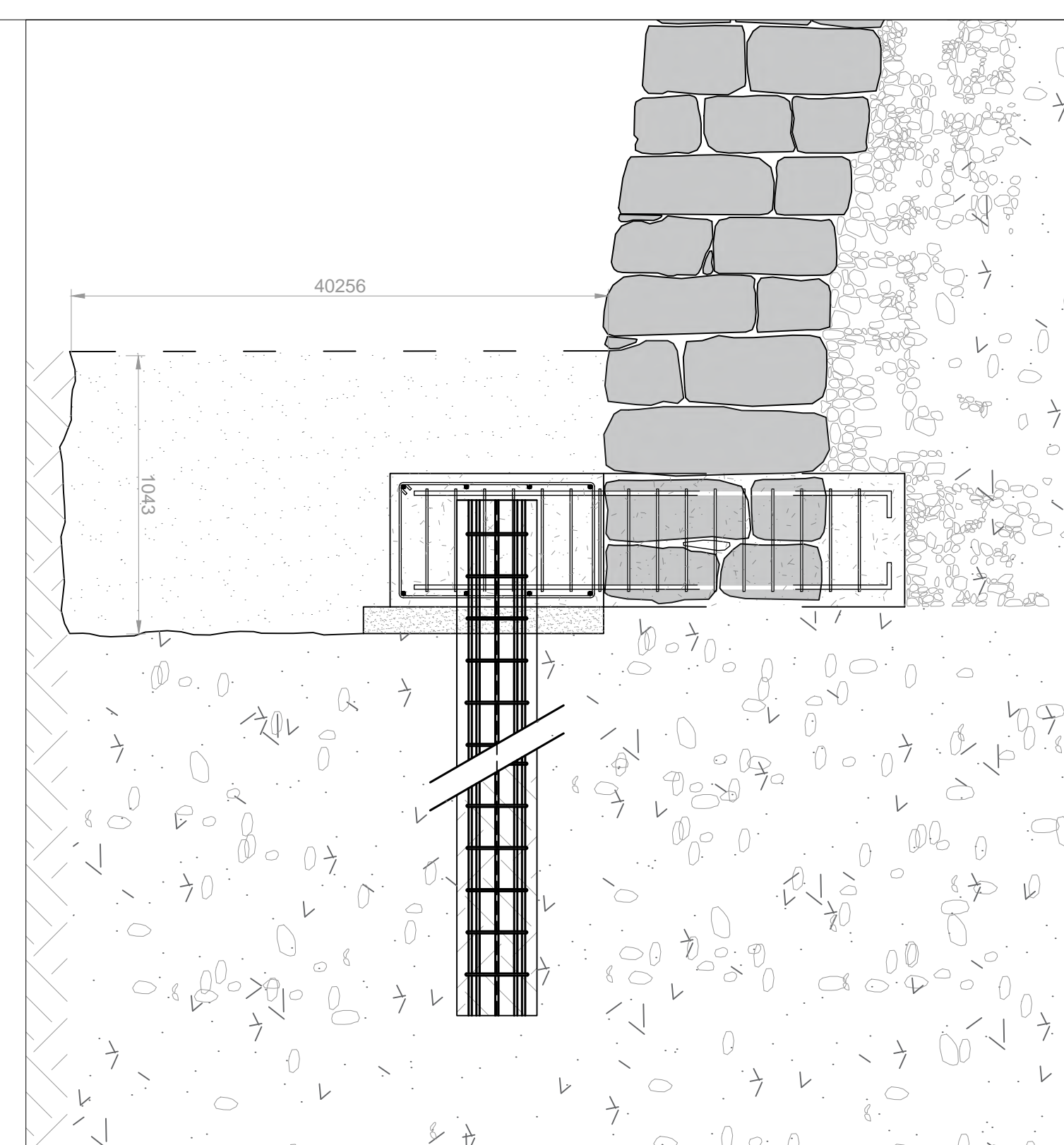
STRENGTHENING AND CONSOLIDATION OF FOUNDATIONS SYSTEM THROUGH THE UNDERPINNING METHOD. RE-STITCHING OF THE BASE OF THE WALL FRONTS WITH REINFORCED CONCRETE CONTINUOUS SIDE BEAM, ANCHORED TO THE WALLS THROUGH REINFORCED CONCRETE BRACKETS AND SUCCESSION OF DRILLED PILES

SUZHOU'S CITY WALLS. INTERVENTION STRATEGIES FOR CONSOLIDATION, STRENGTHENING AND SAFEGUARDING



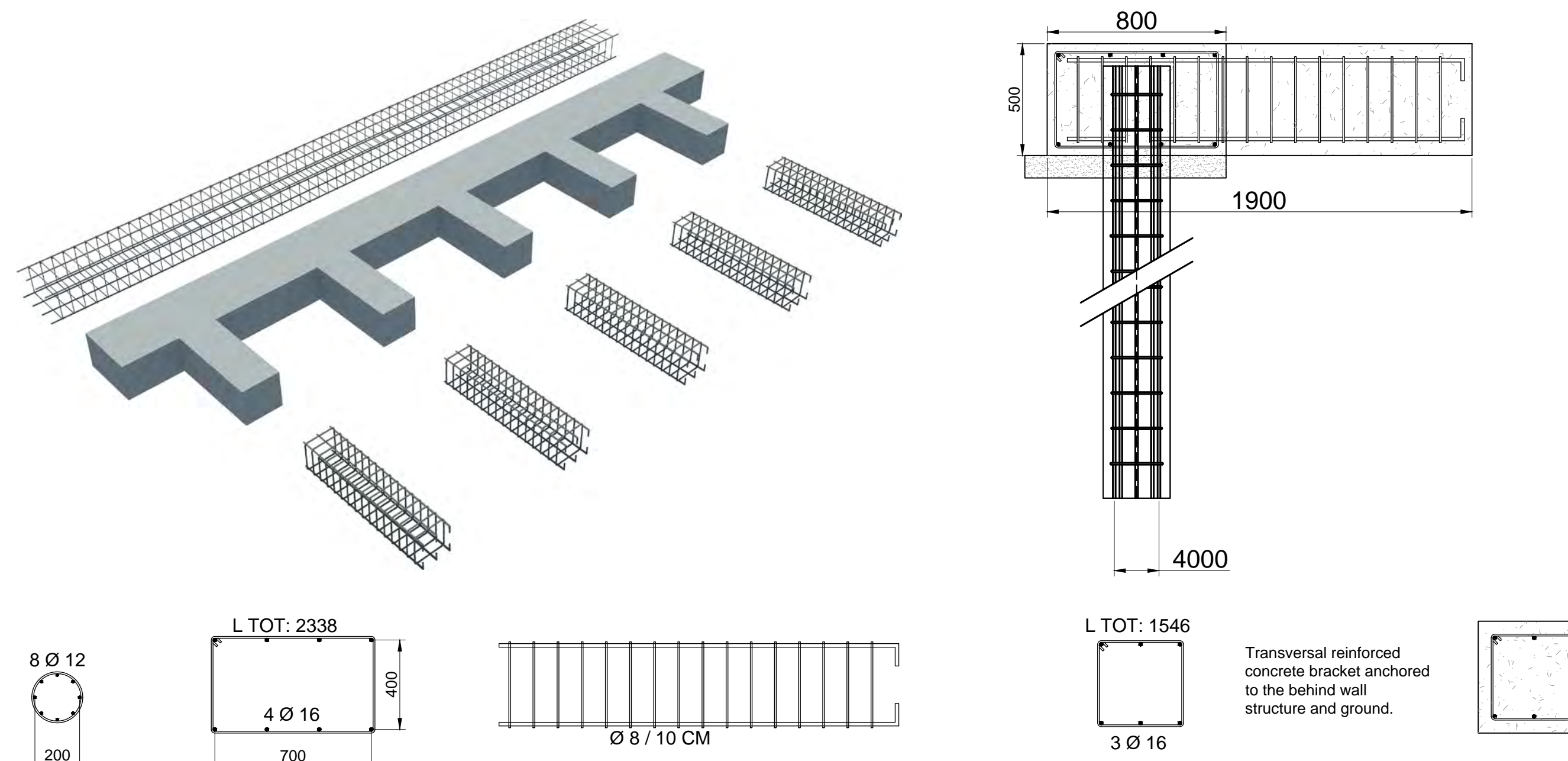
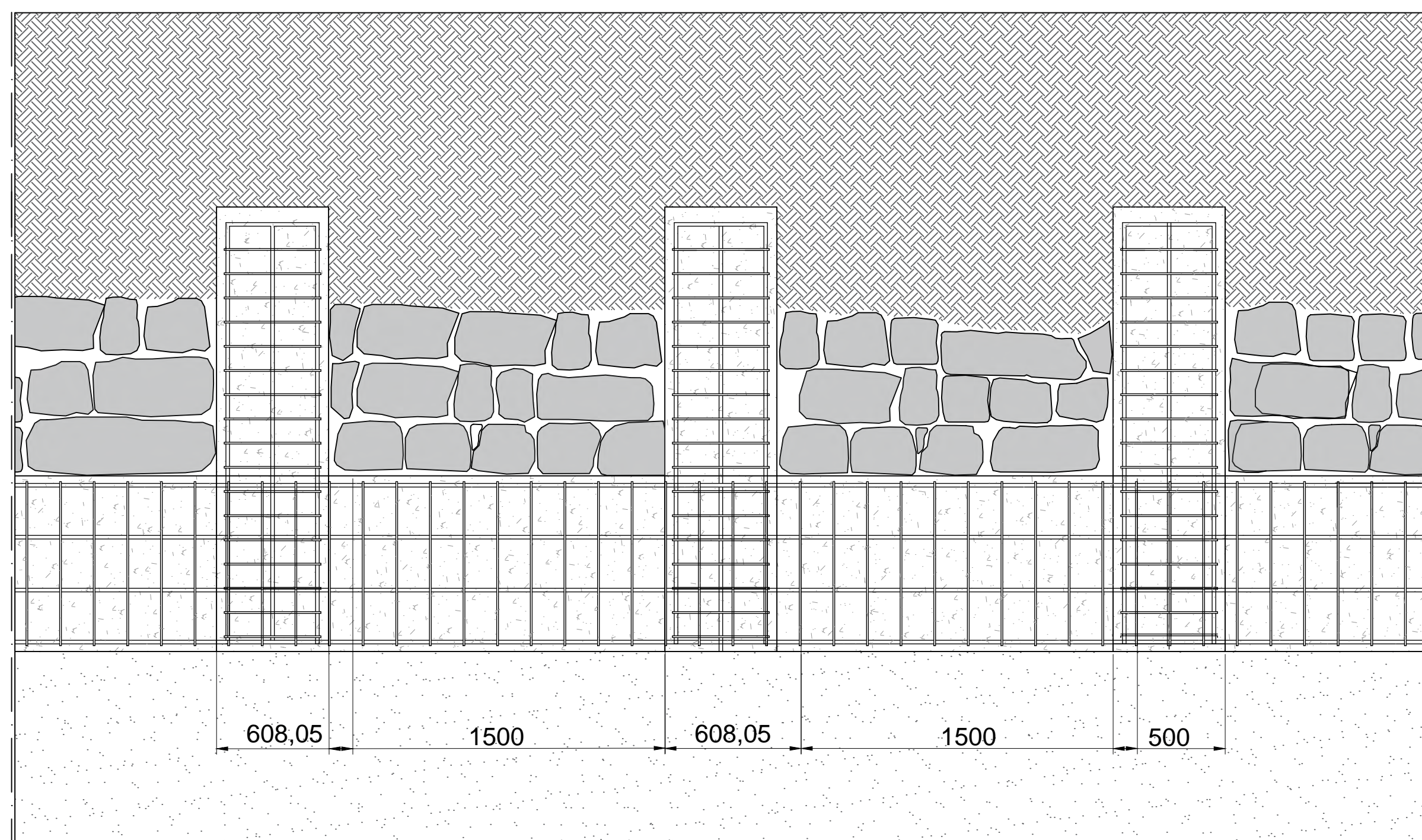
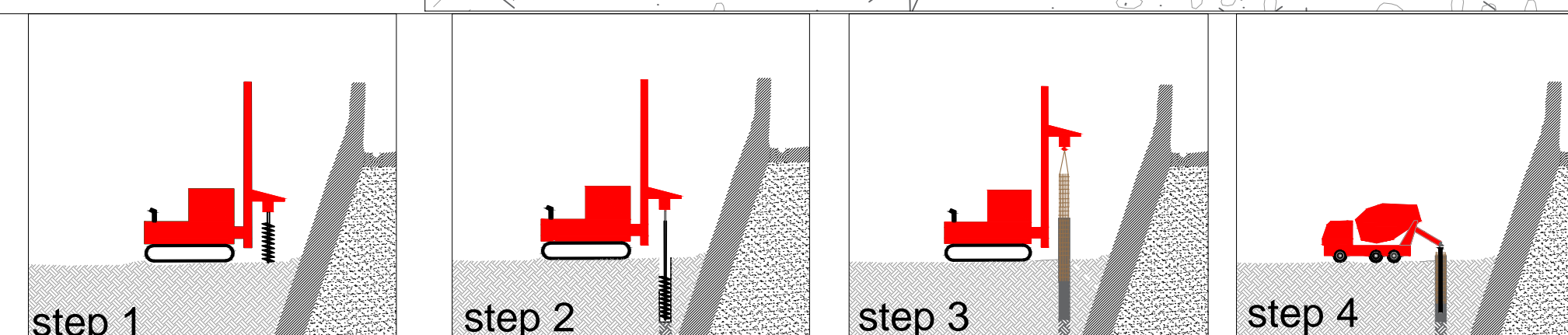
An important and significant general intervention, aimed at the strengthening of foundations system through the underpinning method, must be that relating to the construction of a continuous reinforced concrete side-beam, i.e. a sort of adjacent rib, placed at the level of the original foundation plan (predictably positioned at 1.20 - 1.40 meters below the ground level), anchored both to the masonry and to the ground behind, through reinforced concrete brackets with an axle distance of two meters from each other. The cross-section dimensions of the concrete side-beam are 0.80x0.50 m, those of the reinforced concrete brackets anchored to the behind structures are 0.50 x 0.50 m.

It is possible that the presence of some natural jumps in correspondence of the level of the original foundation oblige to realize a vertical offset of the foundation side-beam, without interrupting the continuity of the structure.

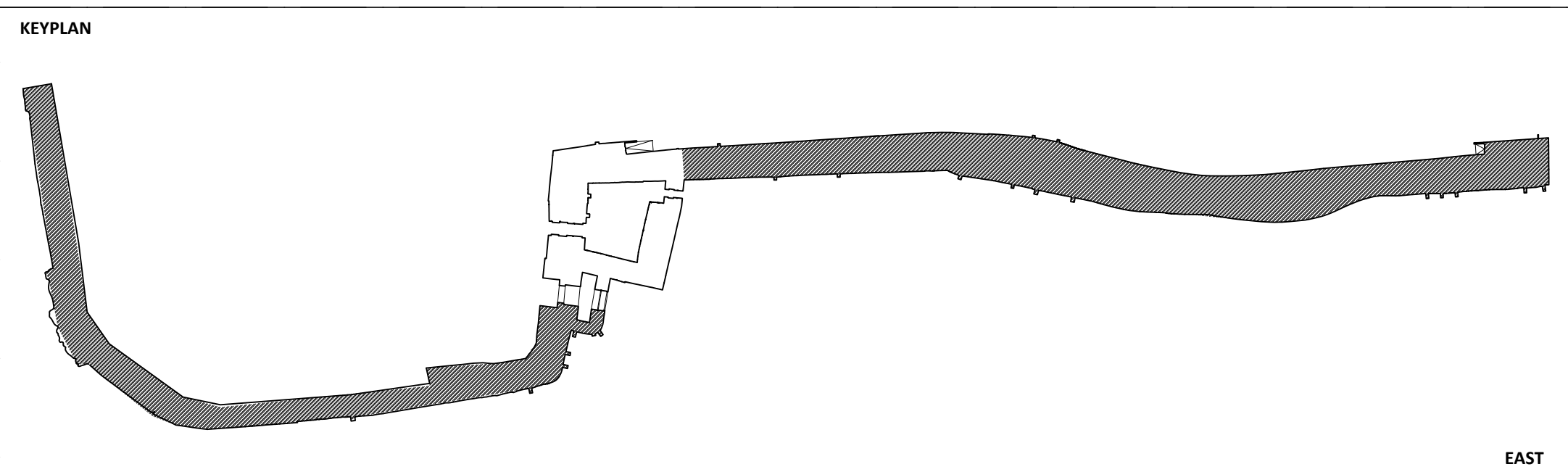


In correspondence of each intersections between the side-beam and the brackets, a reinforced concrete drilled piles, with a 30 cm diameter section and an insertion length in the ground of 8 meters, will be positioned.

The intervention described has the aim of re-stitching up, in continuity, the original system of foundations, constituting an enlargement of the base, for a better distribution of the pressure on the ground, and an effective protection against any phenomena of overturning or sliding of the masonry structures that make up the walls of the rampart.

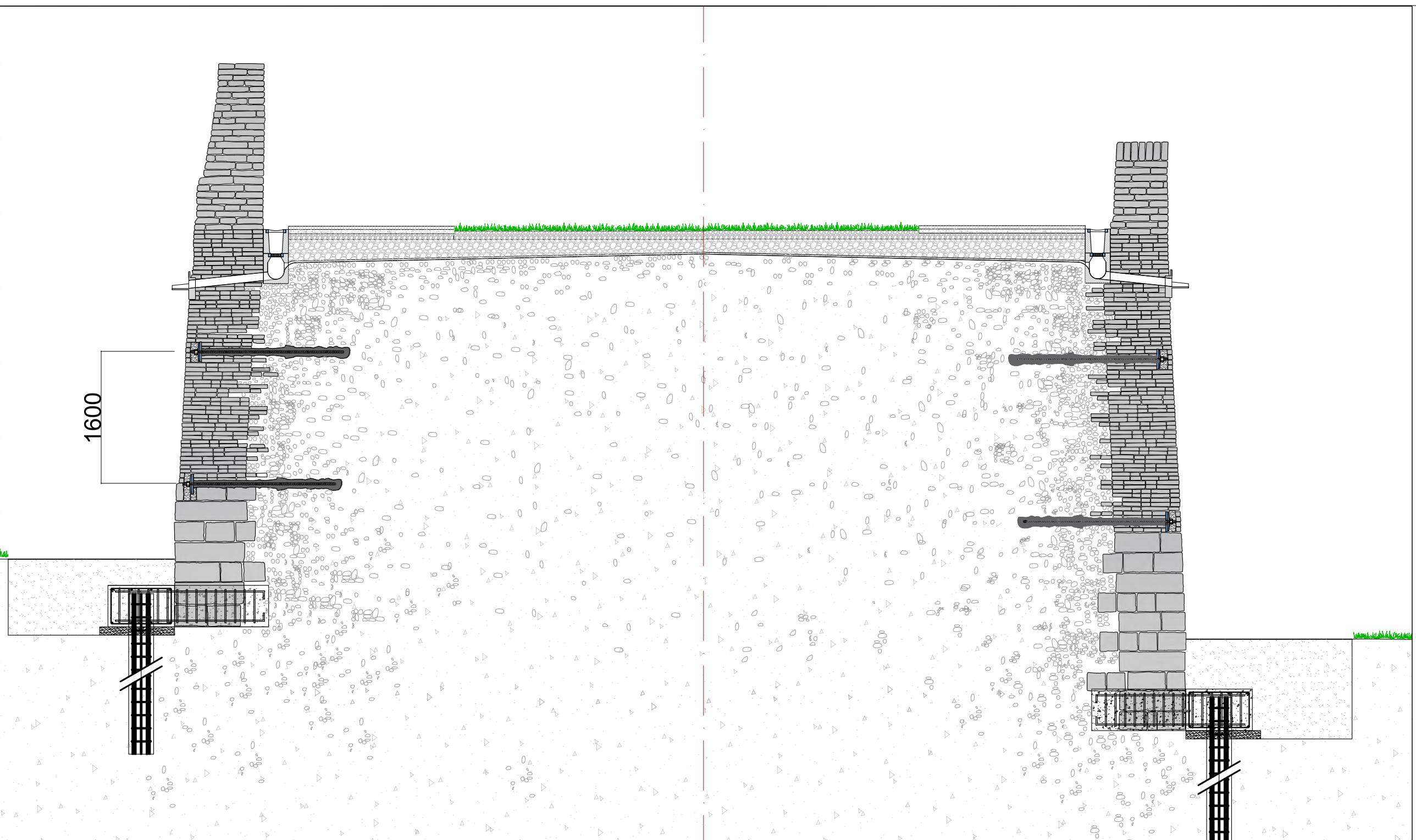


Transversal reinforced concrete bracket anchored to the behind wall structure and ground.



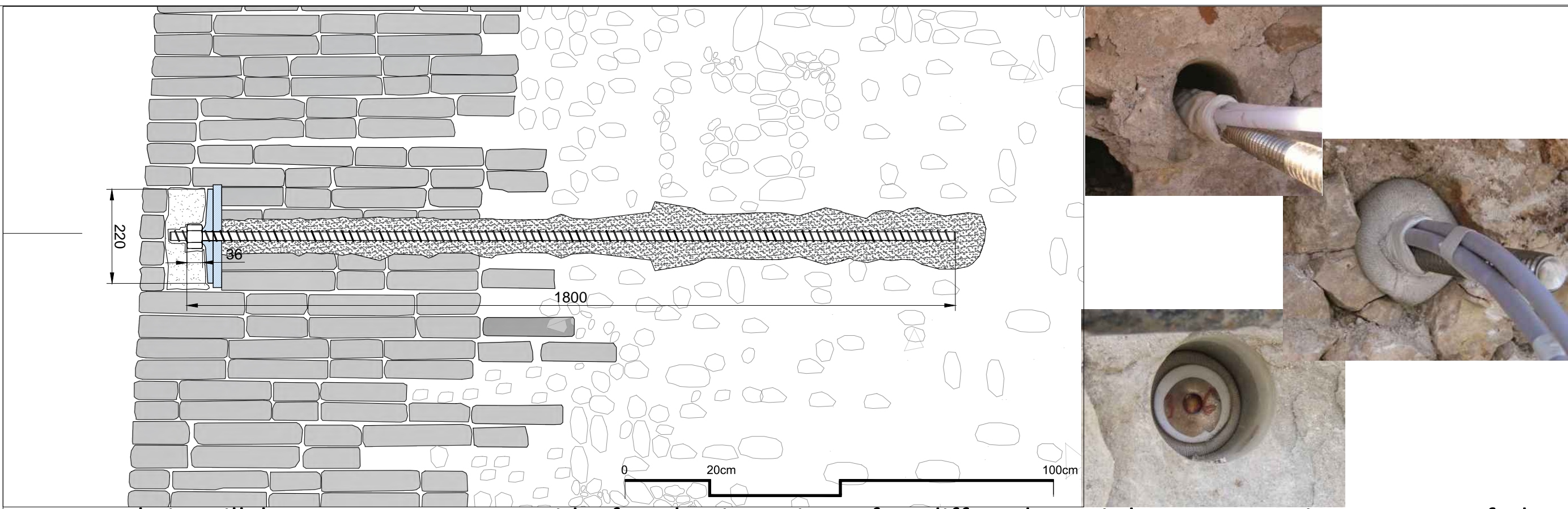
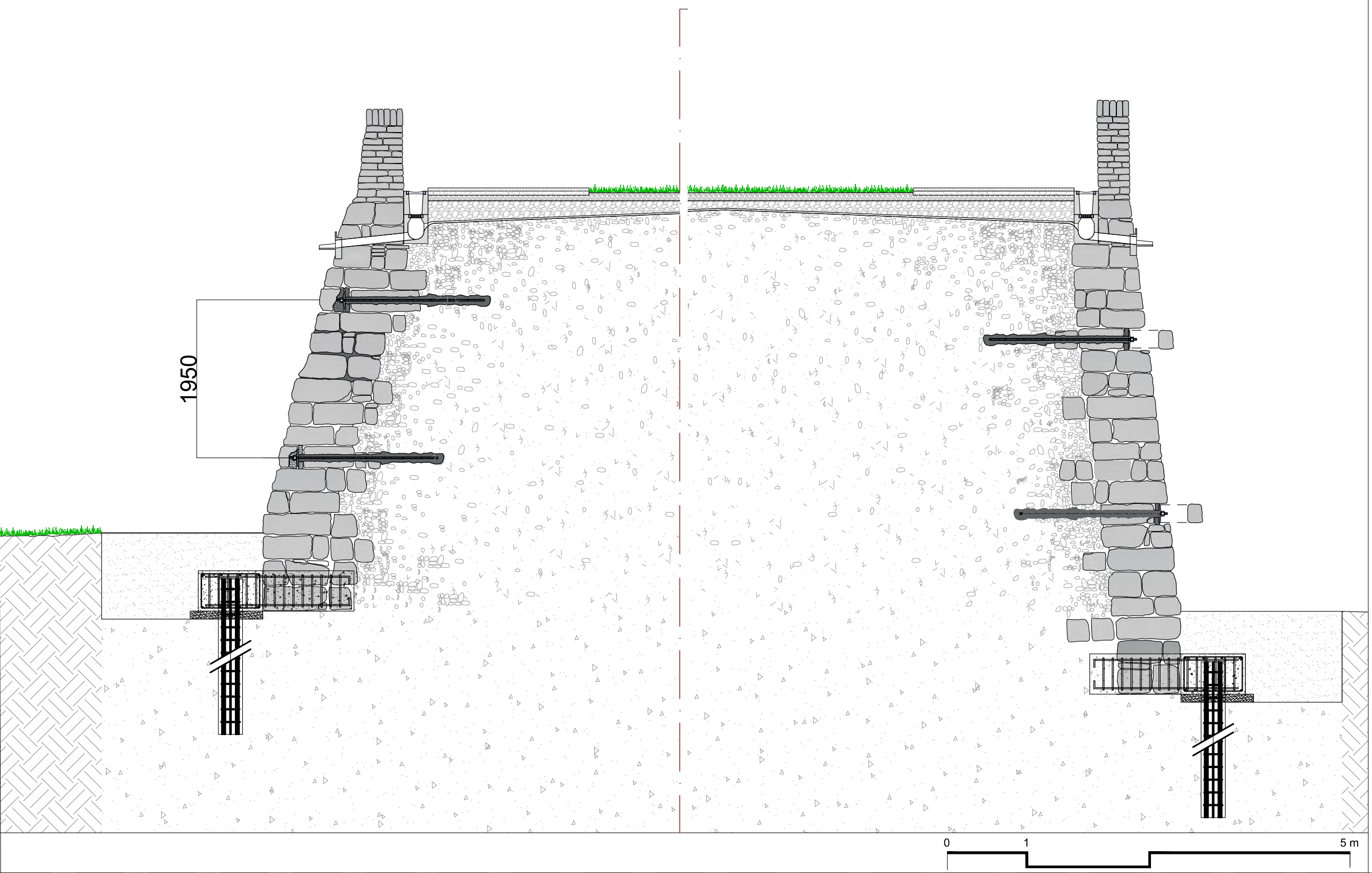
IMPROVEMENT OF THE CHARACTERISTICS OF INTERACTION AND RECONNECTION BETWEEN STONEMWORK OF THE WALL AND THE GROUND BEHIND, BELONGING TO THE INTERNAL EMBANKMENT, AIMED AT INCREASING THE STATIC CONSISTENCY AND THE STABILITY OF THE WALL STRUCTURA FACE.

SUZHOU'S CITY WALLS. INTERVENTION STRATEGIES FOR CONSOLIDATION, STRENGTHENING AND SAFEGUARDING



ARRAGEMENT OF THE ANCHORS on the wall must follow a quincunx geometry: This configuration is characterized by staggered parallel roes, with relative axle spacing in this case of about 2 meters.


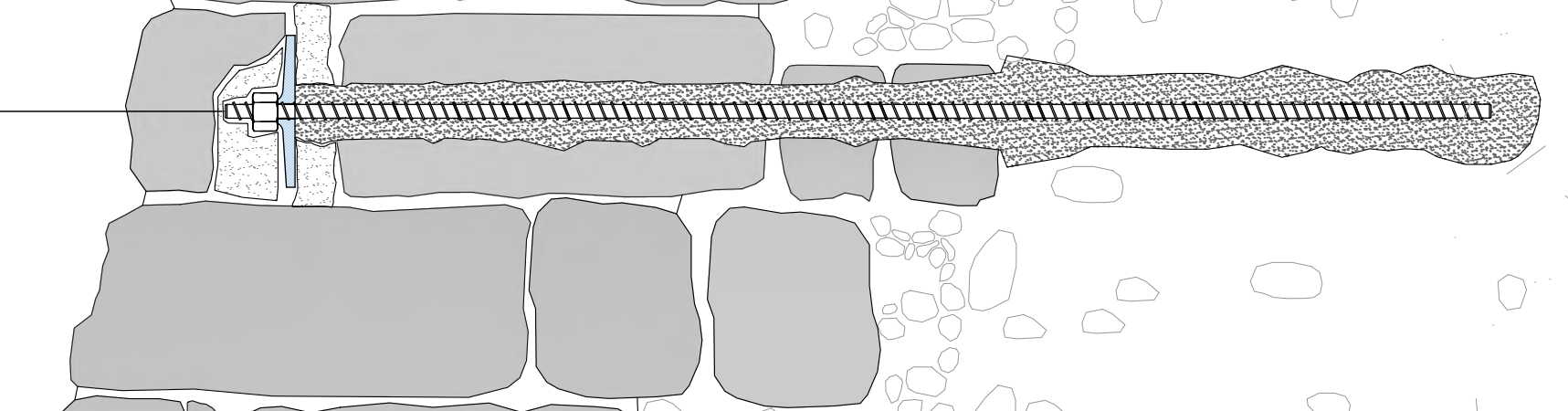
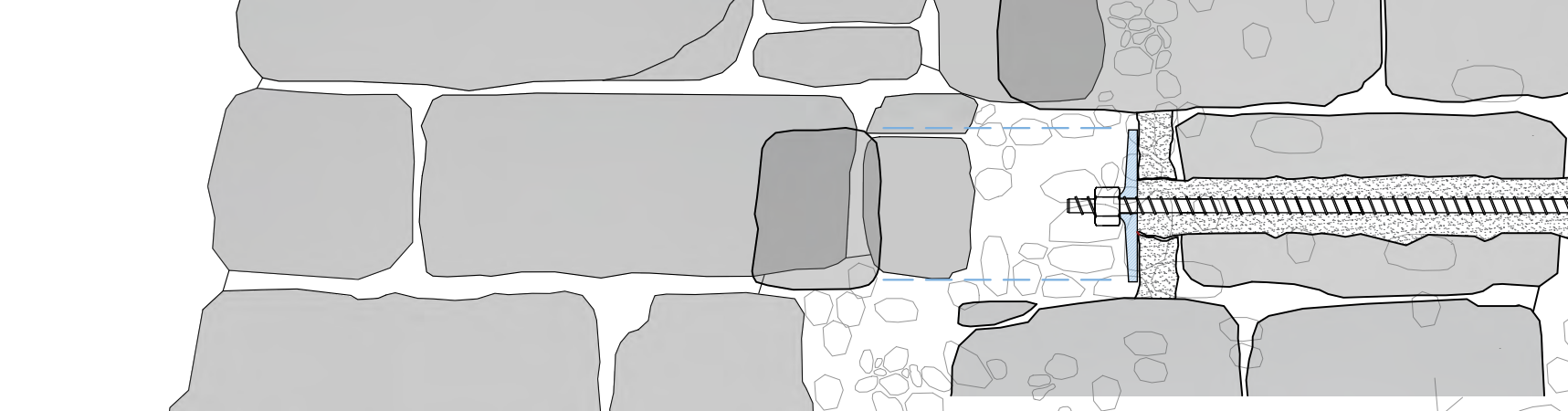
The position of the diaton varies by the extent necessary to remove a whole stone or bricks (minimazing the operazione), keeping the quincunx geometry



In general, it will be necessary to provide for the insertion of a diffused semi-deep connection system of the stonework front facing with the ground behind. This objective can be reached by adopting Bossong-type injected sock anchor devices (identifiable as a sort of artificial “diatons”), equipped with a bolt anchors positioned inside a niche specifically carried out in the masonry front apparatus of the wall, whether in the case that the latter be made of stone or brick elements.

The arrangement of these anchors on the wall must follow a quincunx geometry, that is a configuration characterized by staggered parallel rows, with relative axle spacing, in this case, of about 2 meters.

The intervention described has the function of making the wall stonework front facing and the ground behind interact, improving the anchoring and the general static consistency and the stability of the wall structural face.



GBOS P Injection controlled anchors with sock and PRESSTEC mortar with GBOS type bars

CODICE	ARTICOLO	TIPOLOGIA BARRA	MATERIALE
991200	GBOS 20-60 P	GBOS 20/304	inox AISI 304

DIAMETRO BARRA d_{barra} [mm]	DIAMETRO FORO d_{foro} [mm]	TIPO MALTA INIEZIONE
20	60	Presstec

GBOS
High resistance stainless steel bars with continuous thread

CODICE	ARTICOLO	MATERIALE	DIAMETRO BARRA d_{barra} [mm]	AREA [cm ²]	PESSO A METRO LUNGHEZZA MAX [m]
981120	GBOS 20/304	inox AISI 304	20	261	2,10 6000

TENSIONE DI ROTTURA A TRAZIONE (dovuta materiale)	TENSIONE DI SNERMENTO (dovuta materiale)	CARICO MIN. DI ROTTURA A TRAZIONE	CARICO MIN. DI SNERMENTO A TRAZIONE
f_{tmax} [N/mm ²]	f_{tmin} [N/mm ²]	N_{t} [kN]	N_{tmin} [kN]
750	650	196	170

BA-PLATE
stainless steel ribbed plate

CODICE	ARTICOLO	MATERIALE	DIAMETRO PASTRA [mm]	DIAMETRO BARRA d [mm]	DIAMETRO FORO D [mm]	SPESORE T [mm]
983922	BA-PLATE	inox AISI 304	220	d	d+2 mm	25

PRELIMINARY OPERATIONS - Extraction of one or more stone blocks or brick segments close the chosen anchor point

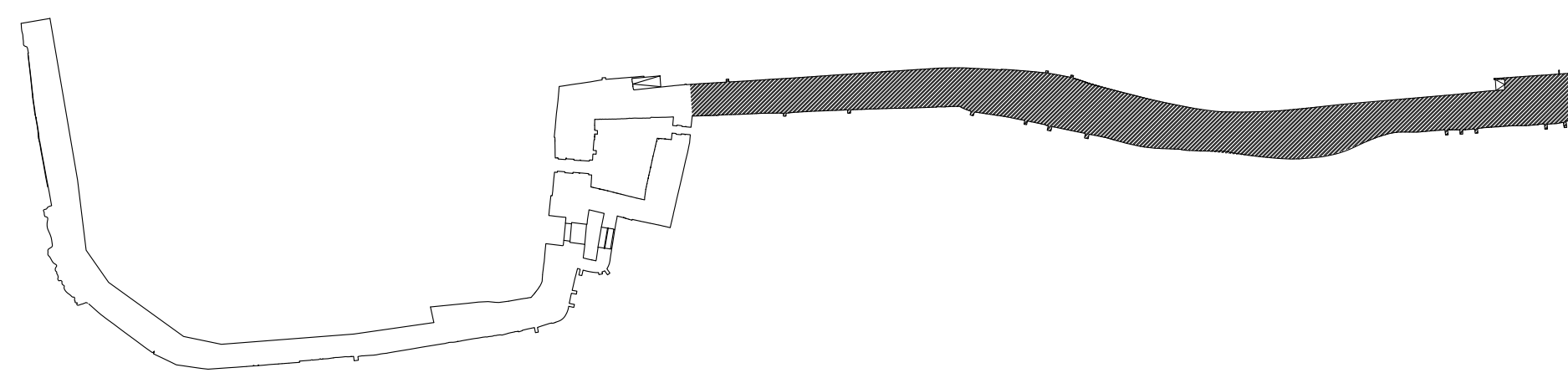
DRILLING - Anchors are embedded into boreholes made in the masonry to be strengthened through drilling machines with diamond bits, that work only with rotation movement in order to avoid vibration and percussion effects on the masonry.

The borehole diameter is designed according to anchors size: it is usually about three times the steel bar diameter; the length of the anchor is a parameter to be evaluated for the right choice of the borehole diameter.

ASSEMBLING AND INSTALLING - After drilling works, before installing injection anchor with sock, it is necessary to insert, inside drilled boreholes, the special Bossong plastic sleeves BOS-TP, of the correct diameter, in order to make the insertion of anchors easier and to avoid the re-drilling work in case of boreholes obstruction.

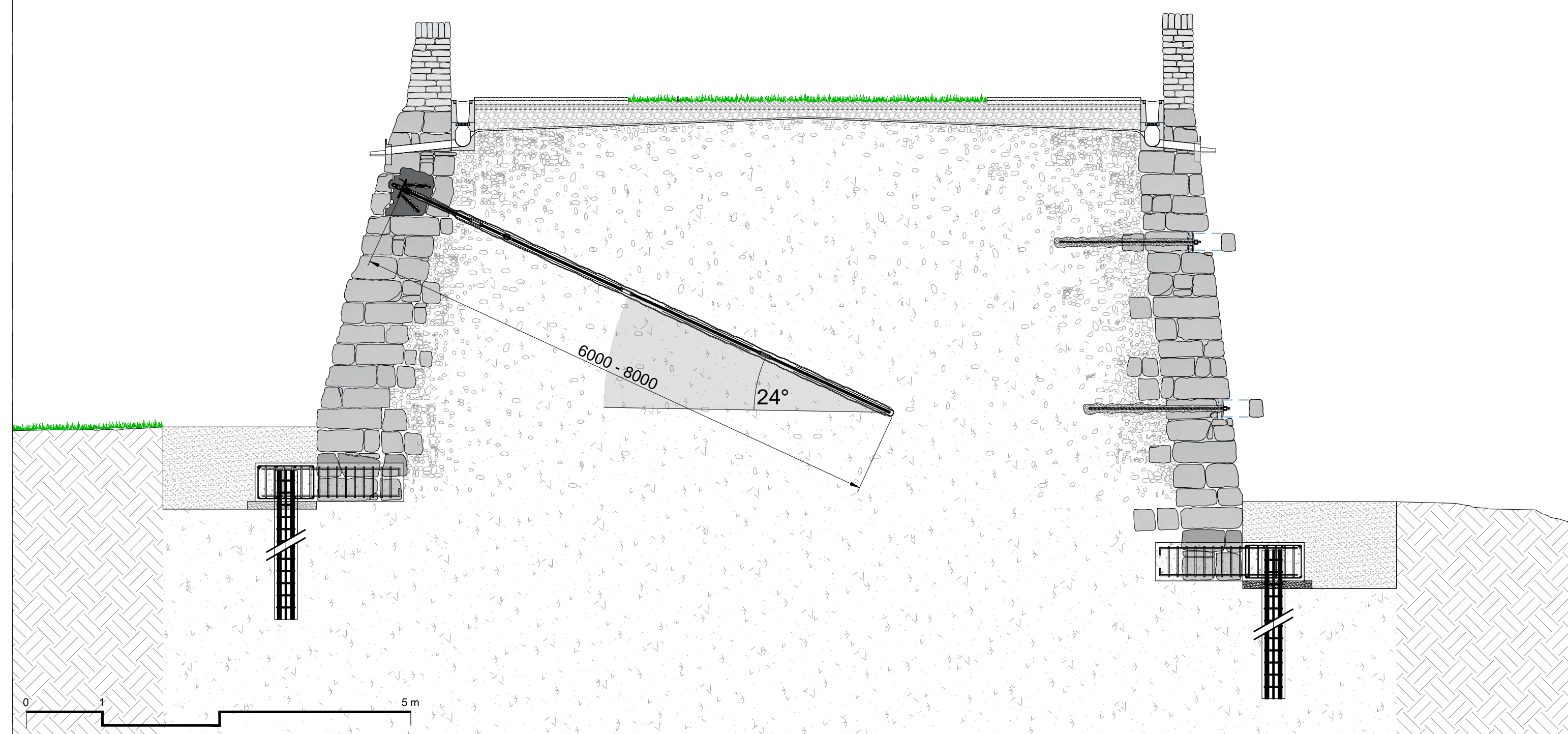
GROUT INJECTION - The special grout is a mixture especially designed to be injected into the fabric sock; the pre-packed product that consists of a binder added with different graded aggregates, when mixed with water, produce a pumpable grout that exhibits. After mixing, the grout is introduced in and into a pressure pot with pressure limits between 3-5 bars. The injection is done gradually until the anchor is fully injected.

FINAL PHASE OF THE INTERVENTION - Positioning of the stainless-steel ribbed plates and the tightening bolt and relocation of stone blocks or bricks.



DEEP ANCHORING OF THE MASONRY WALL WITH STEEL TIE RODS (Dywidag-type) POSITIONED WITH APPROPRIATE INCLINATION, AIMED AT PREVENTING ANY MECHANISMS OF OVERTURNING THE WALL FACE.

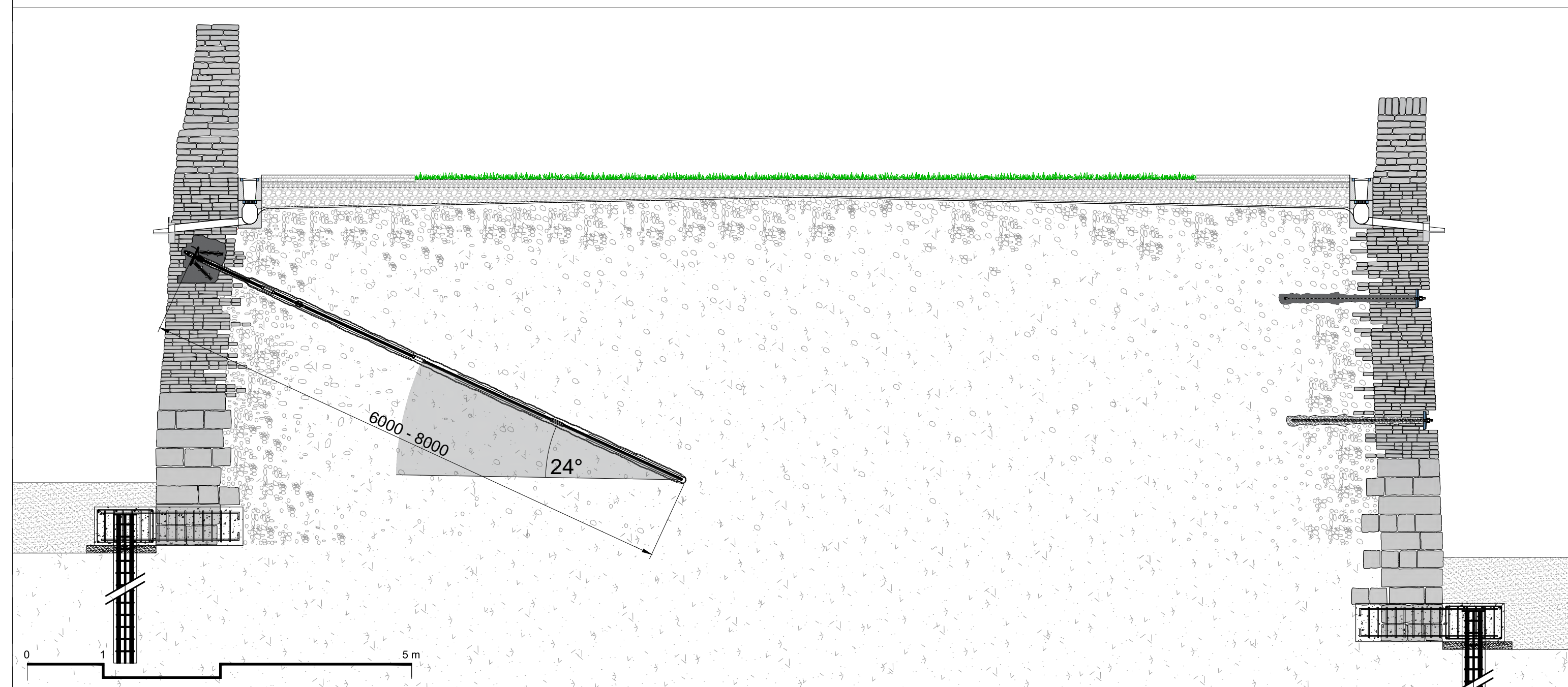
SUZHOU'S CITY WALLS. INTERVENTION STRATEGIES FOR CONSOLIDATION, STRENGTHENING AND SAFEGUARDING



The intervention is carried out at the most vertical wall fronts, which, as the analyzes have shown, are more exposed to the risk of overturning.

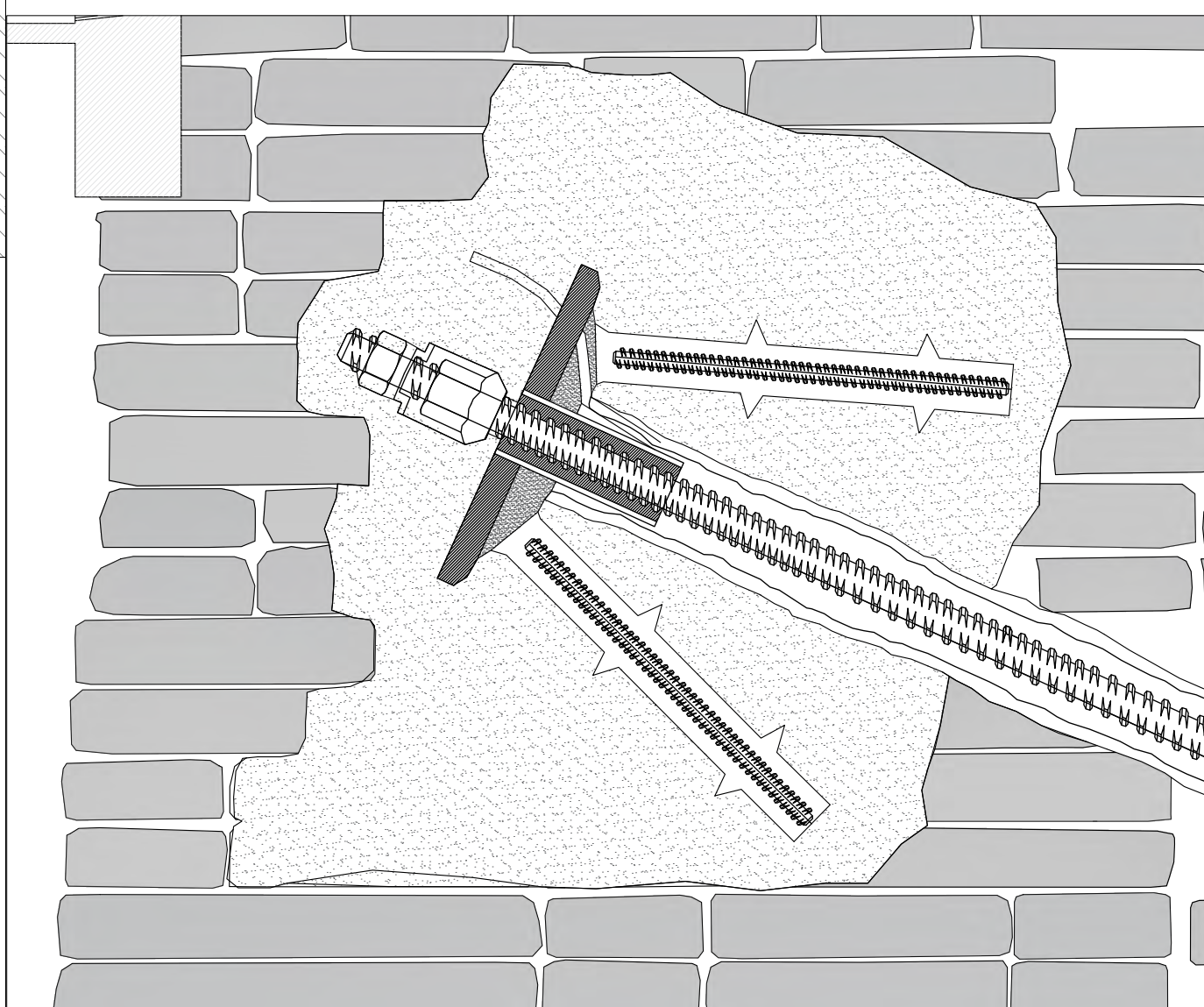
This type of intervention has also very specific characteristics, in the sense that it will be used exclusively at points particularly exposed to this type of risk.

DYWIDAG threadbar anchor is an actively tensioned ground anchor system completely independent of installation conditions on site as well as of existing deviations or alterations. Depending on requirements and steel grades, a variety of corrosion protection methods can be used.



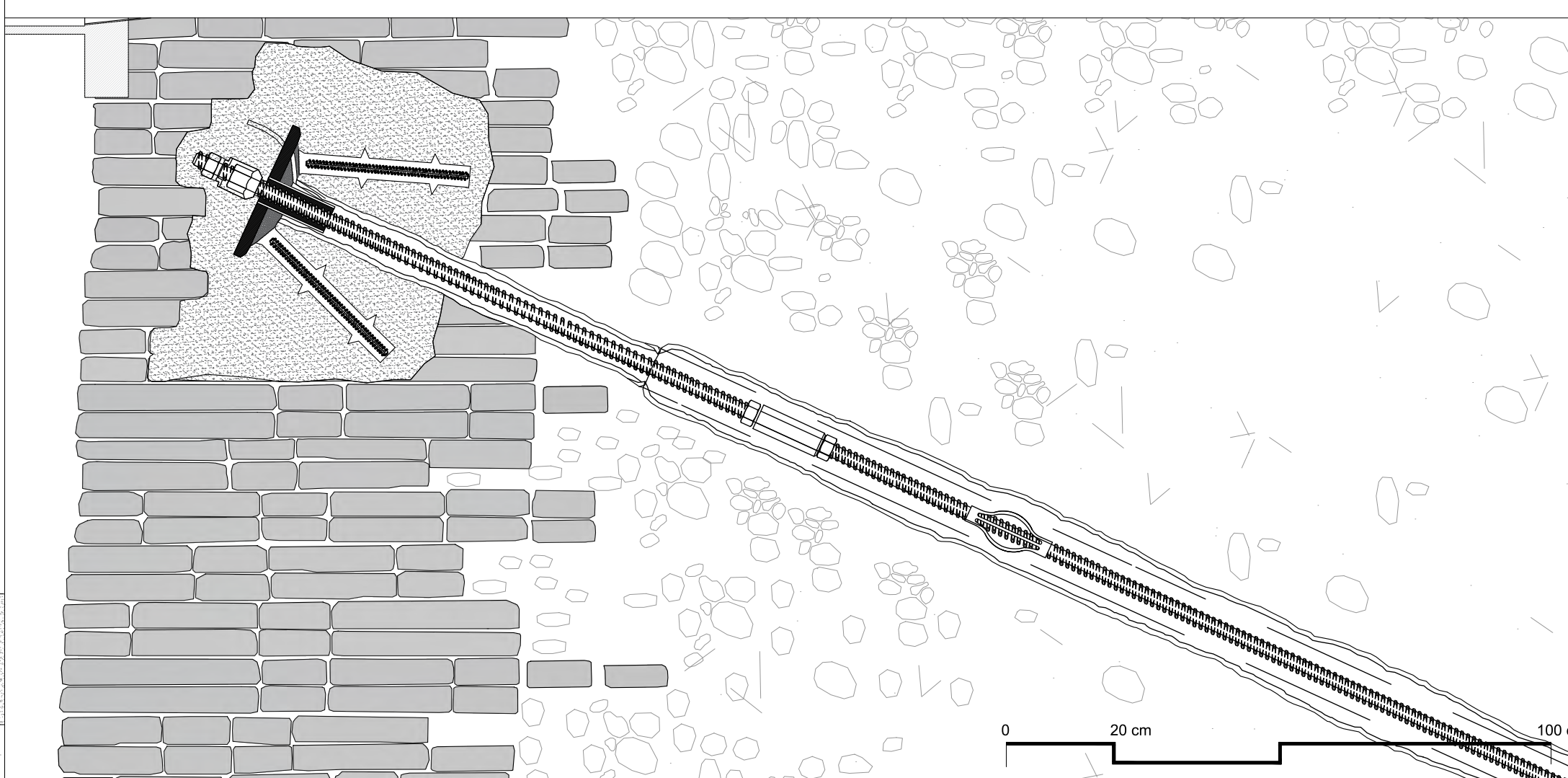
EXECUTIVE PHASES OF IMPLEMENTATION:

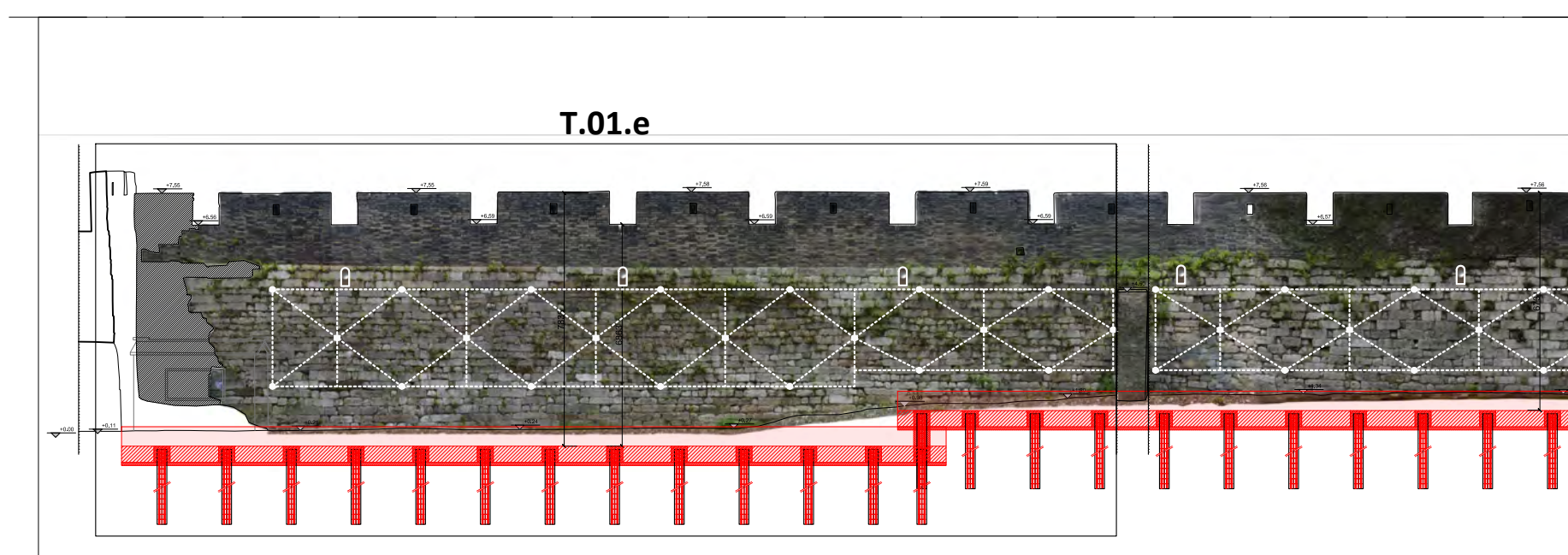
1. Removal of the first facing of bricks or stone elements and creation of a niche that houses the anchor head.
2. Execution of the main hole $\varnothing 100$ for the entire length (6 - 8 m), with an inclination of about 24° .
3. Drilling of holes $\varnothing 30$ for the insertion of the four head bars $\varnothing 18$, insertion of the bars with compensated shrinkage mortar resistant to sulphates.
4. Insertion of the main anchor rod $\varnothing 30$ in high resistance steel with continuous thread, complete with sleeves for prolonging the elements, special centering element, geotextile lining and injection tube.
5. Injection of compensated shrinkage sulphate-resistant cement mortar.
6. Once the injected mortar has matured, the head plate is installed and the tie rod is tensioned by tightening the nut ($F = 5$ ton).
7. Restoration of the open compartment in the masonry by means of the implementation of compensated shrinkage thixotropic cement mortar.
8. The load bearing capacity of each anchor is tested during an approval test.
9. Replacing of the brick or stone elements of the facade.



Description of the main elements that make up the tie rod system:

- Active tie rod total length variable between 6 and 8 meters.
- The head of the tie rod is surrounded by four $\varnothing 18$ threaded bars about $\varnothing 30$ cm long, which play the role of reinforcing the anchoring area.
- The main anchor rod $\varnothing 30$ is made of high-strength steel.

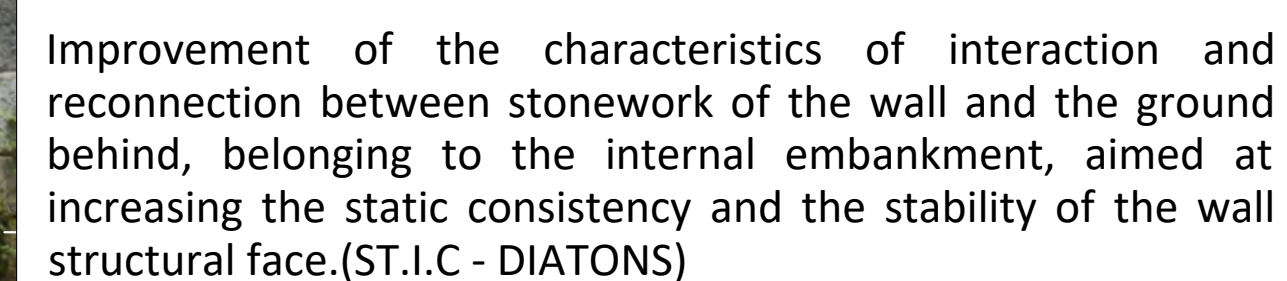




East South Front - Section T.01.e



INTERVENTION STRATEGIES FOR CONSOLIDATION, STRENGTHENING AND SAFEGUARDING: EAST SIDE



SECTION 65-65

