

BUILDING WATERPROOFING REMEDIATION APPLYING THE "TOTAL CUT" METHOD

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Abstract. *The paper analyzes the specific problems of construction of a waterproofing system with an absolute control of the vertical penetration of ground water and dampness from the ground into higher levels of building masonry structure. This method can very suitably be applied in rehabilitation of old brick buildings where the usual waterproofing remediation systems cannot be implemented because of specific structure system. The "total cut" method is very suitable for use in the old traditional masonry buildings, which do not have reinforced concrete vertical beams and where using this method would not interfere with the continuous stability of the building.*

Key words: *Building Waterproofing, total cut total barrier, total dampness remediation, barrier to capillary damp rising, ground water effects remediation.*

BASIC APPROACH TO PROPERTY REMEDIATION OF GROUND WATER AND DAMPNESS

The architectural wealth "handed over" to us by the previous generations obliges us to continue preservation of old structures, just as our predecessors did. Comparing the architecture at the level of present time social and technical development and the architecture of past centuries, we may clearly observe the gradual evolution of its development line from the original "ordinary" cave dwellings at the "ground" level, to the structures of unimaginable heights and audacious spatial and formal entities. Implementation of new construction systems and permanent application of new building materials, resulted in expansion of architecture in width and height, permitting at the same time enormously large structural spans and endless options in creation of spatial-formal entities.

In spite of such inexhaustible possibilities in creating spatial forms, there is one common characteristic of the old and new architectural building eras, and that is that almost every building base "rests" on the ground or its basement is dug in the ground. The influence of the "dug-in" part of the building on the above-ground levels of the old buildings manifested in various ways, in most cases it was extremely damp basement or cellar area,

or even water flooded rooms. This phenomenon was even more prominent in old buildings where the supporting structure deteriorates over time due to dilapidation of some structural materials.

Bearing this in mind and considering the current structural matrix of city entities, including the appearance of most of European cities, we can see, that the existing inherited city structural composition a minimum of 60 ÷ 65% of the old buildings, and somewhere the percentage is considerably higher. By this we are necessarily bound to approach the preservation of such architectural heritage very thoroughly and to find adequate rehabilitation methods in order to continue to preserve and conserve such structures.

Analyzing the structural composition of "**old**" buildings, we can conclude in most cases that these are mostly massive solid "**brick**" structures, whose walls are much thicker than in contemporary structures, and that they have structurally thicker walls at the ground level and in the basement area. The walls become thinner towards the top of the building. Also, it can be observed that lower levels of old buildings were in most cases made of monolith stone blocks and the upper storey levels mostly of brick masonry elements. With this general structure of old buildings in mind, we can conclude that such built-in materials over time lost their original consistent structure and became very susceptible to "**absorption**" and "**penetration**" of water and dampness through their weakened material structure.

Pursuant to the floor plan and depth to which such structures are dug-in the terrain, the "**uniform**" method cannot be applied for remediation and protection from aggressive long-term negative impact of groundwater and the penetration of dampness into structural load bearing walls of such buildings, thus each individual structure must be selectively considered, and appropriate method of rehabilitation and its waterproofing protection must be applied in accordance with its structural characteristics and size of the base.

BUILDING WATERPROOFING REMEDIATION APPLYING THE "TOTAL CUT" METHOD

The "**total cut**" method is a specific method and its application in rehabilitation of old buildings makes it possible to fully protect the property from further aggressive action of penetration of groundwater or dampness capillary rise from the lower parts of the structure up. Like any method this method has its specific conditions that must be met so that it could be effectively used. Application of this method is suitable for those traditional masonry buildings without waterproofing protection and with a dug-in basement, which does not mean it cannot be done in structures with dug-in basements. The most suitable facilities for this type of remediation would be structures with shallow foundations with the first floor being the ground floor level. To prevent the destructive effects of dampness on the further degradation of the materials incorporated in the supporting structural walls of the facility and further disruption of the stability of the whole structure, radical "**total cut**" measures are undertaken. New waterproof barrier is installed at structure base level across all the structural walls. It should be noted that when implementing the conventional method of machine cutting the walls at the base of the building there is a potential of the possible occurrence of partial "**settling**" and "**cracking**" of the structural walls of the building as well as the occurrence of major or minor cracks in bearing wall surfaces. Fig. 1, presents the cross section of an old building (the old steam bath house) with the scheme of a "**required**" cut through the "**lower**" base of the structural wall in order to completely check further penetration of water and dampness capillary rise in higher parts of the structure.

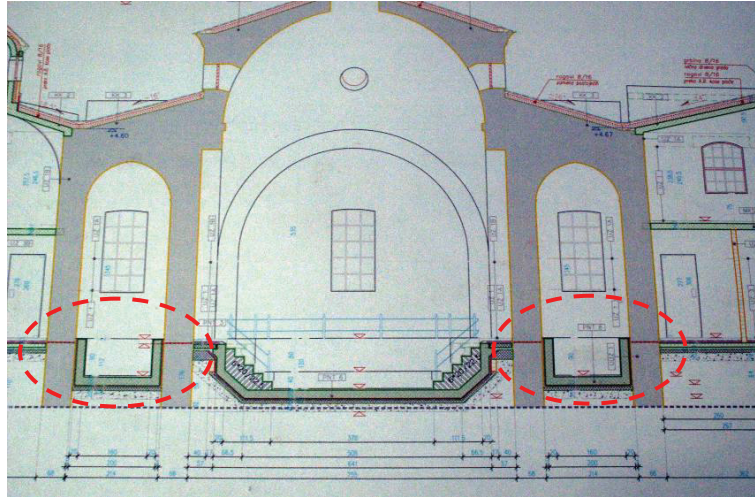


Fig. 1. A cross-section of the spa bath with the remediation scheme of "**total cut**" of bearing wall structure.

Using the method of "**total cut**" at the level of the lower base of structural walls the building stability is not disrupted, nor can any cracks appear in the integral bearing walls. Wall structure is sawed through by special ultra-fast "beaded" wire (see Fig. 2) whose beads are composed of special steel rings with titanium edges, or diamond dust coating. Using special high-speed apparatus in the process no interactive vibration shocks are transmitted to the structural composition of the building.

In Fig. 3 and Fig. 4, there are the details of the steel cutting wires rings where its structural composition can be viewed as a series of cutting "**beads**" mutually separated by spacers of elastic steel springs. Each bead or cutting "**ring**" is thus separated by a steel spring that allows the smooth "**sawing**", i.e. moving of "**cutting**" beads during cutting the wall structure.



Fig. 2. Special beaded wire for masonry cutting.

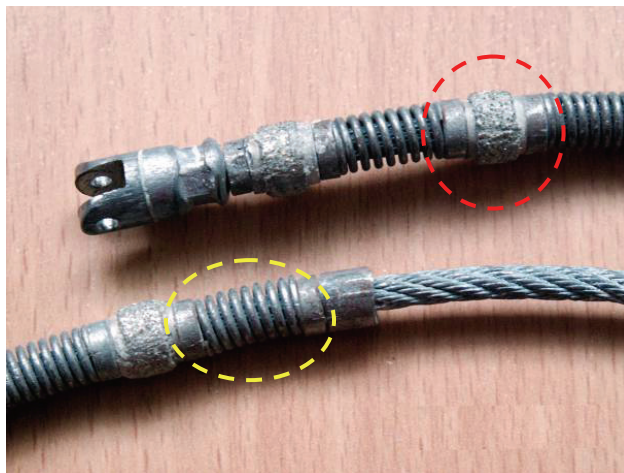


Fig. 3. Detail of bead rings with diamond dust and elastic springs lined on a steel wire

Cutting cable can be modified by inserting a variable size of beads on the wire to saw the cut in the wall structure, depending on the type of material the wall structure is made of (Fig. 3 and Fig. 4). After a cut in the wall structure has been made, the waterproofing ribbed strips of adjustable height are inserted, (spacing adjustment is done by grinding of the bilateral ribs depending on the spacing cut in wall by ultra high-speed cutting wires. Waterproofing splints barriers are laterally joined by insertion (slotting in the groove), which results in a firm continuous node in the cut made in the wall (see Fig. 5).

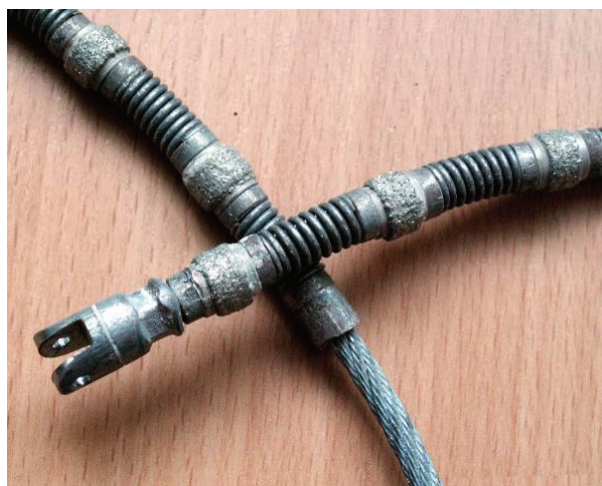


Fig. 4. A Detail of bead segments of cutting wire coated with diamond dust

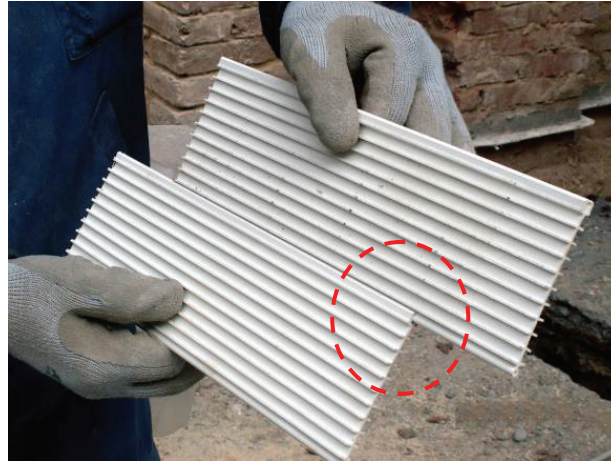


Fig. 5. Methods of connecting waterproofing bilateral ribbed strip barriers

Vertical ribs of waterproofing strip barriers are able to receive all the transferred wall loading of the upper part of the structure without any deformation (bending) and the potential settling of the "**sawed-through**" wall structure. The cut in the wall structure must be grouted with a special injection mass which is polymer-based with exceptional adhesive properties, so that along with the inserted "**ribbed strips**" it creates an unbreakable bond in the wall, i.e. in the newly-formed horizontal "**joint**".

The horizontal joint formed in this way presents a barrier to any further penetration of the ground water and rising damp from the terrain to higher levels of masonry building structure.

PHASES OF REMEDIATION OF BUILDINGS APPLYING "TOTAL CUT" METHOD

When remediating buildings from ground water ingress or applying total barrier control of rising damp to the higher parts of the structure applying "**total cut**" method, it is necessary to take into consideration the entire architecture and geometry the lower base of the building and arrangement of its structural system, i.e. construction system. When it is determined that this method is fully applicable regarding the specific technology and that it can be applied to the entire facility, then we can proceed with the further phase elaboration in the planning of the necessary remedial actions on the structure.

After this kind of consideration and analysis of the whole of the structure, the next phase of work can be undertaken and that is a wide excavation around the base of the walls exposed to permanent impact of water and damp rise (see Fig. 6). Fig. 6 displays the corner excavation around affected structures, where with the next phase of "**total cut**" of the wall will be executed and where remediation joint course will be realized.



Fig. 6. Wide excavation of the structure prepared for the execution of the remediation cut at the base of the wall construction

Joint "**cutting**" at the base foundations of the building is not executed simultaneously along the entire width of the base but in phased cuts, section cut by section cut in the wall structure. The phased cut, i.e. length of the joint cut in the wall depends on the assessment of the quality of wall structure its constructive material. The length of the cut in the wall must not be large so that it would not lead to the possibility of partial settling of the construction of the wall and thereby cause cracking in the bearing wall, fissures onset development of instability of the existing structure.

The initial incision in the wall construction can be started from a corner of a wall and near the base of the wall structure or from the selected section of the base wall. Fig. 7 presents the continuation of the partial total cut, as a continuation of the previously completed remediation cut.

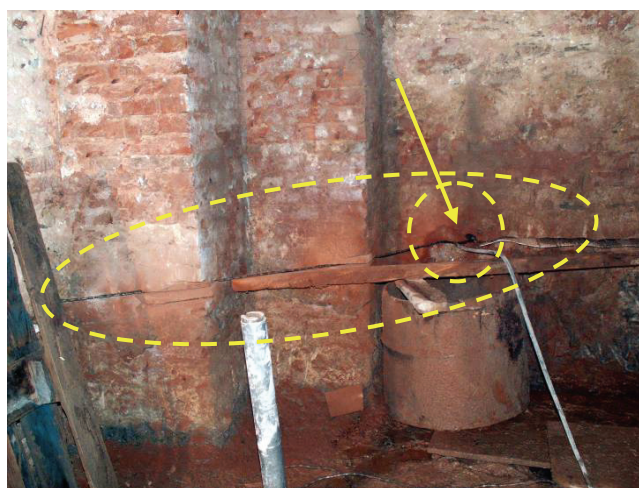


Fig. 7. Part of the wall structure where it is a partial diamond wire cut is performed

To initiate the action of "**total cut**" of remediation joint in the wall construction, it is necessary to drill the appropriate opening (hole) in the wall through which the beaded cutting wire will be inserted (see Fig. 8, fig.9). When the beaded cutting wire has been inserted through the hole made in the wall it is lead to the next hole in the wall, which will be to the desired cut section length. After insertion in the wall, the beaded cutting wire is connected to the regulatory turbo machine that has been well anchored (fixed) previously to the floor surface in order to provide stable course of cutting (see Fig. 11). If necessary, the additional control circular fixing anchor "**node**" is added to provide a better cutting sweep.

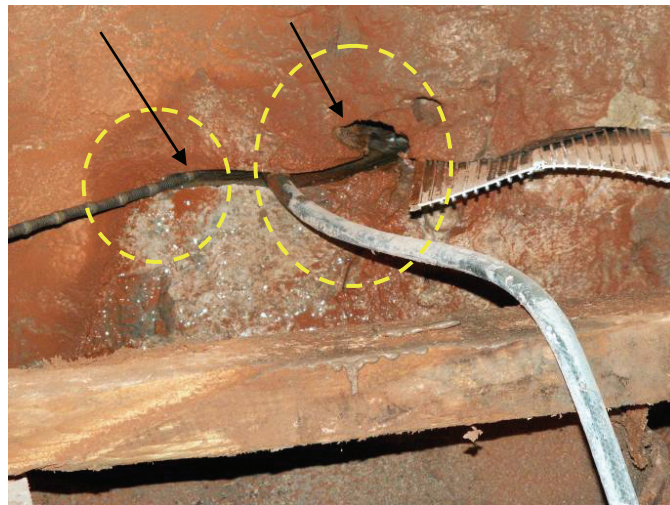


Fig. 8. Details of continuation of total cutting in respect to the previously completed cut section



Fig. 9. Blowing and wetting of the joint during the masonry cutting process

In the course of turbo cutting it is necessary to occasionally wet the joint so as to improve the cutting process and to prevent dust generated in the process from expanding. Also, preferably, a special compressor pump to pull out a new cutting dust resulting from cutting joints (see Fig. 10).



Fig. 10. View of the wall section being cut



Fig. 11. Part of regulation turbo machine used for circular motion of the beaded cutting wire

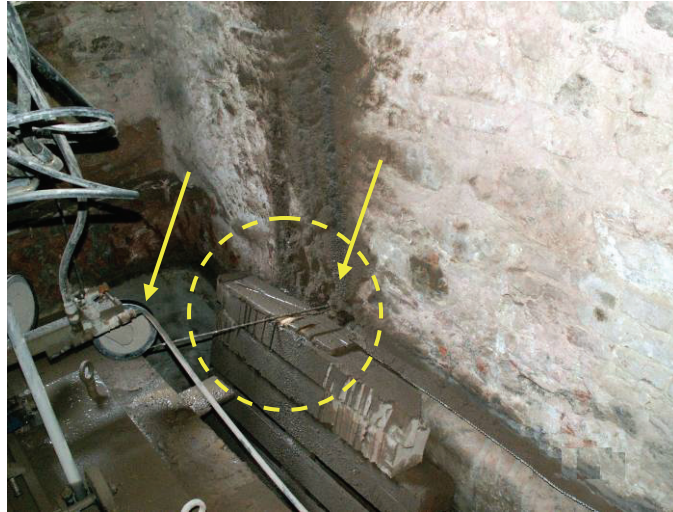


Fig. 12. View of a part of the beaded cutting wire exiting the wall and the tension pulley on a turbo machine

When the beaded cutting wire in its circular motion exits on the outer side of the wall construction, it is necessary to implement an additional fixed "**bracings**" plate support in order to complete the planned cutting interval on the wall structure (see Fig. 13).



Fig. 13. Fixed outer bracings plate assembly as a cutting wire support (anchor)

If the newly realized remediation joint needs additional corrective action in terms of a possible smoothing of the formed cutting surface or further expansion of its height, it can be done later using a special hand-held electric saw (see Fig. 14).



Fig. 14. Auxiliary manual cutting hand-held saws for a possible correction of irregularities of the joint cut or widening of an already existing joint in the wall construction

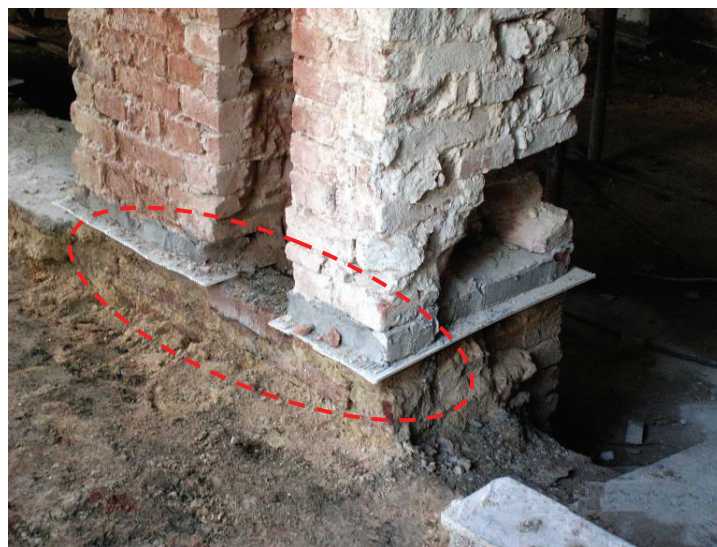


Fig. 15. Achieving total waterproofing barrier on the "short" structural part of the building

The cutting process concerning columns and smaller retaining walls in the building should be made in at least two phased cuts. The first phased cut, would be done to a "half" of the cross-section of the base of the treated column or a short retaining wall, then the cut would be fixed by inserting the waterproofing bilateral ribbed strip barriers and the emulsion mixture would be injected on both sides of the cut. After the joint hardening,

another phase of the "**total cut**" procedure of remaining part of the supporting structure would be commenced. Using such method any potential undesirable settling of the sawed-through part of the structure, and disruption of its stability, i.e. overall stability of the building would be avoided.



Fig. 16. Total waterproofing barrier constructed in the corner part of the wall structure



Fig. 17. Horizontal total waterproofing barrier with emulsion filling in the wall of the structure

In Fig. 17, presents the finalized total waterproofing barrier, which shows total cut of the wall construction without any further possibility of direct water penetration or rising damp from the lower parts of the terrain. Embedded polymer ribbed strip barriers completely took over entire load of upper wall structure without any potential settling.

If for structural reasons or inherited defects (dilapidation) of the structure a single horizontal cut cannot be done then the cascade cut should be done (see Fig. 18), with the required vertical barrier "**connecting**" of two separated horizontal cuts, i.e. joints. Also, in some specific cases, where the horizontal cut cannot be done entirely in the lower part of the wall base (see Fig. 19) and depending on how deep the wall is dug in the terrain on the exterior it is may be necessary perform a cascade horizontal "**overlapping**" of the "**total cut**" with required level difference (spacing).



Fig. 18. Cascade total waterproofing barrier joint with emulsion filling of the wall section of the structure

During the execution of "**total cut**" method one must to try to construct rehabilitation "**joints**" as low as possible the wall base reduce the dampness resulting from underground water penetration or rising damp.

Applying this method fully established a total protection from further aggressive influence of groundwater and negative capillary moisture, because the polymer ribbed strip barrier is a physical break in the wall construction and injecting emulsion mixture on both sides of the inserted barrier creates a new integrated continuum of the newly formed joint with upper and lower part of wall structure.



Fig. 19. Cascade total waterproofing barrier "joint" on the corner part of the wall of the structure



Fig. 20. Provides an example from the practice, of a constructed horizontal waterproofing total barrier in a remediated old spa building

CONCLUSION

The **"total cut"** method can be very effectively applied in remediation of old masonry buildings whose supporting structure has been dilapidated by long-time negative impact of groundwater or of permanent damp rising.

Using this method in structures with **"specific"** base geometry and skeletal structural system **"total"** protection against further destructive ground water penetration and rising damp into the upper levels of the structure can be implemented.

The most suitable facilities for the use of this kind of remediation are shallow foundation structures with the first floor being the ground floor level and which do not have vertical ring beams.

To prevent the destructive effects of dampness on the further degradation of the materials incorporated in the supporting structural walls of the facility and further disruption of the stability of the whole structure, radical **"total cut"** measures are undertaken. In this case this means installing a total waterproof barrier.

Using the method of **"total cut"** at the level of the lower base of structural walls the building stability is not disrupted, nor can any settling of the treated wall section neither any cracks in the integral bearing walls can appear.

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SANACIJA HIDROIZOLACIJE OBJEKTA PRIMENOM METODE "TOTALNOG REZA"

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U radu se obrađuje specifična problematika izvođenja hidroizolacionog sistema s totalnim prekidom vertikalnog prodora podzemne vode kao i vlage iz terena u više nivoe zidne konstrukcije objekta. Ova metoda veoma je pogodna kod primene sanacije starih zidanih objekata gde se zbog specifikuma arhitektonsko konstruktivnog sklopa ne mogu primeniti uobičajeni hidroizolacioni sanacioni sistemi.

Metoda "totalnog reza" veoma je pogodna za primenu kod starih klasično zidanih objekata, kod kojih nemamo ugrađene vertikalne armiranobetonske serklaže kod kojih bi se primena ove metode poremetila kontinualna stabilnost tretiranog objekta.

Ključne reči: Hidroizolacija objekta, totalni rez, totalna barijera, totalna sanacija od vlage, prekid kapilarnog penjanja, sanacija od podzemne vode