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TEMA: STRUTTURE

TITOLO: UN MODELLO MATEMATICO PER L'ANALISI DELLO STRESS NELLE COSTRUZIONI IN MURATURA.

SOMMARIO:

In questo saggio viene trattato un approccio allo sviluppo dell'analisi degli sforzi ai quali sono sottoposte le costruzioni in muratura, considerate « materiale non resistente a tensione », caratterizzato da elementi ben definiti.

Il modello usato è un « modello reticolare » che permette di ottenere la soluzione mediante la condizione stazionaria dell'energia complementare, associata ad un sistema di ineguaglianze.

Il problema da risolvere è quello classico della programmazione quadratica, il quale diventa un « problema di complementarietà lineare » che, secondo i teoremi di Kuhn e Tucker, può essere risolto con il « metodo più semplice ».

In termini fisici, quest'ultimo metodo permette di applicare alcune forze « frenanti » ai modelli di spranghe soggetti a tensione, e di rianalizzare l'effetto di tali forze, finché ogni tensione stressante sarà ridotta ad una quantità irrilevante.

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ADHESIVES IN MASONRY STRUCTURES: EXPERIMENTAL ANALYSIS

Introduction

A great deal of interest has been recently devoted to masonry structures, their use and restoration. Such interest seems to be characterized by problems of structure stability and by morphological considerations As far as reliability of structures must be warranted, the particular problems we intend to deal with can show complex and new uncertainties. These are, for instance, in the lacking of complete and detailed codes for the analysis of such structures, for the implementation of research layouts and for the evaluation of available data.

From this point of view, recent and original contributions have been developed about the use of synthetic resins, by means of impregnation " in vacuo ", since such procedures can be very effective in existing masonry works.

In the same time, we may define a process-strategy for the structural restoration of masonry by means of local or extended use of resins, what implies also a new definition of the framework itself. To this aim, several experimental date must be obviously available, as they are necessary to the control of mechanical parameters.

The object of the present study is mainly aimed to a comparison program between the natural material and the processed one.

Advances

The use of traditional materials has been extended, in recent decades, to other materials where particular chemical technologies are applied, so to obtain consistently better performances. For instance, we may refer to the wide range of concrete types today available, and to the several chemical processes which may be applied to them. In particular, it is well known the possibility of increasing the strength properties of normal and light concretes, when these are impregnated by polymers. The so obtained higher values of compressive strength make the use of such processed concretes fairly advantageous, in comparison of other materials, in the case of compressive stress state only. On the other hand, a generalized use of such materials is not yet possible, in consequence of their low tensile strength.

Nowadays, it is fairly clear that no reliable technique is available to control the use of stone materials when tensile stresses are not negligible. Modern technology faces the problem of no-tension behaviour of masonry, by scarcely effective means such as prestressing or tensile reinforcements.

We must note, however, that tensile stresses which must be taken into account are seldom concentrated in local areas, but they often are diffusely distributed in the whole structure, and act together with other types of stresses. Such reasons may justify the following assumption: low values of tensile unitary strength may be sufficient to warrant the overall structural response to external loads. From this point of view, several attempts have been made to consider and solve the problem of improving the tensile strength of masonry. This loads to the gluing techniques or — more precisely — to the processing of masonry by synthetic resins.

Such procedures have been already tested in steel frame links, with the aim to improve alternative techniques, others than welding and bolts. Actual references about such topic mainly deal with the glued joint behaviour under different load conditions (mechanical, thermal or chemical). So, the gluing technique never involves the whole framework, except than in the interactive effects of the single joints with the overall structure. On the contrary, we are concerned with adhesives not only as structural links, but as catalysts of the general structural assembly. Therefore, the aim is to define a structural material which is still heterogeneous in its internal constitutive characteristics, but its processing warrants a small uniformity in mechanical behaviour, both under tensile and compressive actions. So, the common assumptions of masonry as continuum may be justified and closely related

to the actual behaviour of such material. Therefore, the applied technology — by impregnation of porous material with vacua — must warrant a sure diffusion in the overall frame of the mechanical effects and of the physical changes produced by the used resins (see photos 1 and 2 at end of text). Such technique has been adopted since today for the restoration and strengthening of surface layers in buildings and monuments, or in order to stop physical damage of materials. This procedure may be now proposed with specific structural aims. The impregnation process and the required instruments do not depend on the type of chemical product to be injected: this fact is fairly remarkable to make its use available in different problems of structural restoration. Besides, it is obvious that the impregnation process by resins is quite advisable when structures and materials to be restored are rather damaged; in this case, the micro-crak pattern may simplify capillarity seepage with more diffuse and effective effects of the process.

Furthermore, optimal conditions for links may be obtained in vacuum. The assumption of the constitution of a new material, once the process is complete, seems to be likely and suitable, since the process involves the interlink vacua, but also the interstitial holes of the structural material. Such operations may be easily worked in situ: the procedure can be adapted to the existing conditions in the site, so that the restoration technique results in homogeneous and unitary process techniques, otherwise not easy to obtain. In the structural restoration it is very important to reinforce the cracked or damaged parts without removing or taking down any element. We must also notice that the different steps of the impregnation process do not depend on the dimensional scale of the work, both for modes and order of procedures. The object to be processed is recovered — on all surfaces from down upward — by polythene sheets, under which pressure is decreased as much as the wanted vacuum-state requires, depending also on the depth of the impregnation to be done. At the same time, from tanks which are distributed on the surfaces, the resin is sucked in, the vacua are saturated together with the more easily accessible holes. So, the degree of impregnation depends on the capacity of the exhaust system, on the capillarity penetration and finally on the viscosity of the matter. With reference to this latter problem, we must notice the possibility of increasing the fluidity properties of the solution, by means of suitable diluents. These have no sensible effects on the mechanical properties of the resin and on its action, but the penetration is fairly increased. The same results can be obtained by heating the resin, in order to reduce the molecular links within the matter, until the values of the required fluidity are reached. Anyhow, while the absorption capacity of a porous medium could be theoretically considered as completed, once all the vacua have been saturated, on the contrary, the granular configuration of the matter, its thickness, different types of resistance, produce practical restraints of the possibilities of quick seepage, with definite depths. Beyond these limits, the impregnation process is still possible, but seems quite expensive and no more advantageous. However, particular characteristics of the work and its importance may still justify a generalized use of such technique, without limits in terms of economical criteria.

The present research concerns mainly experimental problems and methods. Since no available reference exists for the resin-processed masonry, we must refer to experimental results and testing procedure.

Experimental tests

The aim of the projected tests was the evaluation of the strength properties of stone materials, under mechanical actions, in order to study the behaviour changes of such properties, by means of experimental results. With reference to the U.N.I. Code three sets of samples have been defined. They had in common the shape and the dimensional parameters, as well as the processing modes:

1st set - cm. 4 x cm. 4 x cm. 16 heavy brick single beams
2nd set - cm. 4 x cm. 4 x cm. 16 plastic mortar beams
3nd set - cm. 4 x cm. 4 x cm. 16 plastic mortar and brick beams, concrete with different gradings.

Each set, except than the first, has been subdivided into three subsets of 36 elements. Among these subsets, the first collects the specimens with materials in its natural state, the remainder two subsets are made by samples processed with epoxy and polyester resins. The choice of these resins, among the wide range of available structural adhesives, depends on their good strength properties, and on their ability to transfer such properties to the impregnated parts of the structural material. They can polimeryze at room temperature and show appreciable resistance against chemical and environmental damage. Furthermore, some properties of theirs can be modified by means of fillers, so to satisfy a greater set of requirements. If suitable fillers are melted, density, shrinkage and thermal elongation may be reduced. Furthermore, such resins may be processed by liquid modifiers, just as reactive diluents, which can reduced viscosity while combining with the polymerized systems, without altering its properties.

On the contrary, the bending strength, the chemical and high temperature strength can be increased. In particular, the epoxy resins, unlike the polyesters, polymerize with fairly neglectable shrinkage. As a consequence, internal stresses are minimized, with hardening of a more durable cohesive link. Unlike the others, the first sample set is made of five subsets, rather than three: each constituted by 36 elements.

Besides the three subsets which are in common to the remainder sets, two others are added, where acrylic and silane resin processed specimens are added. No particular requirement has suggested to process with two different resins the same type of structural elements.

Since they are not commonly classified as structural adhesives in the recent literature, their use has been confined to one sample with the only aim to check their ability to improve the strength. The obtained results, however, are particularly interesting for a correct use of silane resins, generally used to make masonry waterproof and to stop physical damage. The first sample subset, with no processing, has been used as reference point for comparison of resulting data.

The drying period of the plastic mortar and of the concrete has been deduced by the U.N.I. Code, while that of the resins has been as long as necessary to complete polymerization. We must notice that the complete impregnation of materials (brick, mortar or concrete) has been possible only for silane resins, due to their low viscosity, since no particular tools or fluidificant fillers were available. The other resins made the seepage possible through a $1. \div 3.0$ mm. thickness. Anyway the impregnation with resins to greater depths would have poor practical significance: in fact, the large scale of building restoration implies many technical problems for the total impregnation of materials, and the related procedures seem to be excessively fail-safe.

For each set of samples three typeset ultimate strength tests have been carried out: every specimen has been subjected to tensile stresses in the bending test, according U.N.I. 6133; for a stump of each sample, cracked by bending, the compressive axial test has been carried out according U.N.I. 6134, the other has been used for the indirect tensile strength test, according U.N.I. 6135.

Test results

Tensile test on brick specimens: The results of the tensile test on treated brick samples show a generalized increment on the tensile strength. Particularly, considerable increments have been obtained by use of epoxy resin (+70%) and acrylic resin (+10%), that do not impregnate the samples completely because of their characteristic viscosity. But a surface film forms that is able to resist tensile stresses as well as a reinforcement. A less increment of strength is obtainable by use of polyester resin (+4%): in fact, the thickness of its film is more thin and the resin reaches a greater depth.

These evaluations are confirmed in the treatment with silane resins that impregnate the samples completely, without causing any " reinforcing effect "; their use does not bring notable changes in behaviour of the samples, with the exception of a light increment of the tensile strength (+4%). Together with the reinforcing effect, a lower dimensional variation can be found in the results, whose are more affected by the regular behaviour of the resins (see table " A ", tables 1, 2, 3, 4, 5 and figures 1, 2, 3, 4, 5).

Compressive test on brick specimens: The results of the compressive test show a decrement of strength in all the samples but the ones treated with silane resins. In fact, the partial penetration of the resins cannot modify the properties of the whole material and it gives rise to two opposed effects: the formed resin envelope causes an advantageous " circling effect " on the one hand, on the other a detrimental " lubrication ", which decreases the friction between platen and sample. When the film of resin is thicker and more resistant, the two effects are almost equal and the compression strength does not change (epoxy resins). As the thick of the resin film gradually decreases, the friction effect becomes more and more decisive. So, we can justify the fictitious diminution of the compression strength obtained by polyester (about —20%) and acrylic (about —15%) resins, whose film is almost inexistent. Using the silane resin, we obtain an increment of the compression strength, certainly ascribable to the absence of the effects mentioned above, and, therefore, to the improvement of the material properties. Besides, this increment is the same of tensile tests (see table " A ", tables 6, 7, 8, 9, 10 and figures 6, 7, 8, 9, 10).

Indirect tensile test on brick specimen: The results obtained by indirect tensile test seem to make more evident the specific strength of the material, which is less affected by the test conditions. It is more simple to think about the strength of the treated material. Its increment is more appreciable using more deeply impregnating resins (polyester and silane resins); of course, it is higher using more resistant resins (polyester 40%, acrylic 5%, silane 35%). No increment of strength has been noticed in the samples treated by epoxy resins (see table " A ", tables 11, 12, 13, 14, 15 and figures 11, 12, 13, 14, 15).

Tests on mortar and concrete specimens: The results obtained by mortar or mortar and brick conglomerate confirm the evaluations issued from the analysis of the brick samples.

Differences, sometimes notable, of results and evaluation on the efficiency of the various resins, seem to advise a contemporary use of several resins in the same consolidating process: repeating the impregnating treatment by resins with different viscosity, more satisfying results are obtainable.

Conclusion

The executed tests lead to general evaluations. The use of the resins offers the great opportunity of improving the mechanical characteristics of brick and masonry. The prospect of employment is much more interesting when we place under treatment not the only material, but the whole masonry with its discontinuity, its joints and eventual cracks. The tests confirm the possibility of a structural use of resins and they allow to define new criteria of approach to planning and restoring processes.

The remarkable increasing of the bending strength due to surface impregnation shows that an extended use of the resin in the overall material may be considered unnecessary. On the other hand, it is useful, to concentrate the resin process to those parts of the structure, where natural stiffness of material is practically negligible, while the gluing effect are decisive. From this point of view, several interesting new problems arise from taking into account tensile strengthened parts of the masonry, by means of local use of resins.

Initial homogeneity of material — at least in its overall behaviour, not in its internal structure — is no more maintened, since it shows very different characteristics. Now, the aim is to define not only the different strength properties available by resins, but the analytical evaluation of the overall mechanical behaviour in structural elements which are heterogeneous in the inside. To get such aim means the possibility of stating a computational procedure for the " a priori " evaluation of the strength characteristics in such structures, just in the same way as this is possible in the reinforced concrete or in the steel-concrete structural analysis.

We must also notice that the tensile strength values and the elastic moduli of the resins (much lower than in steel) will never allow to keep closely the analogy with the reinforced concrete theory: the criteria for using such resins must obviously be different. These elements, in fact, should be viewed as catalysts of the frame continuity, as long as they help and allow different alternating structural layouts, depending on the adjusting behaviour of frame in the load history, while compressive state of stress will remain, all the same, prevailing.

In point of fact, it is a question of using up the resources of the compression strength in masonry, giving it suitable and localized tensile strength.

Notation

$\bar{x} = \Sigma x_i/n$	arithmetical mean
x_i	value of a performance
n	numerousness of samples
$s_{\bar{x}} = s/\sqrt{\bar{n}}$	standard error of mean
$s = \sqrt{\Sigma(x_i-\bar{x})^2/(n-1)}$	standard deviation
$P\% = s_{\bar{x}}/\bar{x}$	error per cent
$I\% = (\bar{x}_t-\bar{x}_n)/\bar{x}_n$	increment per cent
$\bar{x}_t$	arithmetical mean of values obtained by treated samples
$\bar{x}_u$	arithmetical mean of values obtained by untreated samples
k'	limits of classes
k_1', k_2'	lower and upper limit of classes
k	center of classes
f, $f\%$	frequency and frequency per cent
$\Sigma f\%$	sum of the frequencies per cent on upper limits

Table « A »

Brick	Tensile test $\bar{x}$	$s_{\bar{x}}$	P%	I%	Compressive test $\bar{x}$	$s_{\bar{x}}$	P%	I%	Indirect tensile test $\bar{x}$	$s_{\bar{x}}$	P%	I%
untreated	57.6	6.6	11.4	—	335.0	30.5	9.0	—	22.7	3.0	13.2	—
with epoxy resin	96.5	2.5	2.6	+ 67.6	333.0	22.5	6.7	— 0.5	22.6	1.1	4.8	— 0.4
with polyester resin	59.9	3.5	5.9	+ 3.8	235.0	18.4	7.8	— 29.8	31.6	2.7	8.5	+ 39.2
with acrylic resin	63.0	3.5	5.5	+ 9.3	280.0	16.0	5.7	— 16.4	23.8	2.3	9.7	+ 4.8
with silane resin	60.0	5.0	8.6	+ 4.2	352.0	44.0	12.5	+ 5.0	30.7	4.0	13.0	+ 35.2

Table « B »

Mortar	Tensile test $\bar{x}$	$s_{\bar{x}}$	P%	I%	Compressive test $\bar{x}$	$s_{\bar{x}}$	P%	I%	Indirect tensile test $\bar{x}$	$s_{\bar{x}}$	P%	I%
untreated	83.2	3.5	4.2	—	460.0	18.0	3.9	—	39.8	2.9	7.3	—
with epoxy resin	112.0	2.1	1.9	+ 34.6	435.0	17.3	3.9	— 5.4	38.8	2.8	7.2	— 2.5
with polyester resin	101.0	1.8	1.8	+ 21.3	350.0	12.0	3.0	— 15.2	41.0	2.9	7.0	+ 3.0

Table « C »

Concrete	Tensile test $\bar{x}$	$s_{\bar{x}}$	P%	I%	Compressive test $\bar{x}$	$s_{\bar{x}}$	P%	I%	Indirect tensile test $\bar{x}$	$s_{\bar{x}}$	P%	I%
untreated	46.7	1.3	2.8	—	320.0	11.5	3.6	—	26.9	1.5	5.5	—
with epoxy resin	67.0	2.0	2.9	+ 43.4	284.0	17.1	6.0	— 11.0	26.7	1.4	5.2	— 0.7
with polyester resin	58.6	1.7	2.9	+ 25.5	282.0	8.5	3.0	— 12.0	27.2	1.6	6.0	+ 1.1

(according U.N.I. 4723)

TABLE 1. - UNTREATED BRICK

Tensile test

k'_1	k'_2	k	f	f%	Σf%
30	39.9	34.95	2	5.5	5.5
40	49.9	44.95	9	25.0	30.5
50	59.9	54.95	14	38.8	69.4
60	69.9	64.95	8	22.2	91.6
70	79.9	74.95	3	8.3	99.9

TABLE 2. - BRICK WITH EPOXY RESIN

Tensile test

k'_1	k'_2	k	f	f%	Σf%
60	69.9	64.95	2	5.5	5.5
70	79.9	74.95	5	13.8	19.4
80	89.9	84.95	6	16.6	31.6
90	99.9	94.95	9	25.0	61.1
100	109.9	104.95	7	19.4	80.5
110	119.9	114.95	5	13.8	94.4
120	129.9	124.95	2	5.5	99.9

TABLE 3. - BRICK WITH POLYESTER RESIN

Tensile test

k'_1	k'_2	k	f	f%	Σf%
40	44.9	42.45	2	5.5	5.5
45	49.9	47.45	4	11.1	16.6
50	54.9	52.45	5	13.8	30.5
55	59.9	57.45	10	27.7	58.3
60	64.9	62.45	6	16.6	74.9
65	69.9	67.45	5	13.8	88.8
70	74.9	72.45	3	8.3	97.2
75	79.9	77.45	1	2.7	99.9

TABLE 4. - BRICK WITH ACRYLIC RESIN

Tensile test

k'_1	k'_2	k	f	f%	Σf%
35	44.9	39.95	2	5.5	5.5
45	54.9	49.95	7	19.4	25.0
55	64.9	59.95	16	44.4	69.4
65	74.9	69.95	6	16.6	86.1
75	84.9	79.95	5	13.8	99.9

TABLE 5. - BRICK WITH SILANE RESIN

Tensile test

k'_1	k'_2	k	f	f%	Σf%
45	49.9	47.45	3	8.3	8.3
50	54.9	52.45	7	19.4	27.7
55	59.9	57.45	12	33.3	61.1
60	64.9	62.45	8	22.2	83.3
65	69.9	67.45	4	11.1	94.4
70	74.9	72.45	2	5.5	99.9

TABLE 6. - UNTREATED BRICK

Compressive test

k'_1	k'_2	k	f	f%	Σf%
250	299.9	274.95	8	22.2	22.2
300	349.9	324.95	14	38.8	61.1
350	399.9	374.95	10	27.7	88.8
400	449.9	424.95	4	11.1	99.9

TABLE 7. - BRICK WITH EPOXY RESIN

Compressive test

k'_1	k'_2	k	f	f%	Σf%
200	249.9	224.95	3	8.3	8.3
250	299.9	274.95	8	22.2	30.5
300	349.9	324.95	12	33.3	63.8
350	399.9	374.95	5	13.8	77.7
400	449.9	424.95	3	8.3	86.1
450	499.9	474.95	3	8.3	94.9
500	549.9	524.95	2	5.5	99.9

TABLE 8. - BRICK WITH POLYESTER RESIN

Compressive test

k'_1	k'_2	k	f	f%	Σf%
100	149.9	124.95	4	11.1	11.1
150	199.9	174.95	6	16.6	27.7
200	249.9	224.95	12	33.3	61.1
250	299.9	274.95	7	19.4	80.5
300	349.9	324.95	5	13.8	94.4
350	399.9	374.95	2	5.5	99.9

TABLE 9. - BRICK WITH ACRYLIC RESIN

Compressive test

k'					
k'_1	k'_2	k	f	f%	Σf%
150	199.9	174.95	6	$16.\overline{6}$	$16.\overline{6}$
200	249.9	224.95	7	$19.\overline{4}$	$36.\overline{1}$
250	299.9	274.95	11	$30.\overline{5}$	$66.\overline{6}$
300	349.9	324.95	9	$25.\overline{0}$	$91.\overline{6}$
350	399.9	374.95	2	$5.\overline{5}$	$97.\overline{2}$
400	449.9	424.95	1	$2.\overline{7}$	$99.\overline{9}$

TABLE 10. - BRICK WITH SILANE RESIN

Compressive test

k'					
k'_1	k'_2	k	f	f%	Σf%
170	219.9	194.95	2	$5.\overline{5}$	$5.\overline{5}$
220	269.9	244.95	3	$8.\overline{3}$	$13.\overline{8}$
270	319.9	294.95	6	$16.\overline{6}$	$30.\overline{5}$
320	369.9	344.95	15	$41.\overline{6}$	$72.\overline{2}$
370	419.9	394.95	7	$19.\overline{4}$	$91.\overline{6}$
420	469.9	444.95	3	$8.\overline{3}$	$99.\overline{9}$

TABLE 11. - UNTREATED BRICK

Indirect tensile test

k'					
k'_1	k'_2	k	f	f%	Σf%
10	14.9	12.45	5	$13.\overline{8}$	$13.\overline{8}$
15	19.9	17.45	12	$33.\overline{3}$	$47.\overline{2}$
20	24.9	22.45	13	$36.\overline{1}$	$83.\overline{3}$
25	29.9	27.45	3	$8.\overline{3}$	$91.\overline{6}$
30	34.9	32.45	2	$5.\overline{5}$	$97.\overline{2}$
35	39.9	37.45	1	$2.\overline{7}$	$99.\overline{9}$

TABLE 12. - BRICK WITH EPOXY RESIN

Indirect tensile test

k'					
k'_1	k'_2	k	f	f%	Σf%
20	20.9	20.45	3	$8.\overline{3}$	$8.\overline{3}$
21	21.9	21.45	8	$22.\overline{2}$	$30.\overline{5}$
22	22.9	22.45	14	$38.\overline{8}$	$69.\overline{4}$
23	23.9	23.45	6	$16.\overline{6}$	$86.\overline{1}$
24	24.9	24.45	3	$8.\overline{3}$	$94.\overline{4}$
25	25.9	25.45	2	$5.\overline{5}$	$99.\overline{9}$

TABLE 13. - BRICK WITH POLYESTER RESIN

Indirect tensile test

k'					
k'_1	k'_2	k	f	f%	Σf%
15	19.9	17.45	3	$8.\overline{3}$	$8.\overline{3}$
20	24.9	22.45	4	$11.\overline{1}$	$19.\overline{4}$
25	29.9	27.45	5	$13.\overline{8}$	$33.\overline{3}$
30	34.9	32.45	14	$38.\overline{8}$	$72.\overline{2}$
35	39.9	37.45	10	$27.\overline{7}$	$99.\overline{9}$

TABLE 14. - BRICK WITH ACRYLIC RESIN

Indirect tensile test

k'					
k'_1	k'_2	k	f	f%	Σf%
11	15.9	13.45	4	$11.\overline{1}$	$11.\overline{1}$
16	20.9	18.45	7	$19.\overline{4}$	$30.\overline{5}$
21	25.9	23.45	12	$33.\overline{3}$	$63.\overline{8}$
26	30.9	28.45	8	$22.\overline{2}$	$86.\overline{1}$
31	35.9	33.45	5	$13.\overline{8}$	$99.\overline{9}$

TABLE 15. - BRICK WITH SILANE RESIN

Indirect tensile test

k'					
k'_1	k'_2	k	f	f%	Σf%
23	27.9	25.45	6	$16.\overline{6}$	$16.\overline{6}$
28	32.9	30.45	14	$38.\overline{8}$	$55.\overline{5}$
33	37.9	35.45	9	$25.\overline{0}$	$80.\overline{5}$
38	42.9	40.45	7	$19.\overline{4}$	$99.\overline{9}$

In the preceding tables the stress values are expressed in Kg/cm^2.

(according U.N.I. 4724)

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THEME: STRUCTURES

TITRE: LES ADHESIFS DANS LES STRUCTURES A BASE DE MURS; RECHERCHE EXPERIMENTALE.

RESUME:

Sous une forme expérimentale, l'enquête examine les augmentations des résistance mécanique enregistrées dans les matériaux composant des murs ayant été traités avec des résines synthétiques. La technique employée se fonde sur l'imprégnation sous vide du matériel, selon les critères en vigueur dans le milieu de la conservation.

Les expériences ont été réalisées sur des échantillons traités et non traités, de brique, de mortier plastique et d'un conglomérat de brique et de mortier. Le degré d'imprégnation du matériau dépend directement de la viscosité spécifique de la résine. Le résultat des expériences a démontré une augmentation générale de la résistance à l'effort de traction.

De manière générale, la possibilité d'un emploi « structurel » des résines sur les murs est intéressant. On envisage, notamment, la possibilité de former dans les murs des noyaux de résistance à l'effort de traction par un emploi localisé des résines.

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SUBJECT: STRUCTURES

TITLE: ADHESIVES IN WALL STRUCTURES: EXPERIMENTAL RESEARCH.

SUMMARY:

The programme was designed to permit analysis, by practical experiment, of the increases in mechanical strength to be observed in coursed masonry or brickwork following treatment with synthetic resins. The technique in question is based on vacuum impregnation of the materials and makes use of criteria already in use in the field of conservation.

The tests were carried out on samples of brick, plastic mortar and composites of mortar and brick. The degree of impregnation was found to be closely dependent on the specific viscosity of the resin. The test results revealed a general increase in tensile strength.

The outcome is a general confirmation of the existence of interesting possibilities for " structural " uses of resins in coursed masonry and brickwork and there emerges in particular a possibility of establishing " barriers " of tensile strength through localized use of resins.

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TEMA: ESTRUCTURAS

TITULO: LOS ADHESIVOS EN ESTRUCTURAS A BASE DE MUROS: INVESTIGACION EXPERIMENTAL.

SUMARIO:

La investigación analiza, en forma experimental, los incrementos de resistencia mecánica, registrables en los materiales componentes de muros, después de ser tratados con resinas sintéticas. La técnica empleada se basa en la impregnación al vacío del material, hecha de acuerdo con los criterios operativos vigentes en el ámbito de la conservación.

Las pruebas experimentales se realizaron en muestras tratadas y no tratadas de ladrillo, mortero plástico y conglomerado de ladrillo con mortero. El grado de impregnación del material resultó directamente dependiente de la viscosidad específica de la resina. El resultado de las pruebas reveló un incremento general de la resistencia al esfuerzo de tracción.

En forma general se confirmó la posibilidad de un empleo « estructural » interesante, de las resinas en muros; en particular se sospecha la posibilidad de formar en muros, ciertos núcleos de resistencia al esfuerzo de tracción, mediante un uso localizado de las resinas.

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Тема : СТРУКТУРА

Название : Клейкие Материалы в Кирпичных и Каменных Строениях : Опытное Изучение.

Краткий Очерк : Здесь предстояло произвести анализы, при помощи опытов, увеличения механического сопротивления найденного в материалах употребляемых в кирпичных и каменных постройках вследствии их обработки синтетической древесной смолой. Употребляемая техника базируется на насыщении материала в пустом пространстве и пользуется способами приминяемыми в древних постройках.

Были произведены опыты над образчиками из обработанного или необработанного кирпича, из строительного раствора (из пластики) и так же из сложных материалов из строительного раствора и из кирпича. Было установлено, что процент обработки материала был тесно связан со специфической клейкостью древесной смолы. Результаты показывают существования общего увеличения сопротивлению к растяжению.

В общем, здесь подтерждается необходимость структурного применения древесной смолы в кирпичком и каменном строительстве с перевязками В особенности, является возможным установить в деле каменщиков существование "сильных зон" сопротивления к растяжению при местном употреблении древесной смолы.

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TEMA: STRUTTURE

TITOLO: GLI ADESIVI NELLE STRUTTURE MURARIE: INDAGINE SPERIMENTALE.

SOMMARIO:

La ricerca analizza, per via sperimentale gli incrementi di resistenza meccanica registrabili nei materiali componenti la muratura, in seguito a trattamento con resine sintetiche. La tecnica impiegata è basata sull'impregnazione sotto vuoto del materiale e sfrutta criteri operativi già in uso nell'ambito del restauro conservativo.

Le prove sperimentali sono state effettuate su provini trattati e non trattati di laterizio, malta plastica, conglomerato di malta e laterizio. Il grado di impregnazione del materiale è risultato strettamente dipendente dalla viscosità specifica della resina. L'esito delle prove denota un generale incremento della resistenza a trazione.

Risulta confermata, in linea generale, la possibilità di interessanti impieghi « strutturali » delle resine nell'ambito delle murature; in particolare, si configura la possibilità di determinare, in queste ultime, « presidi » di resistenza a trazione mediante un uso localizzato delle resine.