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Methods and Techniques of Conservation Process for the Heritage Building Walls

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Abstract: ***The issue of the conservation of architectural heritage has been given much attention on the political, cultural and academic level due to the heritage values for being cultural wealth for the nations. However the remains and ruins of these properties come under threat due to the propagation of structural work resulting from industrial development and urbanization. Hence, it has become the responsibility of government institutions to ensure the protection and conservation of humanity's cultural heritage. That's in a manner which strikes a balance and ensures harmony between the preservation of cultural heritage and the changes required by social and economic developments. All efforts have to be exerted to fulfill these two objectives in a spirit of understanding, in a planned timely manner and employing efficient technologies. Therefore, the main aim of the research is to enhance and highlight the new techniques and methods that used for maintaining the heritage building's walls that could achieve the execution of temporary and definitive works. The most used methods that have been successfully implemented for several years for conserving walls are wall grouting injection, Cintec anchoring system, Fiber reinforced polymers, using prestressed steel in buildings consolidation and scaffolding systems .The research methodology is following a qualitative approach through first, defining each technique and it's details (eg, characteristics, way of execution ,advantages , disadvantages and case study) . Second, by analyzing, evaluating the techniques and ensure its efficiency. The implementation of these techniques requires skilled labors, not only at the execution process, but also in the planning stages. The main mission of the conservators of the restoration process is to select the technique that keeps the heritage value of the building without deteriorating the building characteristics, elements or historical materials. To sum up using these techniques with accurate and suitable implementation methods, resulted in conserving the values of the heritage buildings and could safely transform them to the next generations. (The researcher 2016***

Index Terms: Grouting injection, Cintec anchoring system, Fiber reinforced polymers, prestressed steel, Scaffolding systems

I. INTRODUCTION

Modern civilization, its current and future development are based on the cultural values of nations and societies. As the cultural property is a result and a witness to different traditions and cultural achievements of the past, it therefore constitutes an integral element to a nation's identity. As such, this property has to be conserved in accord with its historical and aesthetical importance, and its value has to be brought for people to comprehend its meaning and true values for increasing their recognition of the depth of their history and dignity accumulated over centuries. (Kate Clark, 2005). These days, there are changes and alteration due to the modern era and the appearance of the industrial and technological surge, that resulted in many cities, areas and buildings with heritage and historic values clashed to face new unprecedented problems. These problems are varied from technical and technological factors such as development of production methods, transportation effects, polluted industrial factories and so on. That's in addition to the existed problems such as natural, social, and economic factors. For these reasons, the heritage buildings are subjected to acts of vandalism, demolition, removal and neglect. (Asamer Ahmed, 2005)

From this stand point many countries proceeded to make an effort to protect their heritage. Therefore the responsible organizations cooperated to set clear plans and strategies besides helping of the professional experts and labors in the process of conservation .The management of historic buildings is governed with numerous international conventions beside UNESCO recommendations ,inclusive of standards and specifications defining restoration techniques of these buildings .Therefore, adherence to these international standards and specifications when restoring historic buildings , thus maintaining their cultural identity , would ensure the continuity of international organizations support. (Jack Gillon, 2001)

1.1. literature reviews:-

The Society for the Protection of Ancient Buildings (SPAB) was founded by William Morris in 1877 is considered the first attempt to establish a coherent and logically defensible philosophy for buildings conservation. (Webber Nodro, 2009) Until the end of the 19th century, architectural and archaeological heritage had been a matter of regional and national concern only, as most of the laws regarding the protection of historic buildings in Europe date back to that period. Countless private associations existed in many countries, but their scope did not often extend beyond national borders. Cultural internationalism, as it well known today, was an outcome of the First World War, with the creation of the League of Nations, and most of all, of the Second World War, with the creation of the United Nations Organization and the establishment of The United Nations Educational, Scientific and Cultural Organization (UNESCO). (Intergovernmental Committee, 2013). There are several charters that have been held and developed over the years that put up standards and laws for the conservation process (Webber Nodro, 2009).

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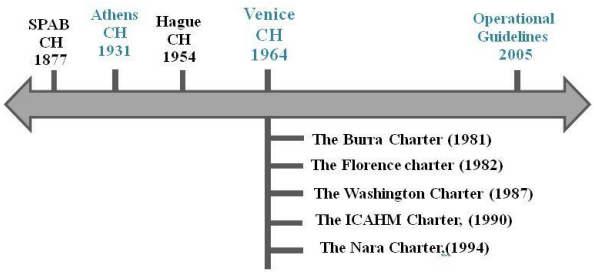

Chart 1: the international charters of developing the conservation science, (WORLD HERITAGE C, 2013)

Common main recommendation of the charters -:

- Ensure the identification, nomination, protection, conservation, presentation, and transmission to future generations of the cultural and natural heritage found within their territory,
- Adopt general policies to give the heritage a function in the life of the community; develop scientific and technical studies to identify actions that would counteract the dangers that threaten the heritage; take appropriate legal, scientific, technical, administrative and financial measures to protect the heritage;
- Not take any deliberate measures that directly or indirectly damage their heritage or that of another State Party to the Convention
- Define the procedure by which requests for International Assistance are to be considered and carry out studies and consultations as necessary before coming to a decision.
- Use educational and information programs to strengthen appreciation and respect by their peoples of the cultural and natural heritage. (WORLD HERITAGE C, 2013).

II. METHODS AND TECHNIQUES

There are various construction techniques for conserving heritage buildings walls , which have been successfully implemented for several years .That techniques enable the execution of temporary and definitive works, namely excavations in urban areas and underpinning, in an economical, practical and, above all, safe manner. This type of work requires skilled labors, not only constructors, but also in the planning stages.

2.1. Types of heritage walls restorations techniques:-

- Wall grout injection.
- Cintec anchoring system.
- Fiber Reinforced Polymers (FRP).
- Prestressed steel in building consolidation.
- Temporary Works for Historic Buildings (Scaffolding).(Adel saad , 2002).

2.1.1 Wall grout injection:-

Grout injection, otherwise referred to as injection grouting, is an effective method for repairing or strengthening masonry walls. This technique involves low-pressure injection of fine lime grout into cracks, voids, and cavities within the masonry. This technique increases building resistance to moisture penetration and restores the material continuity across cracks. Grout injection is especially useful for restoring or stabilizing historic structures because the technique does not alter the building's appearance. It increases the masonry durability and overall service-life by bonding and reducing moisture infiltration.

There are different types of grouts used for repair and strengthening of concrete and masonry structural members. The selection of type of grout for particular type of concrete or masonry repair work should be based on the compatibility of the grout with the original material. (Ashraf Ali, 2012)

2.1.1.2 Grout injection system characteristics:-

- **Crack control,** left unchecked, cracks can sometimes threaten a building's structural integrity, as well as allow moisture to penetrate into a wall system; so it is usually beneficial to repair them. Grout injected into a crack not only blocks the moisture path, but also restores material continuity across the crack. Also the narrow cracks can be injected with micro-fine cement slurries.(Lisandra Miranda, 2014)
- **Moisture resistant,** grout injected into empty joints shows as a gray material, effectively filling empty collar and head joints to bond the wall together as one component and provide an effective barrier against moisture penetration.(Lisandra Miranda, 2014)
- **Strengthening masonry structures,** many older masonry buildings are being retrofitted for change of use or to upgrade their seismic performance. Grout injected into internal voids and cavities strengthens masonry by bonding together all parts of the wall. This increases structural integrity and overall stability, which improves resistance to seismic forces. Parapets, veneers, bearing walls, and shear walls can be strengthened using the technique. (Lisandra Miranda, 2014)

2.1.1.3 Grout injection system execution:-

- A visual assessment of masonry material condition should be conducted, mapping the extent and size of any visible surface cracks, mortar blockages, or other visible surface damage which may have an effect on grout confinement or the injection process.
- Not allow grout to flow into existing expansion joints. Seal around all wall penetrations (including electrical outlets, water cocks, doors, windows, etc.).
- Injection holes are to be drilled in the mortar joints. The diameter and spacing of injection holes shall be determined during the initial site investigation, as the spacing of 60 cm between holes horizontally and vertically. (Asamer Ahmed, 2005)
- Mix all grout materials according to supplier's recommendations.
- Flush all injection holes within the designated repair area with water before grout injection to eradicate any dust and debris.
- Injection shall be proceed from the base of the repair area to the top, moving first across the wall horizontally and then upward, Allow in-place grout to stiffen before proceeding to the next lift.
- Surface cleaning shall be conducted during injection by immediately flushing any grout from the masonry surface with water. Point a mortar similar in color and composition to the original mortar firmly into injection holes.(Lisandra Miranda, 2014)

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2.1.1.4 Grout injection system advantages:-

- **There are 2 different ways of grouting injection technique**
  1. Injection by gravity, this technique is used at the cases of very deteriorated and instable buildings which can't force any pressure.
  2. Injection by pressure, using mechanical pumps to mix and pump the grout into the holes.
- Using few amount of grout for repairing walls.
- The grouting injection process is rapidly and safely executed.(Asamer Ahmed, 2005).

2.1.1.5 Grout injection system disadvantages:-

Less assessment and not enough studies of the structure wall conditions for estimating the suitable grout amount and pressure required, resulting in buckling of the wall structure and at the cases of grouting one side of the wall, the wall façade could be destroyed.(Asamer Ahmed, 2005).

2.1.1.6 Case Study:-

- **Restoration of Fredericton City Hall, New Brunswick**:- When Fredericton was incorporated in 1848, City Council had the authority to build a City Hall. After fire destroyed City Hall in 1875.That time the building had suffered from cracks within its brick masonry walls. Attempts had been made to repair these over the years, but still the cracking continued to occur.(PJ materials Consultants, 2009).

Fig1: Fredericton City Hall, New Brunswick, Source (PJ materials Consultants, 2009)

Fig 2, Wall grout injection in to voids and cracks, Source (PJ materials Consultants, 2009)

2.1.2 Cintec anchoring system:-

The Cintec anchoring system offers a remarkably versatile, proven approach to internally strengthen masonry buildings and structures. For a quarter of a century, As the Cintec anchors are often installed in historic buildings that are unstable; the drilling system must be sympathetic to the structure and avoid causing further damage. Specialist diamond drilling techniques are used to drill long holes, which can be in excess of 12m. The diamond drilling system creates little vibration and is extremely accurate over long distances, making it ideal for historic buildings and structures. (Ashraf Ali, 2012).

The system works by pre-drilling an oversized hole in the structure and inserting an anchor body surrounded by a fabric sock. A cementitious grout is injected through the middle of the anchor under low pressure. It passes through a series of grout flood holes into the fabric sock, inflating the entire assembly like a balloon.(Asamer Ahmed, 2005).

2.1.2.1 Cintec anchoring system characteristics:-

- The Cintec anchoring system is used for tying walls (Walls Tie) at the case of splitted walls in resulting of earthquakes and movements, declining of the whole structure and wall cracks. Tying walls could be implemented through the separated and corners walls to act as a one combined structure. (Faloon.F Construction, 2015).
- The system is used also for (Wall Cracks Stitching) to prolong the stability and the efficiency of heritage wall. Furthermore (Faloon.F Construction, 2015).
- (Consolidation of arches) especially at the heritage Islamic buildings such as mosques and schools , As a result of earthquakes and declining of foundation soil , the building is vulnerable to the tension actions , that lead to movement of the arches and appearance of cracks at the top and the side columns of the arches. Sometimes the arches are prone to the buckling and twisting actions.(Asamer Ahmed, 2005)
- Cintec anchors can be very effective and often are the only means available to strengthen the tying of vertical and horizontal elements of a building. In addition to structural repair solutions Anchor bond can be used to create secure fixings on masonry facades. Typical examples would be the tying of poured gypsum, cast-in-place concrete or hollow core precast roof and floor diaphragms to masonry walls.(Faloon.F Construction, 2015)
- Internal strengthening can be perpendicular to or in the plane of the face of the masonry units, components or systems. Perpendicular strengthening involves tying together the deteriorated masonry or the old units to strengthen their stability. Internal and interconnection strengthening can be post-tensioned. (Faloon.F Construction, 2015)

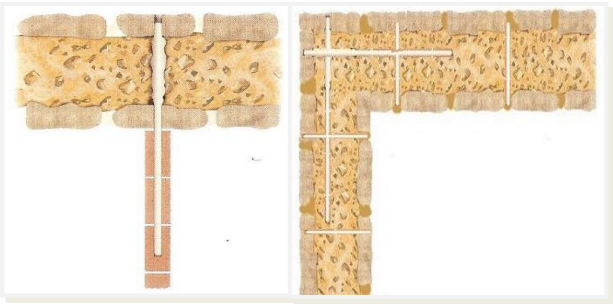

Fig 3, walls connection Details, Source, (Faloon.F Construction, 2015)

2.1.2.2 Cintec Anchor Systems installation:-

- Drill the hole to the required depth of the anchor and the embedment depth required by using drilling mechanism with few vibrations, Flush out all bore holes with water or compressed air to remove all dust and debris.
- Place the anchor in the hole and carefully push the anchor in lifting it over any fissures or voids, do not force or twist the anchor into the hole, check there has been no damage to the fabric sock. (Asamer Ahmed, 2005)
- Inject the anchors through injecting the grout. The grout is injected through a circular hollow section bar or plastic grout tube. This allows the anchor to be pumped from one end, filling the sock up from the rear. This process of grouting from the rear to the front provides a high degree of quality control. Maintain the pressure until all the grout milk has been expelled.

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- After the injection method, the hole is been closed by bricks or stone relying on the main structure of the building. (Asamer Ahmed, 2005).

2.1.2.3 Cintec Anchor Systems advantages:-

- Recognized for using in world heritage, a landmark and heritage structure as it is alternative to the dismantle-and-rebuild approach.
- Invisible when installed, Can be concealed within the fabric of the original structure.
- Various used for repairing as it also used in weak substrates and under water.
- Minimal disruption during installation, Flexibility in positioning entry points for drill holes, facilitating installation. (Faloon.F Construction, 2015)
- Capable of being installed in long anchor lengths - Up to 30m Cintec anchors have been installed
- Optimal system for seismic upgrading of most unreinforced masonry structures and hardening of existing buildings to resist the effects of a blast.
- Controlled grout flow and designed to needed requirement. (Asamer Ahmed, 2005).

2.1.2.4 Cintec Anchor Systems disadvantages:-

- The anchoring system implementation need high experienced technicians and labors or there will be fatal mistakes or more damage to the building structure
- Some of system mechanisms are not easy to be available such as the drilling mechanism.
- The anchoring system has to be implemented at well balanced and stabled structure.(Adel saad , 2002).

2.1.2.5 Case Study:-

- **Christ Church Cathedral, Newcastle :-**

Christ Church Cathedral is an extraordinary piece of architecture in a dramatic setting. Australia's largest provincial cathedral, dating back to 1893. The building, designed by John Horbury, in the Gothic Revival style, is located on a hill at the city's eastern end in the suburb called The Hill. Stylistically the building expresses the significance changes from the Victorian period of architecture with its reliance on academic correctness to the freer realizations of the Federation period and its influence by the Arts and Crafts movement in Australia architecture. (Lorenzo Jurina, 2003).

On Thursday 28th December 1989, the city of Newcastle, in New South Wales was struck by the first significant earthquake to affect an Australian urban area. The Earthquake, registering 5.6 on the Richter scale, the most important building to be severely damaged was Christ Church Cathedral. (Lorenzo Jurina, 2003).

Fig 4, Christ church cathedral changing over years, Source, (CINTEC, 2009)

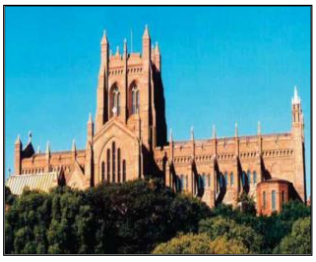

Fig5, Using Cintec Anchor for strengthening walls and Historical features, Source, (CINTEC, 2009)

2.1.3 Fiber Reinforced Polymers (FRP):-

Fiber Reinforced Polymers (FRP) constitute a set of advanced composite materials, made of a polymer matrix reinforced with fibers. The primary function of fiber reinforcement is to carry load along the length of the fiber and to provide strength and stiffness in one direction. FRP have been considered in recent years for various applications in the construction industry. The objective is usually to make a component which is strong and stiff, often with a low density. (Cestelli Guidio, 2015) In the last two decades, advanced composites (FRP) have gained considerable worldwide interest and growing acceptance in the construction industry. The preservation of historical structures is one of the most appealing applications of FRP composites in the construction field. Now-a-days structures like bridges are built completely of FRP composites and the structure proves exceptional stability and effective resistance to effects of environmental contact. (Cestelli Guidio, 2015).

2.1.3.1 Fiber Reinforced Polymers characteristics:-

- Used to increase strength and to repair cracks in the masonry walls and concrete. The full capacity of cracked girders can be restored by bonding the cracks or the splitted elements together by the fibers. (Lorenzo Jurina, 2003).
- Used to increase ductility and the strength of concrete columns. Due to the beneficial effects of confinement, the column ductility is significantly increased. In addition, the fibers helps to make up for inadequate amount, or improperly detailed lateral ties and increases the shear and flexural strength of the columns significantly. (Lorenzo Jurina, 2003).

2.1.3.2 Fiber Reinforced Polymers Installation:-

- Remove any finishing layers of the structure surface till reach to the essential building material of the structure.
- Prepare the surface by using mechanical and hand tools to clean and smooth the structure surface.
- Paint the structure surface with epoxy coatings.
- Using epoxy paints to satiate the fiber reinforced polymer (FRP) well by using paints roll or Immersion machine, this before install the FRP on the structure surface.
- At the case of long fibers, use steel dowels to install the FRP to increase the cohesion between the fiber and the surface.
- Finally, Paint epoxy coatings on the fiber after installation. (Peter Cox , 2012).

2.1.3.3 Fiber Reinforced Polymers Advantages:-

- Costs less than full structural support replacement.
- Allows repairs to be done quickly.
- Restores full capacity of cracked girders.
- Increases flexural capacity and fatigue life. **(Peter Cox , 2012)**.

2.1.3.4 Fiber Reinforced Polymers Disadvantages:-

- Low fire resistance, FRP materials are in principle combustible and have low fire resistance compared to steel. Otherwise there is a need for utilizing constructional measures (fire protection).

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- Carbon fiber is an electric conductor and as such can reflect radio waves which can be a disadvantage in some cases.
- Cannot be used at the buildings facades at the case of existence of ornaments or decoration features.
- The fiber reinforced polymers are fairly expensive compared to other materials.
- Have high thermal expansion coefficient therefore painting epoxy paints after installation is necessary. (Peter Cox , 2012).

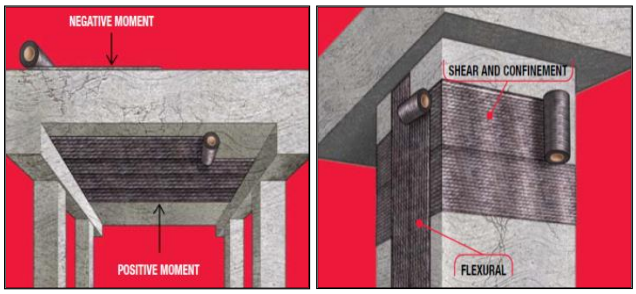

Fig 6,7: Fiber reinforced polymer installation over slabs beams, and columns .Source: (Peter Cox , 2012)

2.1.3.5 Case Study:-

- **Falaknuma Palace, India**:-

Falaknuma palace complex built in1884 is and currently being developed as a luxury heritage palace hotel by a leading hotel group from India. Over the years the palace complex was in state of disuse and had been exposed to environmental vagaries. (Ashraf Ali, 2012).

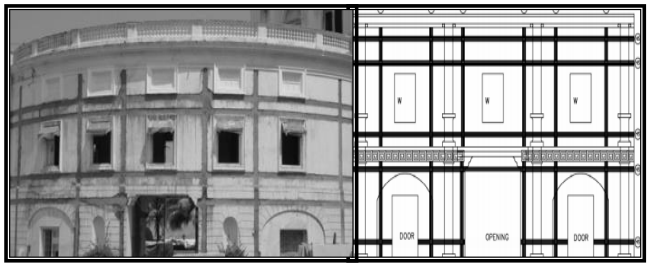

Fig8,9: View of a wall panel with prepared surface ready to receive CFRP strips (Ashraf Ali, 2012)

2.1.4 Prestressed steel in building consolidation:-

Metal components frequently appear in historical buildings, either in restoration work or in the original construction. Not only steel, generally speaking, compatible with the historical building in terms of both resistance and rigidity, but also in the case of stainless steel, any fear regarding lack durability is really unfounded. Beside that steel can be used in work which will stand alongside the existing construction and permit it to be read. Nothing is replaced or removed and a recognizable addition is made of which can easily be removed and this is for reversible. (Cestelli Guidio, 2015)

It is usually advisable to design strengthening system and repair methods to historic buildings as being active rather than passive. It's often helpful if the newly installed repair system that takes up immediately (active) rather than waiting either for further movement to take place or for repair system to move a little before it takes up load. It demands that care be taken to ensure that repair does not need to move itself to significant degree after carrying load (Cestelli Guidio, 2015).

2.1.4.1 The steel in building advantages:-

Steel and stainless steel in particular has been used at the historic building conservation field throughout the UK and Europe for over seventy years, taking on an increasing important role in the conservation of buildings of historical values. This is due to series of obvious advantages:-

- Excellent corrosion resistance and reduced bulk.
- Limited cost.
- Easiness of erection.
- The possibility of immediate recognition and reversal of restoration work.
- Durability comparable with the structure in which it is used.
- High ductility and strength.
- Excellent high and low temperature properties.
- Life-cycle costing benefits.
- Aesthetic surface finish.**(Peter Cox, 2012)**.
- **It is not proposed to suggest at this technique any particular details as repairs to historic structures usually have to be designed for each individual case; however there are some general guidelines.**

2.1.4.2 Case study of using steel consolidation technique:-

- **San Dalmazio tower of Pavia (Italy):-**

Built in the eleventh century, this 45 meters high brick tower showed many local damages and lacks in the masonry and long vertical cracks along the four walls. The main objective of consolidation has been the assessment of the actions taken to restore the San Dalmazio tower; particular attention was paid to the evaluation of the response of the building subjected to wind and earthquake excitations. (Lorenzo Jurina, 2003). The strengthening project involves construction of a new inner meal tower made of carbon steel and partly of stainless steel which is fully exposed and completely renewable but entirely located inside the tower so that it could not be noticed from outside, in other words "**a tower within a tower**". The dead load of the masonry is partially transferred to the inner tower by means of about **300 prestressed sub vertical cables,** lying in the interstice between the masonry and the steel tower. The new structure takes into account the cultural of preservation, such as adoption of strengthening work which stands alongside the existing structure, the reversibility of the work and its easy recognition as belonging to a different historical period.(Federico M. Mazzolani, 2009).

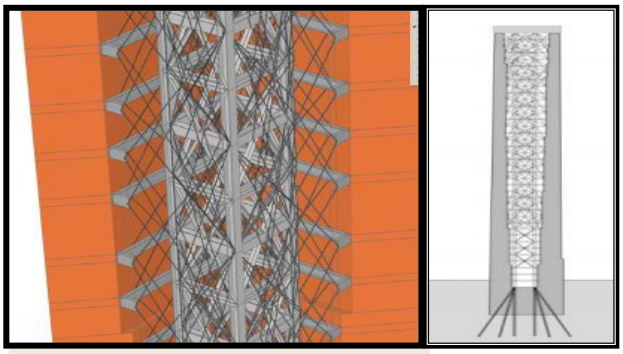

Fig 10, 11: Steel tower within the masonry tower, Source, (Federico M. Mazzolani, 2009)

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2.1.5 Temporary Works for Historic Buildings (Scaffolding):-

A great deal of time and effort is put into developing schemes for the conservation of historic buildings but it sometimes seems that scaffolding and temporary works, the means by which the conservation schemes are successfully completed, receive scant attention.

The main difficulty with shoring historic buildings is to ensure that their installation. Shoring must be designed by a structural engineer or other competent person. Scaffolding and temporary works must be capable of being constructed without the need for major intervention and does not cause damage to the historic fabric. This must be borne in mind by designers and erectors of scaffolding and temporary works.(Ian Hume, 1997).

2.1.5.1 Types of scaffoldings:-

- **Access scaffolding**
- **Shoring and support scaffolding.**

Both of the scaffolding types could be wooden or steel structure. Neither should be expected to carry out the function of the other unless it has been specifically designed so to do independent tied.(Ian Hume, 1997).

Access scaffolds:-

Access scaffolds will normally be provided to gain access to historic building facades for painting, maintenance or other work, they consist of two rows of standards (vertical supports) connected by ledgers and transoms (the horizontal elements).They are termed independent because this type scaffold derives no vertical support from the structure and tied because they must be tied to structure for stability. Because of the need to avoid damage, tying to the facade of historic building can present difficult problems. Longitudinal bracing must be used (Eg, Independent tied scaffolds, Birdcage scaffolds, Mobile scaffold).**(Ian Hume, 1997)**

Shoring and support scaffolding:-

Shoring and support scaffolding , Temporary works are often needed either because there is a risk that a structure might otherwise collapse or because it is necessary to remove some vital supporting member for renewal or alteration and transfer the load from the main structure elements (Columns ,Vaults, Roofs ,Etc) to the scaffolding. Obviously, the loads to be carried by shoring can be very great and failure can be disastrous causing major damage to historic building.**(Ian Hume, 1997)**.

Fig 12, Access scaffolds at Bridge Street Chester listed building, Source: (Ian Hume, 1997)

Fig 13, Support scaffolding for supporting facades at McKenzie heritage building, Source, (Ian Hume, 1997)

2.1.5.2 Necessary Erection Instructions:-

- Where fixings are made to stone or brickwork it is necessary to check that the scaffolding is adequately safe and not endangering the safety of the heritage building or damaging the historic fabric. (Asamer Ahmed, 2005)
- Architects and engineers involved in historic buildings work should have a clear understanding of the requirements of scaffolding and temporary works and be aware of the consequences if something goes wrong.
- It is a statutory requirement that all working scaffolds are inspected weekly by a suitably qualified person, the architect or engineer should examine the contractor's proposals for all scaffolding and shoring. (Asamer Ahmed, 2005)

III. RESULTS

The main aim of using these techniques and methods is remaining the value of the historic buildings relying on the current state of the materials and their resistance. So the professional conservators have to be well understood of the current state and causes of deterioration of the structural elements to be able to select the suitable technique at the conservation process, without causing more damage to the structural elements.

The Aspects / The Techniques	Duration of remaining values	The Cost	The rigidity modulus	Rate of changing	Time of execution
Wall grout injection	Long period (Definitive)	High	Rigid building	Slight changing	Short time
Cintec anchoring system	Long period (Definitive)	High	Rigid building	Slight changing	Short time
Fiber Reinforced Polymers	Long period (Definitive)	Medium	Flexible building	Slight changing	Short time
Prestressed steel	Long period (Definitive)	High	Rigid building	High changing	Long time
Scaffolding	Temporary	Low	Flexible building	No changing	Short time

There are some aspects that could be through judged the efficiency of the used techniques at the heritage conservation process. These aspects are, duration of remaining values, the cost, the rigidity modulus, rate of changing and time of execution. (Kate Clark, 2005) Depending of estimating and analysis these aspects for the used technique, the conservators and professionals could judge the extent of the conservation process success, (The researcher 2016).

Table 1, illustrates the aspects that could be through judged the efficiency the modern techniques (The researcher, 2016)

After analyzing these aspects for the most used techniques these days, the conservators are able to choose the suitable method and technique for the conservation process according to the current state of the heritage building. These various techniques have advantages and disadvantage. Despite, all of them prolong the historical values of the buildings, some of them need high cost and long time of execution .That beside some could change the main form of the heritage building and affect the historical characteristics and features. The rigidity modulus also has big effects on selecting the suitable technique as most of modern techniques convert the building characteristics from the flexibility in to rigidity structure, as the result these rigid structures could be easily affected by the natural collapses like earthquakes and tornados. (The researcher, 2016).

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IV. CONCLUSION

The cultural properties are a result of different traditions and cultural achievements of the past, therefore they constitute an integral element to a nation's identity. As such, this property has to be conserved on accord with its historical and aesthetical importance, and its value has to be brought for people to comprehend its meaning for increasing their recognition of the depth of their history and dignity accumulated over the centuries.

These days, the remains and ruins of the past became in danger due to the propagation of structural work resulting from industrial development and urbanization. So the government took crucial procedures to protect and conserve the humanity's cultural heritage. As a result, a new science arises and specified to maintain heritage buildings. This is called (Conservation). A new plan and strategy that aims to prolong the life of the architecture heritage. The conservation issue is considered one of the most important contemporary issues in the whole world these days. **(The researcher, 2016).**

At the end of the twentieth century the conservation techniques and methods have been developed. On a hand conservation science is based on chemistry , nature, geology , biology , architecture and water . On the other hand it based on also art and origins of the buildings. In addition, the international regional and local laws beside UNESCO recommendations arise to be considered the bases and principles that guide and organize the conservation process. After the scientific progress and modern techniques and materials, there is no way for failing at the conservation process and finding alternative solutions. **(The researcher 2016).**

The strength of the historical building structure is the main system that remains the stability and the longevity of the building elements throughout the year's .Therefore the conservation of the building structural walls, is considered the main step of the conservation process. There are a lot of techniques and methods for restoring the historical elements, relying on the current state of the materials and their resistance. Some of methods of conservation could restore the strength of the structural elements but at the same time may result in real damage to the main values and features of the heritage building. So the professional conservators have to be well understood of the current state and causes of deterioration of the structural elements to be able to select the suitable technique at the conservation process, without causing more damage or deteriorations to the structural elements. **(The researcher 2016).**

There are various construction techniques, which have been successfully implemented for several years. Those allow the execution of temporary and definitive works, namely excavations in urban areas and underpinning, in an economical, practical and, above all, safe manner. This type of work requires skilled professionals, conservators and labors.

The most used methods that have been successfully implemented for several years for conserving walls are wall grouting injection, Cintec anchoring system ,Fiber reinforced polymers, using prestressed steel in buildings consolidation and scaffolding systems. Every system have own features, characteristics and method of execution. On one hand the main missions of the techniques is to keep and prolong the historical values, on the other hand there are some disadvantages for each method that have to be considered at the conservation process. Some techniques need high cost and long time of execution .Others could change the main form of the heritage building and affect the historical characteristics and features. The rigidity modulus also has big effects on selecting the suitable technique as most of modern techniques convert the building characteristics from the flexibility in to rigidity structure, as the result these rigid structures could be easily affected by the natural collapses like earthquakes and tornados. So the professionals have to be very accurate at choosing the suitable method according to the current state of the heritage building to maintain the main heritage values and historic characteristics. **(The researcher 2016).**

REFERENCES

1. Kate Clark. (2005). Conservation Planning Methodology search, Developing policies for the conservation of historic places. Columbia: Heritage branch.
2. Asamer Ahmed. (2005). Master Thesis: Contemporary techniques in restoration of historical buildings. Cairo: Cairo University.
3. Jack Gillon. (2001). CONSERVATION CHARTERS AND STANDARDS. Retrieved from http://ihbc.org.uk
4. Webber Nodro.(2009). Cultural heritage and the law search. Africa: ICCROM.
5. WORLD HERITAGE CENTRE. (2013). Operational Guidelines for the Implementation of the World Heritage Convention. France: UNESCO World Heritage Centre**.**
6. Intergovernmental Committee.(2013). Operational Guidelines for the Implementation of the World Heritage Convention. France: UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANISATION**.**
7. ICOMOS. (2001). International Council on Monuments and Sites. Retrieved from http://www.icomos.org**.**
8. The parliament. (2006). **قانون رقم 144**. Cairo: The parliament publishing center.
9. Ashraf Ali. (2012). Master Thesis: Restoration of historic Islamic buildings and its compliance with international standards. Egypt: Faculty of engineering, Cairo University.
10. Adel Saad. (2002).Master Thesis: **اسس وقواعد ترميم المباني الاثريه بين النظريه والتطبيق**. Cairo: Faculty of archaeology, Restoration department.
11. Lisandra Miranda. (2014). DEFINITION AND EVALUATION OF A GROUT FOR CONSOLIDATION OF ANCIENT MASONRY . SEISMIC VULNERABILITY OF A "PLACA" BUILDING. Portugal: DECivil, Instituto Superior Técnico, Universidade de Lisboa.
12. PJ materials Consultants, 2009, Restoration of a National Historic Site Building, Fredericton City Hall, New Brunswick. Retrieved from http://www.pjmc.org.
13. Faloon.F Construction. (2015). Scientific paper:Cementitious Sock Anchors. United States: Faloon Construction Center.
14. Ian Hume. (1997). Scaffolding and Temporary Works for Historic Buildings. Retrieved from http://www.buildingconservation.net
15. Cestelli Guidio. (2015). Strengthening of buildings structures – therapy search . Berlin: ETH Zürich, Rämistrasse 101, 8092 Zürich.
16. Lorenzo Jurina. (2003). The structural consolidation of old massive structures search . Italy: Department of Structural Engineering.
17. Federico M. Mazzolani. (2009). Refurbishment by steelwork search .: Department of Structural Analysis and Design, University of Naples, Naples, Italy "Federico II"
18. Peter Cox. (2012).Scientific paper:Wall Stabilization, Aniseed Park, Manchester, Broadway Business center.

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