NANOTECHNOLOGY IN SUSTAINABILITY

- DESIGN ETHICS

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OBJECTIVE

- The objective is to highlight the importance of globalization and its impact on architecture through the use of nanotechnology.
- The aim of this research is to bring to light the applications offered by nanomaterials in a particular sector and to examine the new materials from the point of view of architects, interior designers and designers.

RESEARCH METHODOLOGY

- Secondary method – collecting information from internet.
- Tertiary method – speaking to architects about the nanotechnology methods used in architecture.

SCOPE AND LIMITATIONS

- Nanotechnology, is still in its infancy, we should make the society aware of it in order to drive this technology to improve its benefits for the society.
- In Mumbai, it’s not much come into effect but should happen soon as the world is changing on global bases and more of sustainability is been done.
ABSTRACT

- The research investigates the importance of the use of new up-and-coming technologies as an outcome of globalization.
- Nanotechnology as a result of the global cooperation in technology has become the cutting-edge technology of the 21st century.
- This manipulation of matter at the nanoscale has revolutionized our contemporary technology in all aspects of life, especially in material design, building methods, and architectural perceptions.
- Nanotechnology introduces promising economical solutions and products to achieve reliable sustainable environment.
- The building sector shows a great potentiality to be beneficiary from this technology.
- Nanapplications in the field of energy have introduced many environmentally friendly energy systems to reduce energy consumption or to produce renewable energy by production of improved solar cells.
- However, on one hand nanotechnology is likely to significantly changes in our modern way of life.
- On the other hand the benefits of nanotechnology must be maximized and risks are identified and controlled.
INTRODUCTION

▪ We are very familiar with the concept of getting raw materials, bringing them together in an organized way and then putting together into a recognizable form.
▪ This is our role in society and we have performed it well for hundreds or thousands of years. So we can say construction is definitely not a new science or technology and yet it has undergone great changes over its history.
▪ In the same vein, nanotechnology is not a new science and its not a new technology either. It is rather an extension of sciences and technologies that have already been in development for many years.

WHAT IS NANOTECHNOLOGY ?

▪ Nanotechnology is the use of very small pieces of material by themselves or manipulation to create a new scale of materials.
▪ At the nano-scale material properties are altered from that of larger scales.
▪ The nano-scale is the size range from approximately 1nm to 100nm.
▪ Nanotechnology is an enabling technology that allows us to develop materials with improved or totally new properties.
APPLICATIONS OF NANOTECHNOLOGY

NANOTECHNOLOGY IS WIDELY USED IN CONSTRUCTION MATERIALS SUCH AS:

- IN CONCRETE
- IN COATING
- IN GLASS
- IN STEEL
- IN WOOD
1. NANOTECHNOLOGY AND CONCRETE

- IN THE FIELD OF CEMENT AND ITS DERIVATIVES, SUSTAINABILITY IS A MAJOR ISSUE.
- THEIR PRODUCTION PROCESSES COULD BE MORE ENVIRONMENT-FRIENDLY.
- NANO-SILICA ADDITION TO CEMENT BASED MATERIALS CAN LEAD TO IMPROVEMENTS IN DURABILITY AND THE COMpressive STRENGTH OF THE REFINED MATERIAL.
- CONCERNING THE CORROSION PROBLEMS IN CONCRETE PRODUCTS, NANOTECHNOLOGY CAN OFFER SMART SOLUTIONS PROVIDING COATINGS THAT RESPOND TO EXTERNAL AGENTS WITH A RESPONSE THAT CAN REPAIR OR PREVENT DAMAGE.
- NANOPARTICLES ARE USED TO PENETRATE AND CLOSE SMALL CRACKS ON THE CONCRETE SURFACE AND, IN STRENGTHENING APPLICATIONS, THE MATRICES FORM A STRONG BOND BETWEEN THE SURFACE OF THE CONCRETE AND THE FIBER REINFORCEMENT.
- THE ABILITY OF THE SAMPLES TO SUSTAIN LOAD AFTER CRACKING IS GREATLY IMPROVED BY THE CARBON TOWS AND BOTH THE MATRIX AND THE INTERFACE ARE DURABLE UNDER WETTING AND DRYING AND SCALING (SCRAPING) CONDITIONS.

Fig 1:  
- a. SYNTHESIZED CEMENTITIOUS NANOPARTICLES
- b and c. CARBON NANOTUBES BRIDGING CRACKS IN A CEMENT COMPOSITE.
- d. NANO LAYERED CALCIUM ALUMINATE PARTICLES.

http://precast.org/2014/01/next-big-thing-concrete-big/
CASE STUDY 1

JUBILEE CHURCH
ROME, ITALY
1996-2003

MATERIALS : CONCRETE, STUCCO, TRAVERTINE AND GLASS

INTRODUCTION

- WITH THIS WORK, NOT ONLY MANAGED TO INCORPORATE A RICH HERITAGE LANDMARK CHURCH OF ROME, BUT WAS REVITALIZED THE NONDESCRIPT NEIGHBORHOOD OF TOR TRE TESTE, WITH MORE THAN 35,000 VISITORS A YEAR.
LOCATION

- In the rather featureless peripheral zone of Tor Tre Teste the ancient agricultural landscape has been awkwardly invaded by industrial zones and unattractive modern apartment blocks.
- The church is located there in a flat terrain triangular plane about six miles east of downtown Rome.
- It is located adjacent to a medium-density housing complex built in 1970 on the brink of a public park.
- The 108,414-square-foot complex contains the church and the community center.

Fig 3 : SITE PLAN OF TOR TRE TESTE
http://architecturalmoleskine.blogspot.in/2010/10/richard-meier-jubilee-church.html
CONCEPT

- The proposal of the Church by Ar. Meier was noted for its distinctive and elegant use of materials in relation to innovative construction technologies, the presence of generous light as an element that determines the character of the work and the strong connotation of the building as a place for humans, "not only as a Christian place, but for the entire world community."
- The chapel is composed of three walls curved like sails of a boat, and which symbolizes the Holy Trinity.
- His work is characterized by a rational use of geometry, the clarity of their spaces, the superb handling of light and the use of white as a symbol of purity because it is a color that contains all others.

Fig 4: Conceptual Sketches of the Church
http://architecturalmoleskine.blogspot.in/2010/10/richard-meier-jubilee-church.html
**SPACES**

- THE CHURCH FORMALLY DIFFERENCIATES ITSELF FROM THE SURROUNDING BUILDINGS, BECOMING A WHITE LANDMARK IN FRONT OF SQUARE, AN AREA THAT RECEIVES THE CONGREGATION.
- THE PROJECT CONSISTS OF TWO ELEMENTS: THE CHURCH ITSELF AND THE PARISH CENTER, CONSISTING OF OFFICES, AN AUDITORIUM AND A MULTIPURPOSE ROOM.
- BOTH BUILDINGS ARE SEPARATED BY A CONCAVE WALL AND LINKED BY A GLASS SCREEN ON THE FACADE OF THE BUILDING.

Fig 5 : a. GROUND FLOOR PLAN  
 b. UPPER FLOOR PLAN  
 http://architecturalmoleskine.blogspot.in/2010/10/richard-meier-jubilee-church.html

Fig 6 : c and d. ELEVATIONS OF THE CHURCH  
 http://www.richardmeier.com/?projects=jubilee-church-2
STRUCTURE

- The architectural concept is very interesting and innovative in the vocabulary of Meier, but posed a challenge engineering and constructive.
- The proposal of Meier’s technical team was to create a steel structure covered with concrete blocks and then cover it with plaster, but that the building would have given him a lifetime maximum of 50 years.
- Therefore, at the suggestion of Antonio Michetti, technical consultant of the Vicariate, was a structure of prefabricated blocks of double curvature, then assembled and connected by means of post-tensioning, through horizontal and vertical wires.
- In order to preserve the whiteness of the building, the company Italcementi developed a new cement containing titanium dioxide, called TX Millennium, which ensures the whiteness of the concrete, despite the pollution, rain and weather effects.

Fig 7: COMPLETED CHURCH
http://architecturalmoleskine.blogspot.in/2010/10/richard-meier-jubilee-church.html
INTERIORS

- The interior of the church is impressively lighted, giving different types of light from the glazing surfaces above and the facade of the building, as well of the light that plays with the convex surfaces of the sails.
- A prism located in the altar area uses beveled windows to achieve indirect lighting, recalling the effect of the church of Notre Dame du Haut, by Le Corbusier, of which Meier is a declared admirer.

Fig 8: Altar of the Church
http://architecturalmoleskine.blogspot.in/2010/10/richard-meier-jubilee-church.html

Fig 9: Altar Lighting
http://architecturalmoleskine.blogspot.in/2010/10/richard-meier-jubilee-church.html
• IN THE OPPOSITE EXTREME, NEAR THE ENTRANCE, LIES THE PIPE ORGAN, MOUNTED ON ANOTHER PRISM WHICH SURFACES AND EDGES ARE BROKEN BY THE ARCHITECT TO CREATE A TRANSPARENT VIRTUAL TARGET VOLUME, WHICH SEEMED TO FLOAT ON THE MARBLE WALL.

Fig 10 : a AND b – INTERIOR DETAILING SHOWING PIPE ORGAN
http://architecturalmoleskine.blogspot.in/2010/10/richard-meier-jubilee-church.html

• THE WALL OPPOSITE THE SAILS IS COVERED WITH WOODEN SLATS, WHICH PROVIDES WARMTH TO THE SPACE.

Fig 11 : WOODEN SLATES WALL
http://architecturalmoleskine.blogspot.in/2010/10/richard-meier-jubilee-church.html

• THE FURNITURE, ACCORDING TO THE MINIMALISTIC AESTHETICS OF THE CHURCH, HAS A VERY PURE AND SIMPLE STYLE. THE ALTAR, MADE OF TRAVERTINE MARBLE, AGAIN RESEMBLES THE SHAPE OF A BOAT.

Fig 12 : ALTAR MADE OF TRAVERTINE MARBLE
http://architecturalmoleskine.blogspot.in/2010/10/richard-meier-jubilee-church.html
2. NANOTECHNOLOGY AND COATINGS

SELF-CLEANING: PHOTOCATALYSIS

- HYDROPHILIC SURFACES.
- DEPOSITED DIRT IS BROKEN DOWN AND LIES LOOSE ON THE SURFACE.
- A WATER FILM WASHES DIRT AWAY.
- UV LIGHT AND WATER ARE REQUIRED.
- REDUCES MAINTENANCE REQUIREMENT.

- PHOTOCATALYTIC SELF-CLEANING IS PROBABLY THE MOST WIDELY USED NANO-FUNCTION IN BUILDING CONSTRUCTION, WITH JAPAN LEADING THE FIELD.
- ITS PRIMARY EFFECT IS THAT IT GREATLY REDUCES THE EXTENT OF DIRT ADHESION ON SURFACES.
- THE TERM "SELF-CLEANING" IN THIS CONTEXT IS MISLEADING AND DOES NOT MEAN, AS COMMONLY ASSUMED, THAT A SURFACE NEED NOT BE CLEANED AT ALL.
- FEWER DETERGENTS ARE REQUIRED, RESULTING IN LESS ENVIRONMENTAL POLLUTION AND LESS WEAR AND TEAR OF MATERIALS.

BEFORE AND AFTER: ON CONVENTIONAL TILES, WATER FORMS DROPLETS THAT DRY LEAVING BEHIND DIRT DEPOSITS.

ON THE HYDROPHILIC SURFACES OF PHOTOCATALYTIC TILES, WATER FORMS A FILM THAT RUNS OFF TAKING ANY LOOSE DIRT DEPOSITS WITH IT.

Fig 13 : SELF CLEANING GLASS
https://core.ac.uk/download/files/74/1564184.pdf
A further advantage is that light transmission for glazing and translucent membranes is improved as daylight is obscured less by surface dirt and grime.

Energy costs for lighting can be reduced accordingly.

For the function to work, UV light present in normal daylight is sufficient to activate the photocatalytic reaction.

Organic dirt on the surface of a material is decomposed with the help of a catalyst – usually titanium dioxide, which has been used in all kinds of products.

At a nanoscalar dimension, titanium appears no longer white but transparent, and it’s also hydrophilic.

Photocatalytic surface coatings are often applied to façade panels made of glass or ceramics or to membranes.

Fig 14 : BASIC PROCESS OF SELF CLEANING
https://core.ac.uk/download/files/74/1564184.pdf
CASE STUDY 2

G- FLAT
TOKYO, JAPAN
2006

NANO PRODUCT : SAGAN COAT, PHOTOCATALYTIC SELF CLEANING COATING ON GLASS

Fig 15 : G- FLAT
http://www.archdaily.com/266997/g-flat-architecture-workshop
- Structural walls have been installed in the center of each residential block, and these walls are arranged in alternating directions in adjacent residential buildings.
- They are structurally unified by the connecting balconies, and so horizontal forces are directly taken by structural walls running in two directions.

Fig 16: Residential blocks
http://www.archdaily.com/266997/g-flat-architecture-workshop

- In this system, steel posts take vertical loads from the flat slabs, which are independent from the structural walls.

Fig 17: Steel post loads
http://www.archdaily.com/266997/g-flat-architecture-workshop
• DUE TO THIS STRUCTURAL SYSTEM, THE PERIMETERS OF THE RESIDENTIAL BLOCKS ARE COMPLETELY FREE FROM THE STRUCTURE, AND EVERY RESIDENCE HAS A SPATIAL FORM LIKE A DETACHED HOUSE, COMPRISING MANY SURFACES THAT INTERFACE WITH THE EXTERIOR.

![Fig 18: EXTERIORS](http://www.archdaily.com/266997/g-flat-architecture-workshop)

• THE PRIVACY AND THERMAL CONDITIONS OF THE INTERNAL SPACES ARE CONTROLLABLE DUE TO THE INSTALLATION OF A DOUBLE LINE OF OPERABLE FITTINGS ALONG THE PERIMETER, LIKE AN ENGAWA-STYLE VERANDA.

![Fig 19: ENGAWA STYLE VERANDA](https://s-media-cache-ak0.pinimg.com/736x/51/37/24/5137243d5cfcf0a6a9d4541b0c5c9ac3.jpg)
- EACH OF THE BUILDINGS IN THIS HOUSING SCHEME IS FULLY GLAZED WITH WALL SLABS SERVING TO DIVIDE AND STRUCTURE THE SCHEME.
- FITTINGS IN EACH FLAT ALLOW THE DEGREE OF PRIVACY AND INDOOR CLIMATE TO BE REGULATED INDIVIDUALLY DESPITE FULL HEIGHT GLAZING.
- SUCH BUILDINGS MUST BE KEPT SCRUPULOUSLY CLEAN TO MAINTAIN THEIR TRANSPARENCY.
- A PHOTOCATALYTIC SELF-CLEANING GLASS COATING HELPS THE GLASS STAY CLEAN AND ITS TRANSPARENT DUE TO ITS NANO-SCALAR QUALITIES.

Fig 20 : SELF CLEANING GLASS FAÇADE
http://www.archdaily.com/266997/g-flat-architecture-workshop
Fig 21: FLOOR PLAN OF G FLAT
http://www.archdaily.com/266997/g-flat-architecture-workshop/50384aae28ba0d445f000041_g-flat-koh-kitayama-architecture-workshop_floorplan.png

Fig 22: SECTION OF G FLAT BLOCK
http://images.adsttc.com/media/images/5038/4ab1/28ba/0d44/5f00/0042/large_jpg/section.jpg?1436816025
3. NANOTECHNOLOGY AND GLASS

TEMPERATURE REGULATION: PHASE CHANGE MATERIALS (PCMS)

- passive temperature regulation.
- reduced heating and cooling demand.

- controlling light and heat entering through building glazing is a major sustainability issue.
- nanotechnology offers four different strategic solutions to block light and heat coming in through windows.
- Firstly, thin film coatings are being developed which are spectrally sensitive surface applications for window glass.
- these have the potential to filter out unwanted infrared frequencies of light reduce the heat gain in buildings; however, these are effectively a passive solution.
- Secondly, thermo-chromic technologies are being studied which react to temperature and provide thermal insulation to give protection from heating whilst maintaining adequate lighting.
- a third strategy, that produces a similar outcome by a different process, involves photo-chromic technologies which are being studied to react to changes in light intensity by increasing absorption.
- all these applications are intended to reduce energy use in cooling buildings and could make a major dent in the huge amounts used in the built environment.
CASE STUDY 3

SUR FALVENG

Housing for eldering people

ZURICH, SWITZERLAND

NANO PRODUCT: LATENT HEAT STORING GLASS, PHASE CHANGE MATERIAL (PCM)

Fig 23: SUR FALVENG
file:///C:/Users/Meghz/Downloads/Nanotecnologie_per_edilizia.pdf
- AFTER THE DEMOLITION OF A FORMER SAWMILL AREA IN DOMAT/EMS CLOSE TO A RETIREMENT HOME, THE OPPORTUNITY AROSE TO BUILD A HOUSE FOR THE ELDERLY.
- THE SITE IS LOCATED NEAR THE FALVENG TUMA NEAR THE RECREATIONAL AREA.

Fig 24 : SURROUNDING OF THE HOUSE
https://core.ac.uk/download/files/74/1564184.pdf

- HORIZONTAL WINDOW OPENINGS FRAME THE VIEWS TO THE NORTH, WHILE THE SOUTH FACADE IS AN OPEN GLASS AND METAL CONSTRUCTION.
- THE CENTRAL TOPIC OF THE BUILDING ARE THE NEEDS OF ITS RESIDENTS.
- SPACIOUS WHEELCHAIR ACCESSIBLE APARTMENTS WITH THE BEST FACILITIES GIVE EVERY RESIDENT THE OPPORTUNITY TO FURNISH HIS PRIVATE SPACE INDIVIDUALLY.

Fig 25 : INTERIORS
https://core.ac.uk/download/files/74/1564184.pdf
- The central of three cavities of an 8 cm thick composite glass element contains a salt hydrate fill material that functions as a latent heat store for solar heat and protects the rooms from overheating.

- The latent heat store has a thermal absorption capacity equivalent to a 15 cm thick concrete wall.

- The glass panel is transparent when the fill material has melted and milky white frozen.

- The whole façade is made up of such glass panels which keeps the building warm throughout.
CONCLUSION

1. THE APPLICATIONS OF THE NANOTEchnology IN ARCHITECTURE CAN VARY WIDELY FROM EARLY STAGES OF DESIGN TO THE FINAL TOUCHES OF FINISHES AND THROUGHOUT THE BUILDINGS LIFETIME.

2. DISRUPTIVE TECHNOLOGIES SUCH AS NANOTEchnology GIVE US THE OPPORTUNITY TO MOVE INTO NEW HIGH VALUE ADDED AREAS BOTH BY CREATING NEW ARCHITECTURE AND BY RADICALLY CHANGING TRADITIONAL ONES.

3. WE NEED ARCHITECTS, SCIENTISTS AND TECHNOLOGIES TO GIVE CAREFUL THOUGHT TO ANY ETHICAL, CULTURAL, ARCHITECTURAL AND ENVIRONMENTAL ISSUES RAISED BY NANOTEchnology, TO SAY WHETHER ANY NEW REGULATORY CONTROLS ARE REQUIRED, AND TO ENTER INTO AN OPEN DIALOGUE WITH PUBLIC.

4. THERE ARE THREE MAIN ISSUES THAT MIGHT PREVENT THE WIDESPREAD USE OF THE NANOTEchnology: • LACK OF VISION TO IDENTIFY THOSE ASPECTS THAT COULD BE CHANGED THROUGH ITS USE. • LACK OF SKILLED PERSONNEL. • LEVEL OF INVESTMENT. AS WITH MOST MAJOR INNOVATIONS, THERE ARE TWO PRINCIPLE OBSTACLES TO BE OVERCOME
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