Waterproofing using nano technology as an alternative solution

W Wangidjaja
Architecture Department, Faculty of Engineering, Bina Nusantara University, Jakarta, Indonesia 11480
E-mail: wellyw@binus.ac.id

Abstract. After construction phase is done, often we found leakage problems, not only at wall, floor and others area, so we need another solution to repair the leakage. The aim of using Nano Technology as waterproofing material is to make the job easier but still we could get the good result. The study was conducted by collecting data according to the calculation on the field by noting the benefit and difference time, and the results of work per day. The study was conducted at the residential house project in Jakarta Pusat.

Keywords: leakage problem, problem solving, building material, nano technology,

1. Introduction
Nanotechnology is the term given to those areas of science and engineering where phenomena that take place at dimensions in the nanometer scale are utilized in the design, characterization, production and application of materials, structures, devices and systems.

Nanotechnology, shortened to “Nanotech”, is the study of the controlling of matter on an atomic and molecular scale. Generally, Nanotechnology deals with structures of the size 100 nanometers or smaller in at least one dimension, and involves developing materials within that size (Figure 1) [1].

Figure 1. What is nano particle [1]
Nanotechnology is very diverse approach based upon molecular self assembly, from developing new materials with dimensions on the nanoscale to investigating whether we can directly control matter on the atomic scale. Any technology based on particles size less than 10 ηm is considered Nano Technology. Molecule of modern nanotechnology based water proofing compounds, when dissolved in solvent has estimated size of 5-6 ηm [2].

Nanotechnology based waterproofing uses monomeric water repellent compounds that can penetrates several millimeters inside the core of the substrate. 2000 hours of UV test results for such compounds indicates that nanotechnology base water proofing compounds are very stable and does not change chemically and protect the bulk of the substrate structure.

Nanotech has made it possible to waterproof almost any material, such as bricks, concrete, woods, metals. The idea behind a nano coating and waterproofing is simple: an extremely thin layer of microscopic particles is used to fill up every pore of a materials surface. The nano coating provides a second, water- and dirt-repellent skin [3].

Many nanotech solutions have made their way into everyday life – one of the most prominent being the use of ceramic coating for waterproofing. Nano coating is hydrophobic (water repellent), oleo phobic (oil repellent) surface layer that repels water, oil, dirt, and other dry particles.

Super hydrophobic coatings are used in dry surface application. These naturally occur in some plant leaves, such as the lotus leaf, and some insect wings (Figure 2).

This study aims to compare between conventional material for waterproofing and waterproofing with nanotechnology material. The method used in this study is a comparative study with sample of work and technical data.

The nanotechnology system used here (we use 1 brand called Nano Star™) could be useful as a building material is an environmentally friendly product, because has several advantages like:

- Safe: The product does not contain dangerous ingredients.
- Light Weight: The product does not additional weight to the remaining structure
- Durability: The product could sustained to 10 years (applied by certified applicator appointed)
- Breathable: Since the coating allow the material to be able to ‘breathe’, so the material after treatment with nano coating still could be applied to other material, such as paint, cement.
- Non-Toxic: The product itself already certified Green Label by Singapore Environment Council, as it is safe and ecofriendly.
- Self-Penetrate: The product does not change the texture and colour of the material, also the product does not adding another layer above the material, instead the product penetrate into the material.
- Efficient: Estimated time needed for application studied 70% quicker compared to conventional waterproofing material.

With the development of building materials technology, the demands to accelerate working time is a must, and therefore many alternative building materials been studied to be used, one of which is the Nano Coating Technology / NSC for waterproofing treatment, which had some advantages compared to conventional materials.

NSC is the brand name from one company in Singapore, that use this nano technology material to do waterproofing jobs, it is called Nano Star for Concrete or in short NSC [4].

![Figure 2. Bricks after applied with nano coating spray [2](image)]
2. Methodology
The methodology is to collect and analyse the data. This study use the case study method to take sample of the Residential house building in Jakarta - Indonesia that use NSC waterproofing as building material for waterproofing repairment, also find out comparison of using NSC waterproofing material compared with conventional materials.

The data collecting use observation method; to observe how to apply the NSC waterproofing material in the projects, to find out the pros and cons the use of the material itself. The data collected from the literature and catalogue, will be analysed and discussed. The implementation also has been done to know what has been taught and applied directly in the field work, in this case is the use of NSC waterproofing material for waterproofing work on site.

3. Results and discussion
Almost all material commonly used for construction can be treated with these water proofing compounds. This includes Concrete, Bricks, Sand Stone, Granite, Lime stone, Marble, Plaster, Cement sheet and Natural stones.

*Nanotechnology based Water proofing compounds are generally a monomeric compound. The size of the molecule is less than 6-8 nm. They can easily enter into the pores of the substrates. Because of their small size, the molecules flows through the pores branches inside the substrate. Normally they are applied as water solution though other solvent may also be used as indicated by manufacturer (Figure 3). Such water proofing compounds are found to be very efficient in covering the surface and provide deep penetration as below:

(a) They withstand hydraulic pressure generated by high wind driven rains.
(b) They give protection against micro cracks
(c) They also protect the structures from water damage after abrasion due to heavy traffic or natural weathering of the surface
(d) Protects the reinforcement bars from corrosion.*

*Nano technology in waterproofing building materials*,

Building materials are known to have water seepage, water leakages due to inherent porosity and micro cracks.

Waterproofing is a treatment, which is expected to make the material impervious to water. Lots of technology and product development has taken place in various waterproofing products for the last 50 years, particularly using polymeric backbone and variety of other materials.
The nano technology has ensured that service life of this approach will lead to life cycles beyond 20 to 30 years at very economical cost. Nano based protective Waterproofing material is reactive waterproofing with penetration up to 2 mm into concrete pores / cementitious surfaces offering 360° envelope and creates an impervious monolithic membrane to eliminate seepages.

**Application of Nanotechnology Based Water proofing compounds [5],**

Preparation of surface:
- 1. The substrate should be made clean and dry.
- 2. Surface should be free from loose particles, wax, sealers, curing compounds, grease and efflorescence.
- 3. Concrete should be fully cured for at least 28 days.
- 4. Now surface sealers should be applied to surfaces that are already reach the strength required.
   Surface should be dry with no rain expected within 2 hours following application.

The case,

Repayment for the surface of concrete wall and concrete before screeding work to prevent leakage problems were:
- 1. The screed plaster crack or not bonding with the surface of the concrete
- 2. The area need to be water tight to prevent leakage
- 3. The demand of the user to make the repairment work not to dusty and noisy
- 4. The below surface have limited space due to MEP installations
- 5. If possible not making any changes to the existing condition (after treated with nano coating) as shown in Figure 4.

![Figure 4](image1)

*Figure 4. The condition of crack at the screeding plaster*

**The methods of repairment works**:
- 1. Removed all the cracks plaster and then clean all the surface of concrete as show in Figure 5.

![Figure 5](image2)

*Figure 5. Remove all the cracks at the screeding plaster plaster*

- 2. Do the leakage test by filling the pool with water, and test for leakage within 24 hours
- 3. If no leakage then dry the pool and clean the surface of concrete from dust and dirt
- 4. Mixed the NSP liquid with cement in proportion 1:1 then apply the solvent material by roller brush to all concrete surface in vertical way, let it dry for 24 hours (Figure 6).
5. Do again the same thing as no 5, but now in horizontal way, let it dry for 24 hours
6. Do the leakage test by filling the pool with water, and test for leakage within 2x24 hours
7. Re-do screed plaster again and instalment of ceramic for that area, take caution not to damage the surface of the concrete that had been treated with nano coating as shown in Figure 7.

**Figure 6.** The diagram sequence of works [4]

**Figure 7.** The screed plaster after treatment with NSC

**What is new in nanotech waterproof materials,**

1. Less material wasted, because we only need to make the surface clean before treated, no need to add screed, plaster, etc.
2. Because nano particle could penetrate into substrate material, it also allows the material to breathe not like the conventional methods that make a layer which ‘block’ the substrate like envelope
3. The nanotech treatment makes surfaces ‘water repellant’ and ‘water resistant’ yet the surface still could be applied to ordinary plaster or other finishing
4. Changes surface properties of the substrate, because the nano particles could penetrate into the pores of the material itself, making it like filling and cover each pores with nano particles.

**The result,**

Repairment for the surface of concrete wall and concrete after treated with nano coating was successful and the result meet our requirements as shown in Figure 8.

**Figure 8.** The difference before and after treated with nanotech material

The study make comparison of several waterproofing materials in terms of application, workman skill, and some other effects (as shown in table 1).
Table 1. The comparison in general methods of waterproofing materials

| No | Items / Property          | Nano coating treatment | Cementious | Bitumen Membrane | Liquid Applied Membrane Acrylic | Liquid Applied Membrane PU |
|----|---------------------------|------------------------|------------|------------------|---------------------------------|----------------------------|
| 1  | Ease of Application      | V skilled labour preferred | X skilled labour preferred | X skilled labour must | V skilled labour must | V skilled labour must |
| 2  | Workman skill            | V                      | V          | X                | V                              | V                          |
| 3  | Application at cornered surface | V                 | V          | X                | V                              | V                          |
| 4  | Positive Pressure         | V                      | V          | X                | V                              | V                          |
| 5  | Negative Pressure         | V                      | V          | X                | X                              | X                          |
| 6  | Breathable               | V                      | V          | X                | X                              | X                          |
| 7  | Fully bonded system      | V                      | V          | X                | V                              | V                          |
| 8  | Thickness of system      | V                      | V          | X                | V                              | V                          |
| 9  | Weathering               | V                      | X          | X                | V                              | V                          |
| 10 | Ageing of system         | V                      | X          | X                | V                              | V                          |
| 11 | Installation Period      | V                      | V          | X                | V                              | V                          |
| 12 | No primer                | V                      | V          | X                | V                              | V                          |
| 13 | Green Product            | V                      | X          | X                | V                              | V                          |
| 14 | Non Toxic                | V                      | V          | X                | X                              | X                          |
| 15 | Repair - ability         | V                      | V          | X                | V                              | V                          |

The study also make comparison to most often used waterproofing materials in terms of cost, time, material used, and the other effects (as shown in table 2), area to be repaired 70m².

Table 2. The comparison in general methods of waterproofing materials applied

| No | Items                 | Nano coating treatment | Cementious | Membrane |
|----|-----------------------|------------------------|------------|----------|
| 1  | Cost                  | IDR 225,000/m²         | IDR 85,000/m² | IDR 150,000/m² |
| 2  | Time                  | 5 days                 | 10 days     | 9 days    |
| 3  | Material used         | fully used             | wasted / unused material | wasted / unused material |
| 4  | Screed plaster        | could be applied clean | cannot be applied clean | need additional material clean |
| 5  | Effect                | easy to install ceramics | need additional material | need periodic maintenance |
| 6  | Finishing application |                        |            |          |
| 7  | Durability *          | 20 years               |            |          |
4. Conclusion

Nanotechnology is a rapidly expanding area of research where novel properties of materials manufactured on nano-scale can be utilized for the benefit of construction infrastructure, and a number of promising developments exist that can potentially change the service life and life-cycle cost of construction infrastructure to make a new world in the future. New materials and products based on nanotechnology can be found in building insulation, coatings, and solar technologies.

The use of micro nano materials (MNMs) in the construction industry especially in leakage treatment and repairment, should be considered not only for enhancing material properties and functions but also in the context of energy conservation.

This paper provides the practice how to apply nano tech material in construction work, especially leakage problems and it’s useful to other treatment after the applications, the benefit of the material used throughout the building life span.

Repairment for the surface of concrete wall and concrete before screeding work to prevent leakage problems was successful compared to other methods.

References

[1] Guidelines on Waterproofing in New / Old Construction 2015 report no RDSO/WKS/2015/1-Revision 1, Government of India 46-48

[2] Ioelovich M, Figovsky O and Leykin A Polymate Ltd and Nanotech Industries Inc 2012 Biodegradable nano-composition for application of protective coatings onto natural materials US Patent 8,268,391

[3] Directorate Works Guidelines/Specification & standardization/Reports Guidelines (S.No.8) (http://www.rdso.indianrailways.gov)

[4] Nano Star Catalogue 2019 Nano Star Concrete Manuals of Instruction

[5] Pradesh H 2012 Application of nanotechnology in building materials International Journal of Engineering Research and Applications 2 1077-82