Simulation of Water Proofing Building Using Poly Ethylene (PE) Sheets

Reem A. S. Ibrahim, Akram H M Ali, Isam. A. Ishag

College of Engineering and Industries' Technology - Sudan University of Science & Technology, Sudan

Abstract— *The research focused on how to use high density poly ethylene (HDPE) sheets in waterproofing operations of floor buildings (bathrooms, kitchens, basements and swimming pools), which uses Bitumen and how the Bitumen is modified by introducing some polymeric materials, until using of forced thermoplastic booster (carbon black or Fiber Glass). In insulation process HDPE sheets is placed under the concrete floor, which displays the sheet pressure and this pressure causes the stresses and deformations in the insulation material by using (solid work program) the geometric design sample dimensions were determined using stress analysis and simulation the input data are the material (HDPE) characteristics such as density, tensile strain, the poison ratio and tear resistance. The applied load on the sheet is a tile weight was analyzed by (solid work program) to determine stresses and deformations that have occurred to the insulation material. Absorption coefficient of moisture conducting test shows the HDPE has an excellent absorption properties to use in waterproofing, when using insulation material under concrete, the concrete dry out after 12 hours; which would lead to more cohesion of cement and concrete. Noting that the concrete without using insulation material will dry within 3 hours.*

Keywords— HDPE (High Density Polyethylene), Bitumen, Thermoplastic booster, Waterproofing operations, Insulation material

I. INTRODUCTION

While the plastics industry has witnessed a spectacular growth over the last six decades, the acceleration in consumption rates of plastics has taken place in several phases since World War II. Much of the use of plastics just after the war was as a cheap substitute for traditional materials (in other cases, the material was used for its novelty value), and in many instances the result was determined to the industry.

Plastics have been widely accepted in industrial equipment development as materials for many critical components and for accessories where such features as toughness, abrasion resistance, corrosion resistance, electrical insulation capability, nonstick properties, and transparency are of importance. Waterproofing is the combination of materials used to prevent water intrusion into the structural elements of a building or its finished spaces. Its main purpose is to resist hydrostatic pressure exerted by moisture in the liquid state. Waterproofing membranes consist of waterproof plastic, rubber, or coated-fabric materials. The materials are used in a system to prevent the ingress of water into foundations, roofs, walls, basements, buildings, and structures when properly installed. The term damp proofing is often confused with waterproofing, however, damp proofing is a system designed to resist the flow of moisture in a gaseous state. Tightly integrated with Solid Works CAD, stress analysis of plastic and rubber parts using Solid Works Simulation can be a regular part of design process—reducing the need for costly prototypes, eliminating rework and delays, and saving time and development costs. Designing in a modeling package such as Solid Works is beneficial because it saves time, effort, and money that would otherwise be spent on prototyping the design.

The stress analysis of plastic and rubber components, or assemblies containing plastic or rubber parts, requires the use of nonlinear stress analysis methods, since these types if parts generally have a complex load deformation relationship (that is, the basic relationship assumption of Hooke's Law is violated)

To carry out plastic component stress analysis, the plastic stress-strain curve must be known and entered into the Solid Works material database to achieve the best results. This database is easily customizable to include the particular material requirements. You can choose from:

Nonlinear elastic or hyper elastic Mooney-Revlon or Ogden formulations (for rubber components)

Hyper elastic Blitz-K formulations (for compressible polyurethane foam type rubbers)

Solid Works Simulation uses finite element analysis (FEA) methods to discredited design components into solid, shell, or beam elements and applies nonlinear stress analysis to determine the response of parts and assemblies due to the effect of: Forces, Pressures, Accelerations, Temperatures, Contact between components and Loads can be imported from thermal and Simulation studies to perform multi physics analysis.

1.2 The Waterproof:

The use and installation of a special membrane is primarily designed to prevent water leakage or moisture from and to different construction elements. Contains items that are usually sequestered in buildings internal and external plate. Internal surfaces, such as: bathrooms, toilets, laundry rooms, shower units, water tanks. External bodies, such as: ceilings, open terraces, retaining walls, ponds and swimming pools. And would prefer to begin the separation of water from the bottom and continues around the concrete surfaces thicken up buried all of down to Earth and a little higher.

As it covers the entire Earth under sea level ground for that duration provides the following protection: Good waterproofing prevents the rise of radon gas harmful to human health from the underground into the building. Separation of water prevents the rise of moisture in the form of water vapor, especially in winter when the ground is warmer than yard adjustments, moving moisture through non-insulated floors and water penetrate concrete and tiles and degradation to oxides and carbonates in white appear on the tile surface as white foam. Insulation moisture prevents water from getting into the pores of the external walls and internal partitions to appear on surfaces inside and out and lead to the fall of the paint layers and fragmentation of alkosara above. The pores of the concrete better whenever the moisture to higher levels have stepped up, as if the concrete columns.

Protect insulation waterproof concrete in Foundation of disintegration due to exposure to soluble sulphate salts in the soil, as well as protects the steel from corrosion. Rising humidity may result in damage to the walls, electrical wiring and plumbing, working on her rust and diversion of electricity or water, the greater the damage. In some cases preferably external corridors under the insulation level of the concrete term directly to protect it from moisture and water to preserve soil moisture stability throughout the seasons of the year.

In summary, the additional cost incurred by the owner in a water well insulated building insulation does not constitute a considerable financial burden and at the same time they rest him from ongoing maintenance that will suffer in the future and make wishes do it since the beginning. The waterproofing is not a luxury but a necessity, the walls, floors and ceilings moist also contributes to the loss of large amounts of heat energy in the winter, which makes heating home on cold days the issue very difficult with large financial burdens. Causes of moisture: Building; Quantities of rainwater; Surface water; Groundwater; Capillarity Capillary Action; Condensation; Misuse and drainage; Modern construction: the newly-built walls in case of humidity for certain time period; Bad employment. Damage caused by water leaking of various construction elements: Corrosion of steel doors and steel structures; Fragmentation and weak resistance;

Fig.1: Uses of bitumen

Damage to the Interior finish of walls and separated from the building structure; The growth of algae and rooted and deformation; Damage to coatings and paints; Shows the power to harm, damage, disconnection voltage; The separation of ceramic tiles for walls and floors; Ntvakhalkosara and exfoliating it by demolishing and separation walls; Salt and contaminants to leak water tanks; Health problems relating to the users of the buildings either mold or odors. Insulation for moisture: Flexible Materials; Metal Sheets; Bitumen; Water Proofing Liquid; Polyethylene Membrane. Uses of bitumen Adhesive; Waterproofing water spray on surfaces or floors; Used as established by a dielectric layers; Paints; Used in the manufacture of rubber flooring tiles and some other buffer; Used as a paint for absorbent surface; Be good when used as adielectric moisture on concrete and wooden ceilings.

Today, these products include those cold-applied at ambient temperature ,those applied after softening the material sufficiently to ensure good adhesion to the roof substrate, and those using hot liquid bitumen to laminate the elements of the roof system. The shares of these three types of systems in the North American and European bitumen roofing markets are shown in Table (1).

Table 1
2006 North American and European Bitumen Roofing Production, Stratified by Application Temperature*

North America

	Cold-Applied Products	Soft-Applied Products	Hot-Applied Products
Shingles	3403	0	0
Built Up Roofing	39	0	259
Bitumen Membranes & Underlayments	1418	0	0
Polymer Modified Bitumen Roofing	235	35	39
Total	5095	35	298
Market Shares by Application temperature	94%	1%	5%

Europe

	Cold-Applied Products	Soft-Applied Products	Hot-Applied Products
Shingles	40	0	0
Built Up Roofing	0	0	2
Bitumen Membranes & Underlayments	14	256	14
Polymer Modified Bitumen Roofing	32	514	64
Total	86	770	80
Market Shares by Application temperature	9%	82%	9%

1.3 Uses of HDPE sheets:

The first use of a plastic film in agriculture is said to date from 1948When Prof. E.M. Emmert had no money to buy a glasshouse and covered a wooden structure with cellulose acetate film, which here placed with polyethylene film some time later. The use of polymers in agriculture on a significant scale started in the early 1950s when low-density polyethylene (LDPE) was used to replace paper for mulching vegetables.

Geotextile Protection for Geo membranes (1): The protection layers investigated were nonwoven needle punched geotextiles. The two geomembranes currently used in landfills in South Africa, high-density polyethylene (HDPE) and flexible polypropylene (FPP) were used to compare any differences, which might occur due to the various protection layers. A variation of the German Federal Institute for Materials and Testing(BAM) liner protection test method was used in order to ensure repeatability and hence reliable comparisons of results.The study found out many results, were obtained as follows:

Increasing the thickness of the geo-textile improves the level of protection to the geo- membrane.

The shore hardness / modulus of the sub grade material has a marked influence on the geo-membrane deformation.

Assessment of deformation can be carried out in South Africa at a relatively low cost.

OBJECTIVES:

In building construction, a structure needs waterproofing since concrete itself will not be watertight on its own (but note concrete is easily waterproofed with additives). The conventional system of waterproofing involves 'membranes'.

This relies on the application of one or more layers of membrane (available in various materials: e.g., bitumen, silicate, PVC, EPDM etc.) that act as a barrier between the water and the building structure, preventing the passage of water.

New membrane materials seek to overcome shortcomings in older methods like PVC and HDPE. Generally, new technology in waterproof membranes relies on polymer-based materials that are extremely adhesive to create a seamless barrier around the outside of a structure.

II. MATERIAL AND METHODS

One of the most important tests that use of plastic materials is tensile test because it determines the most important mechanical properties such as tensile stress at yield point and elongation at break and stress, so we conducted a tensile test on a sample to determine the tensile strain and we will enter in the program solid work. They must be identified are characteristic absorption coefficient of moisture even says our use of the material as insulation for moisture.

III. METHODOLOGY

Test of moisture absorption:

Type of sample: HDPE sheet 2.5% carbon black, antioxidants, UV and heat stabilizer.

Shape of sample: Rectangular 170 × 150 mm

Thickness of sample: 0.5 mm

3.1 DESCRIPTION of Test:

- Weighed sample in a sensitive balance and recorded the result (W1) and then flooded with water sample for 48 hours and weighed sample which is saturated with water(W2), and put the sample in a thermal oven temperature 110 ° C for 2 hours and weighed dry sample and recorded reading(W3).

The weight of the sample before immersion in water:$w_{1=}$11.2 g

The weight of the sample after immersion in water for 48 hours to rise more than 10 cm:$w_{2\,=}$11.2 g

The sample was put inside the oven temperature 110°C for two hours, bringing the weight: $w_3 = 11.2$ g

This means: Moisture absorption coefficient equal zero.

Mechanical properties test:

$$\text{The density: } \rho = \frac{11.2\times10^{-3}\,\text{kg}}{170\times150\times0.5\times10^{-9}\text{m}^3} = 878\ {}^{\text{kg}}/_{\text{m}^3}$$

IV. TESTS AND RESULTS

4.1 TENSILE TEST:

Sample preparation:

Cut the sample in accordance with the specification ASTM D638 According to the form below:

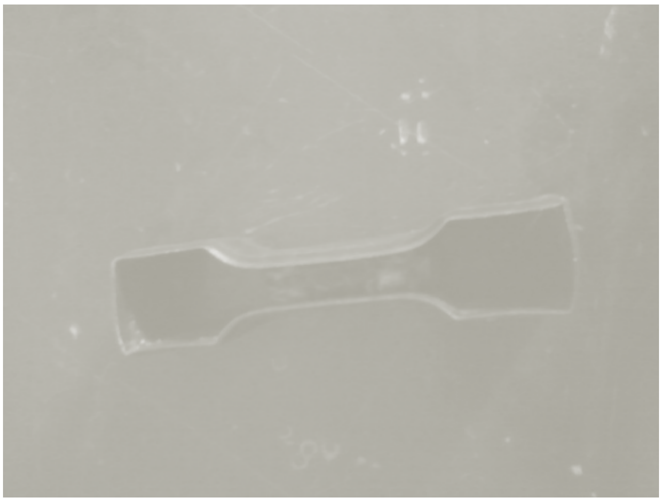


Fig.2: Model of sample

Length of sample L=50mm

Table.2: Sample (1): HDPE sheet {2.5% carbon black, antioxidants, UV and heat stabilizer}

	Unit	Test Method	Min. Values
Strength at yield	N/mm	ASTM D638	7
Elongation at yield	%	ASTM D638	12
Strength at break	N/mm	ASTM D638	12
Tear Resistance	N	ASTM D1004	65
Water Tightness	%	EN-1928	0
Thickness	Mm	ASTM D5199	0.5

Table.3: Sample (2): HDPE Sheet is a self-adhesive, cold applied, Fiberglass carrier.

Test property	Unit	Test Method	Min. Values
Strength at yield	N/5cm	ASTM D-5147	250
Elongation at yield	%	ASTM D-5147	3
Strength at break	-	ASTM D-5147	-
Tear Resistance	N	ASTM D-5147	-
Water Tightness	%	EN-1928	-
Thickness	mm	-	1.7

The sample was failed in the oven so we used the first sample.

Sample (1) was chosen to be analyzed by solid work program to analyze stresses and identify anomalies that occur, so as to: Easy configuration and manufacturing; Cheaper; Ease of Use. The stress analysis of plastic and rubber components, or assemblies containing plastic or rubber parts, requires the use of nonlinear stress analysis methods, since these types if parts generally have a complex load deformation relationship (that is, the basic relationship assumption of Hooke's Law is violated).

4.2 SOLID WORKS MODELING SOFTWARE

Is used around the world to design products, develop machinery, and create production systems. The success of the software's application in industry has led to its growing presence in education. Mechanical engineering , industrial design, and transport technologies are just a few of the functions in which Solid Works software is successfully used as an advanced tool by designers and Engineers.

4.3 SPECIFICATION of SOLID WORK:

Solid Works modeling and easily move the model and tested. This program first in its field, which deals with the design and engineering three-dimensional models. Offers an integrated solution to view engineering designs is three-dimensional and realistic to the fullest extent. It is considered the optimal emulator, which will help in creating a clearer vision for your designs and inventions and engineering will facilitate you to work significantly. And forgotten the existence of not listening cosmetics built and which you can test your design.

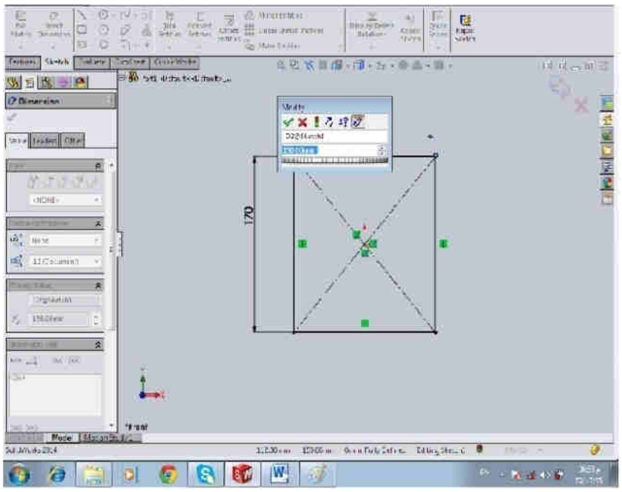


Fig.2: Model dimension

Draw the shape of sample Rectangular170 × 150 mm, Thickness of sample: 0.5 mm

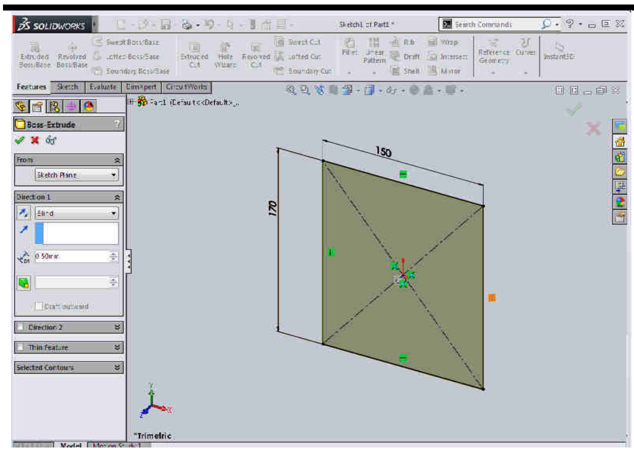


Fig.3: 3D shape

In figure 4 the Material window; the properties are highlighted to indicate the mandatory and optional properties. A red description (Elastic modulus, Poisson's ratio) indicates a property that is mandatory based on the active study type and the material model. A blue description (Mass density, Tensile strength, Compressive strength, Yield strength, Thermal expansion coefficient) indicates optional properties. A black description (Thermal conductivity, Specific heat, Material damping ratio) indicates properties not applicable to the current study. In the material window, open the Solid Works Materials menu, followed by the plastic menu. Select HDPE film. Select SI units under the Properties tab (other units could be used as well). Notice that the HOLLOW PLATE folderin the tensile load 01study now shows a check mark and the name of the selected material to indicate that a material has been assigned. If needed, you can define your own material by selecting custom defined material . Defining a material consists of two steps: Material selection (or material definition if a custom material is used); Material assignment (either to all solids in the model, selected bodies of amulets body part, or to selected components of an assembly).

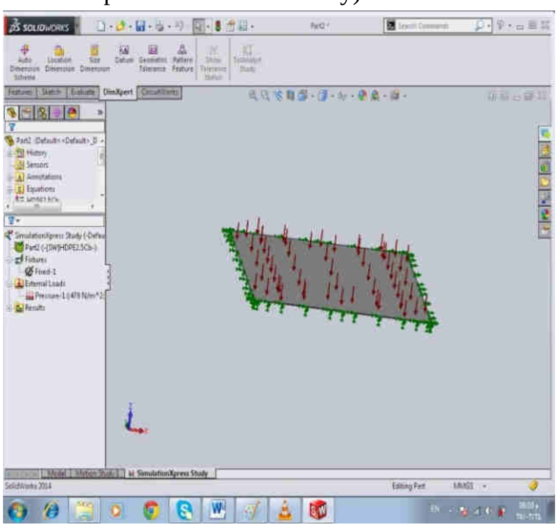
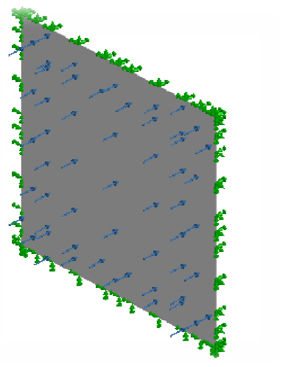


Fig.4: Appling Load

Fixture the sample on all direction and apply the pressure on one face. The pressure applied on the sample is about the weight of tile:



$$P = \frac{1.245\text{kg} \times 9.81\ {}^{\text{m}}/_{\text{s}^2}}{25500 \times 10^{-6}\text{m}^2} = 479\ {}^{\text{N}}/_{\text{M}^2}$$

Solid Works Simulation, the term "Fixture" implies that the model is firmly "fixed" to the ground. However, aside from Fixed Geometry ,which we have just used, all other types of fixtures restrain the model in certain directions while allowing movements in other directions.

Therefore ,the term "restraint" may better describe what happens when choices in the Fixture window are made.

Assumption:

Table.3: Study results

Name	Type	Min	Max
Stress	Von:von Mises Stress	0.0221412 N/mm(MPa) Node:7945	8.89086N/mm(MPa) Node:16169

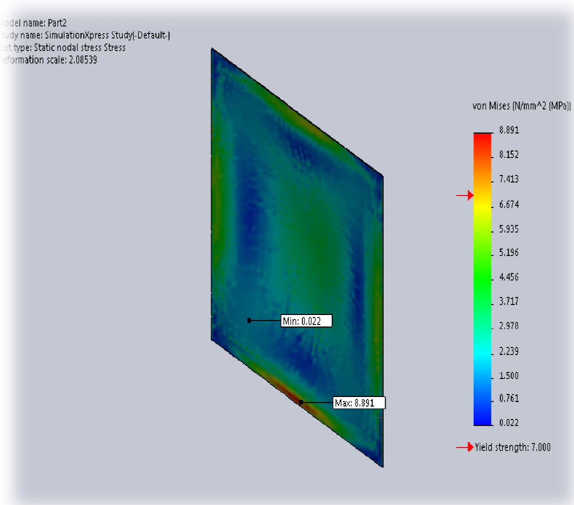


Fig.5: Simulation X stress Study-Stress-Stress

Von Mises stress results are shown by default in the stress plot window. Notice that results are shown in [N\m2] as was set in the Default Options tab (Figure). The highest stress 8.891N\M2 is below the material yield strength, 7.000N\m2.The actual numerical results

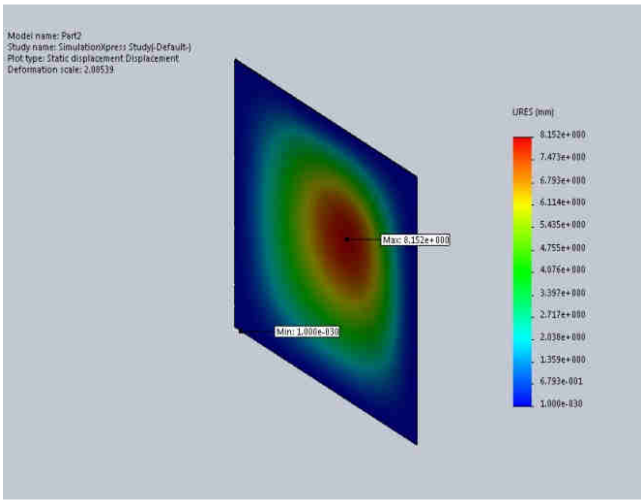


Fig.6: Simulation Xpress Study-Displacement-Displacement

May differ slightly depending on the solver used, software version, and service pack used. A factor of safety of 1.0 at a location means that the material is just starting to yield. A factor of safety of 2.0, for example, means that the design is safe at that location and that the material will start yielding if you double the loads.

Results

Lists the following mass properties: Density, Mass, Volume, Surface area, Center of mass, Principal axes of inertia and Moments of inertia and products of inertia. In the graphics area, a single-colored triad indicates the principal axes and center of mass of the model. A tri-colored reference 3D triad appears at the origin. The moments of inertia and products of inertia are calculated to agree with the following definitions:

$$I_{xx} = \int (y^2 + z^2)dm$$

$$I_{yy} = \int (z^2 + x^2)dm$$

$$I_{zz} = \int (x^2 + y^2)dm$$

$$I_{xy} = \int (xy)dm$$

$$I_{yz} = \int (yz)dm$$

$$I_{zx} = \int (zx)dm$$

The inertia tensor matrix is defined below from the moments of inertia:

$$\begin{bmatrix} I_{xx} & -I_{xy} & -I_{xz} \\ -I_{xy} & I_{yy} & -I_{yz} \\ -I_{xz} & -I_{yz} & I_{zz} \end{bmatrix}$$

V. CONCLUSION

Been identified the most important property of HDPE material to be used in waterproofing buildings, a moisture absorption coefficient is equal to zero, making it an excellent material for the insulation process. And when using insulation material under concrete, the concrete dry out after 12 hours; which would lead to more cohesion of cement and concrete. Noting that the concrete without using material for insulation will dry within 3 hours, also were obtained for analysis of the stresses of the sheets in with solid work was a very good score for the blue color on the analysis as well as the safety coefficient article assumes that weaken the applied load.

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