Journal of Engineering and Computer Sciences
Qassim University, Vol. 11, No. 1, pp. 1-24 (January 2018/Rabi II 1439H)

Reducing Overburden Pressure on Concrete Buried Pipes Utilizing SABIC Polystyrene Products in Saudi Arabia

Hany A. Dahish[1,3] Abdullah AlSuwaiyan[2] Ahmad F. Alragi[1,3] Sherif M. ElKholy[1]
[1]Civil Engineering Dept., Qassim Engineering College, Qassim University, KSA
[2]Mechanical Engineering Dept., Engineering College, Qassim University, KSA
[3]Civil Engineering Dept., Faculty of Engineering, Fayoum University, Egypt
ha.dahish@qu.edu.sa

ABSTRACT. Concrete buried pipes, as a green construction material, has some disadvantages when they are used compared to other flexible, non-green materials such as plastic and steel pipes. To overcome this problem; a compressible inclusion, such as SABIC Polystyrene products, will be used to surround part of the concrete buried in order to help motivating arch action. This technique shall help in increasing the allowable buried depth of concrete pipes hence spreading the use of green materials and assisting in publicizing the culture of green building concept.

A numerical simulation of the problem is conducted and the effect of different factors will be investigated through a parametric study. Factors such as; width of the EPS geofoam layer, thickness of the EPS layer, and the location of the EPS layer are studied utilizing the numerical analysis in order to suggest the ideal solution are presented.

The study showed that the concrete pipes are much more durable than any other kind of pipes, they will last you a lifetime and they are not easily damaged as well. Concrete pipes are extremely cheap, environmentally safe and friendly since it is made of all natural local materials, which are also recyclable.

The numerical analysis showed that the expanded polystyrene (EPS) geofoam can be utilized in reducing stresses on buried rigid pipes and can be used as a compressible sheet for all types of underground structures against those faces in contact with earth.

Keywords: EPS, Geofoam, Green Material, Concrete Pipes, Numerical and Environment.

List of Symbols

Do: Outer diameter of pipe (m);

H: Height of fill up to pipe (m);

PL: Prism Load;

VAF: Vertical Arching Factor;

W: Soil unit weight (N/m3).

1. Introduction

With the urban development going on at a fast pace in Saudi Arabia, the infrastructure projects increased for connecting sewage networks to many areas. At the beginning, cast iron pipes were used in these networks, however they are fragile and need to be treated carefully during transportation and installation under the ground. Moreover, by the time, the cast iron pipes may cause environmental problems to soil and groundwater due to steel corrosion and rust. In recent years, new materials have been introduced for manufacturing sewage pipes such as plastic, reinforced concrete, and fiberglass. Reinforced concrete pipes are considered to be a good and economic choice for sewage pipes since they are less expensive, locally produced, and environmentally safe.

Concrete buried pipes have a reputation for strength and durability. They will not burn, prematurely corrode, deflect or move off grade to reduce hydraulic performance, or collapse under loads designed into the pipe structure. Comprised of the world's most commonly used building materials, concrete buried pipes are quickly integrated into ecosystems. This is clearly demonstrated by the use of three-sided precast boxes used to accommodate the natural channels of streams at road crossings, and precast concrete pipe. In this study, techniques to increase and improve the usability of concrete buried pipes are discussed in order to improve their performance as a green-building alternative for other type of pipes which are considered non-green materials.

2. Literature Review

Rigid pipes rely mostly on the strength of the pipe and is only slightly dependent on the strength derived from the backfill soil envelope. Steel reinforcement in concrete pipe adds significantly to its inherent strength [1]. There are many advantages for using reinforced concrete pipes like, suitable for conveying all types of water, easy to install and with flexible joints, it has a relatively high compressive strength, can withstand backfill pressure and because of the smooth inner surface, there are small friction losses. But these type of pipe require special care in its manufacturing, transportation and installation and it has a low tensile strength caused cracks under loading [2]. Another type of pipes used in the same field is steel pipes and it has some advantages like, resistant to high pressures, easy to connect, install, operate and maintain and they can withstand shocks and traffic vibrations. But these pipes are susceptible to wear and corrosion in sub-surface lines that reducing their lifespan compared to other types of pipes and they have low resistance to acidic or highly-salinity soils [2]. The analysis, design, and installation of buried structures thus require an extensive understanding of soil-structure interactions [3]. Reinforced concrete (RC) pipes are considered an economic and environmental safe alternative when engineers think of installing utility pipe lines. Compared with other types such as steel, composite, or plastic pipes, concrete pipes are built using locally produced, less expensive, and less harmful to environment materials. Therefor they are widely used worldwide as open channels for sewage and storm water conveyance [4]. The serious problem that threatens the increase the usage of concrete pipes is their ability to resist high overburden pressure when burying them at high embedment depth underground surface. In these cases, they usually don't last long and break under these soil loads.

Reinforced concrete pipes are specifically designed and used for sanitary sewers, storm sewers, industrial waste, irrigation, gravity water supply and micro tunneling operations. It can be designed and plant tested to resist any live and dead load required. Reinforced concrete pipes are most durable and long-lasting pipe that can exceed more than 100 years, however, increasing the embedment depth expose them to high overburden soil pressure which would reduce their service life expectancy.

Expanded polystyrene (EPS) geofoam blocks have been evaluated for vertical load reduction on buried pipes and culverts under highway fills. The earth pressure imposed on deeply buried pipelines and culverts is significantly affected by soil arching. Both the magnitude and distribution of earth pressure on buried pipelines and culverts depend on the depth of burial and the relative stiffness's of the pipe/culvert, compressible inclusion and surrounding soil [5]. For the case of putting a strip of EPS geofoam at a distance on top of buried reinforced concrete pipe, the soft zone caused by the compressible inclusion compresses more than the surrounding fill, thus inducing positive arching above the pipe. The deformation in the compressible inclusion provides mobilization of the shear strength of the soil above the pipe and as a consequence the vertical earth pressure remains lower than the overburden pressure caused by the weight of the soil [5].

Expanded polystyrene (EPS) geofoam is an ultra-light geosynthetic often incorporated in transportation infrastructure to reduce horizontal and vertical stresses imposed on buried pipeline and culvert systems [5]. EPS geofoam is manufactured by pre-expanding polystyrene beads which are molded and fused in block-molds using dry saturated steam.

There are many applications for using EPS geofoam below the ground in civil engineering including road embankments, bridges, retaining walls, protection of pipelines and buried structures, slope stabilization, airports and road construction over poor soils. It is utilized in reducing settlement below embankments, sound and vibration damping, reducing lateral pressure on sub-structures, reducing stresses on rigid buried conduits and related applications [6]. EPS has been widely applied in geotechnical engineering as lightweight fill [7].

There are two important material properties of geofoam that make it beneficial for protecting buried pipelines: (1) its ultra-light unit weight when compared to other earthen materials, (2) its allowance for controlled compression and yielding while maintaining much of its original shape and size [8]. The closed cell structure of EPS results in excellent insulating characteristics that remains stable over the life of the material. Expanded polystyrene is a very stable compound chemically and no material decay should be expected when placed in the ground and protected according to the present design guidelines [9]. Stress, an internal ‘force’ response of a deformable body subjected to external forces, is associated with a deformation that excites a strain response.

EPS geofoam consists of approximately 98% air and 2% polystyrene, and polystyrene is not biodegradable and chemically inert in both soil and water. Therefore, EPS geofoam will not contaminate the ground or ground water. [6] EPS geofoam is resistant to water and aqueous solutions of salts, alkalis, and acids. The thickness of EPS geofoam will not change much over a long period of time if the initial compression is less than 1.5% [10].

Poisson’s ratio for EPS is approximately value of 0.12 within the elastic range. The coefficient of friction, μ, between EPS geofoam is 0.5 along molded faces [11]. Modulus of elasticity for EPS geofoam ranged (2–14) MPa [6]. EPS has a closed-cell structure that limits water absorption. An increase in density of EPS geofoam can be expected over time due to water absorption if the blocks are installed in a submerged application. EPS is resistant to fungi and mold and offers no nutritional value to insects. Based on these tests, the friction angle between sand and geofoam is approximately 31° and friction angle between geofoam and geofoam is approximately 42° [12]. Table (1) shows the densities of different types of EPS that produced by SABIC Inc.

Table (1). EPS densities from SABIC

Grade	Density (kg/m^3)	Bead Diameter (mm)
EPS 452	18 – 35	0.4- 0.8
EPS 552	17 – 30	0.6 – 1.1
EPS 652	16 – 25	0.9 – 1.4
EPS 763	15 – 20	0.2 – 2.5

Properties of EPS geofoam can solve many important engineering problems such as settlement problems, slope stability problems and bearing capacity problems. Conventional geotechnical solutions for such problems (e.g., deep foundations, sheet piles, retaining walls or other solutions) [6]. In 1994 EPS geofoam was utilized for construction of a 21 m embankment for an emergency truck escape ramp in Hawaii. Also, In Colorado, a 61 m section of US highway 160 failed and caused the east-bound lane of this heavily traveled highway to close. A 648 cubic meters of EPS geofoam was utilized as fill in the crest of the slope to increase the factor of safety [6]. An explosion on the ground surface may cause significant damage to an underground structure, such as a tunnel or a pipeline. The extent of damage would depend on the intensity of blast, the material and configuration of the structure, as well as the nature and geometry of the intervening material. An underground structure may be protected by means of a protective barrier, installed directly above the structure. The effectiveness of using a compressible barrier, made of polyurethane geofoam, to mitigate the effects of surface explosion was investigated [13]. Reduction of the vertical stresses between 10% and 30% of the overburden stresses was reported in the three tests. Strains in the EPS geofoam were 27 to 42 percent. Use of the compressible inclusion above rigid culverts in Norway has resulted in cost reductions of the order of 30 % and has made possible the use of concrete pipes beneath high fills [14]. Pipes that are manufactured from steel and composite materials are tested with only 130 mm thick sand protecting layer without any geofoam structure, and with two different geofoams with different thicknesses. Results are presented in a comparative form and the effect of geofoam on the impact behavior of sand layer is investigated. Impact load and accelerations on the pipes are measured with respect time during experiments [15]. The best result is obtained from the 50 mm thick geofoam with sand layer. EPS geofoam enables engineers, architects, and builders to design for key geosynthetic functions and select the best combination of products to achieve project goals. Also, it is utilized in reducing settlement below embankments, sound and vibration damping, reducing lateral pressure on sub-structures, reducing stresses on rigid buried conduits and related applications [6]. Vaslestad, et al., (1993) reported the results of three tests for concrete culverts with EPS geofoam placed above them. In the first test the instrumented culvert was a 1.95 m diameter pipe beneath a 14 m high rock fill embankment. In the second test a 1.71 m diameter pipe was used beneath a 15 m high rock fill. In the third test a 2 m width box culvert was used beneath 11 m of silty clay. EPS geofoam have some of good physical properties for using underground like, compressive strength, water absorption, decay, not soluble in water and the water absorption of it is low.

3. Numerical Study

The study investigates how to improve the performance of concrete pipes under heavy overburden soil loads using a thin layer of EPS-Geofoam on top of the buried pipes which shall reduce the stresses on the buried pipes. A numerical model is established to investigate the stress on buried rigid pipes and the various parameters that may affect the performance of these pipes under loading. Finite Difference-based computer software “FLAC”, which is an “explicit, finite difference program that performs a Lagrangian Analysis of Continua, would be used for the numerical analysis of the problem.

3.1 Geometry and Dimensions:

The geometry and dimensions of the numerical model are shown in Table (2) and Figure (1).

Table (2). The geometry and dimensions of the model

Center of Pipe position from ground surface	=	5 m
Inner diameter of the pipe	=	2.0 m
Outside diameter of the pipe	=	2.6 m
Foam caution dimension	=	4.0 m x 0.2 m
Sand above pipe and below foam	=	0.7 m

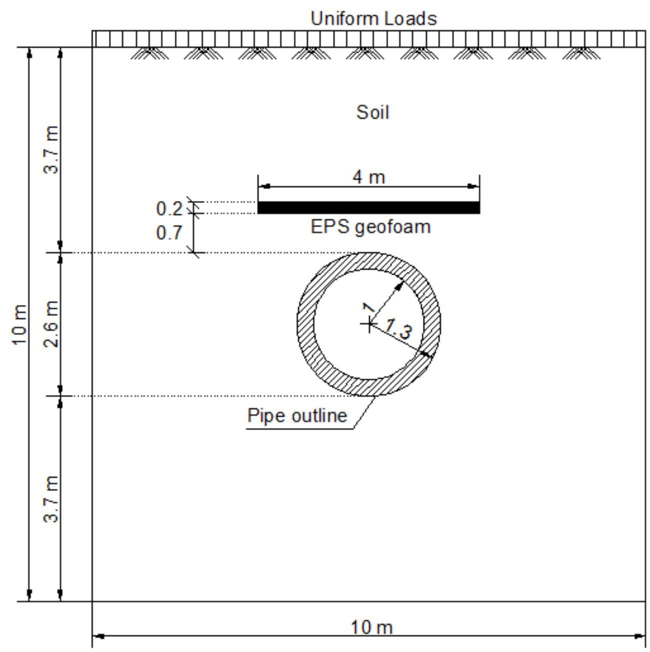

Fig. (1). Geometry and dimensions of the model (all dimensions are in m)

3.2 Material properties for Analysis:

Material properties used in the numerical model are as follow:

- Soil of the backfill: Sand with density of 1600 kg/m^3, friction angle Φ of 30^o, modulus of elasticity of 50x10^6 kN/m^2, and Poisson's ratio of 0.3.
- Pipe material: Concrete, with density of 2400 kg/m^3, modulus of elasticity of 2x10^6 kN/m^2, and Poisson's ratio of 0.2.
- Caution above pipe: Grade 763 EPS Foam from SABIC, with density of 20 kg/m^3, modulus of elasticity of 5x10^6 kN/m^2, and Poisson's ratio of 0.25.

3.3 Numerical Model Mesh and Load/Boundary Conditions

Figure (2) shows a schematic diagram for the finite difference mesh used, 100 mm size. While Figure (3 – 6) show the various configurations investigated. The initial boundary conditions and applied pressure loads are shown in Figure (7). The load was applied as a uniform load with intensity of 12 KN/m^2. The used soil model for the analysis was Mohr Coulomb. The data point's locations for the FLAC software were taken as shown in Figures (8 and 9).

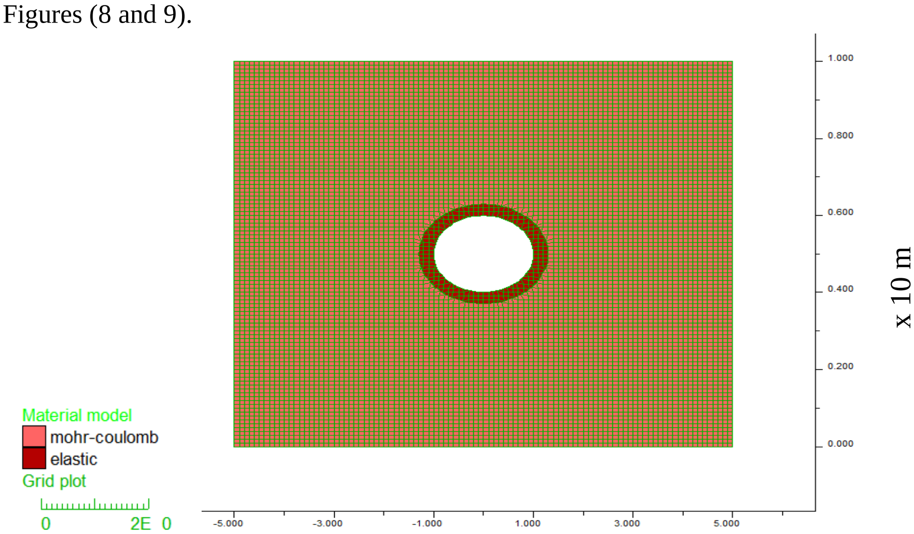

Fig. (2). Mesh for the model of pipe with no foam

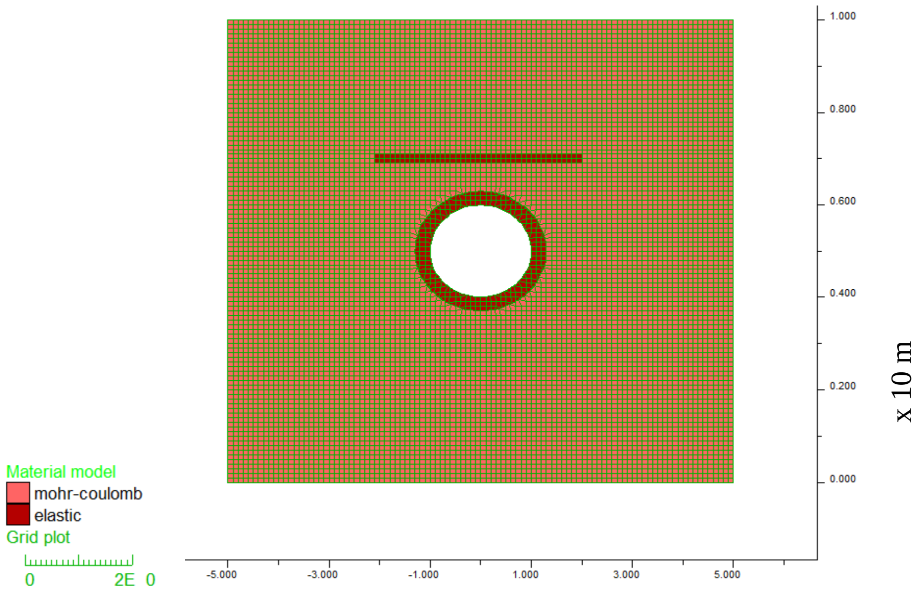

Fig. (3). Mesh for the model of pipe with foam 4m wide 20 cm thick

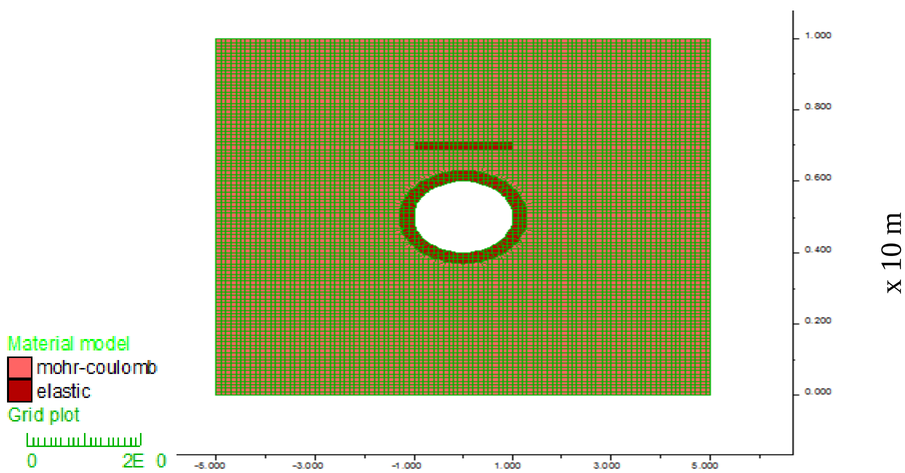

Fig. (4). Mesh for the model of pipe with foam 2m wide 20 cm thick

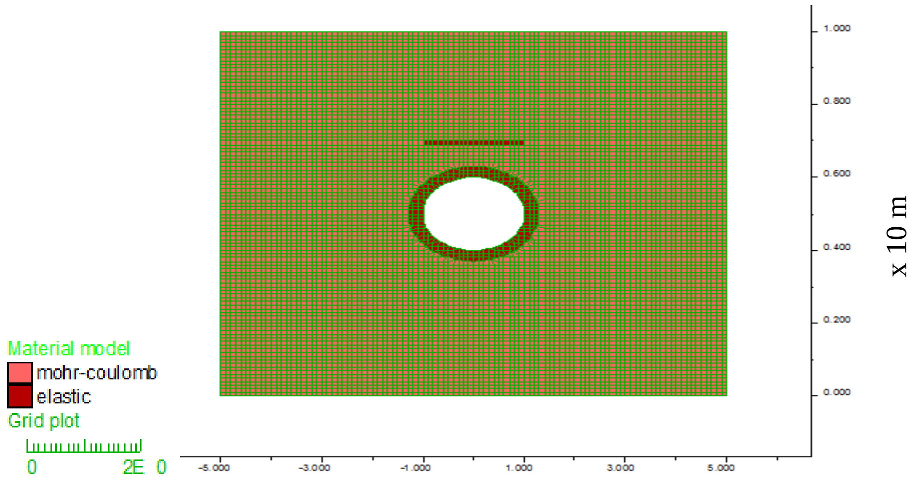

Fig. (5). Mesh for the model of pipe with foam 2m wide 10 cm thick

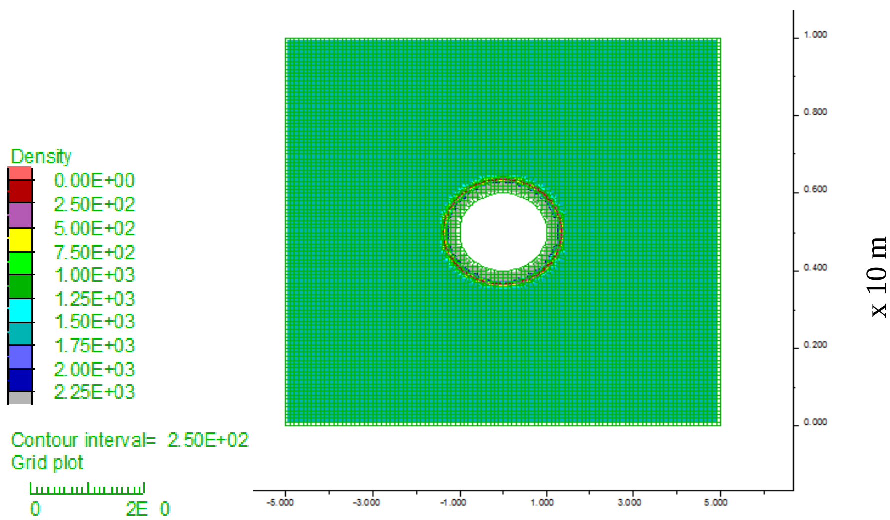

Fig. (6). Mesh for the model of pipe with foam 10 cm round

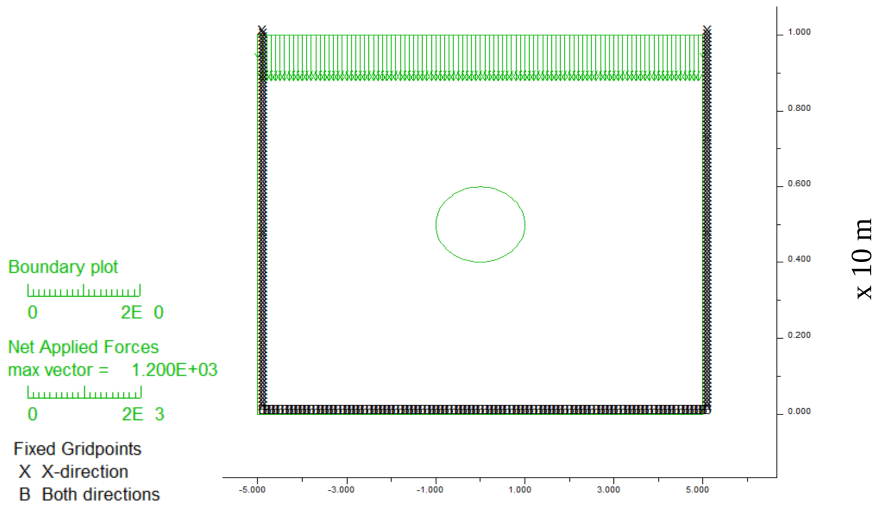

Fig. (7). Boundary Conditions and Applied Pressure Loads

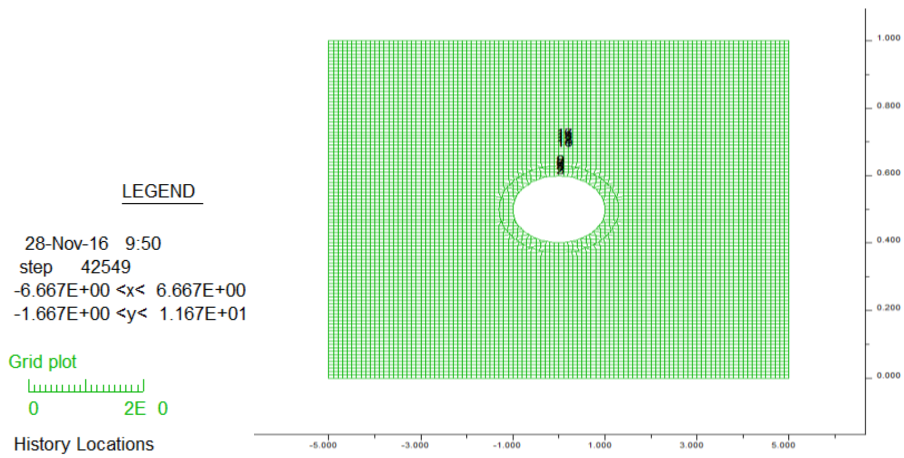

Fig. (8). Locations of displacement and stress results points above the pipe

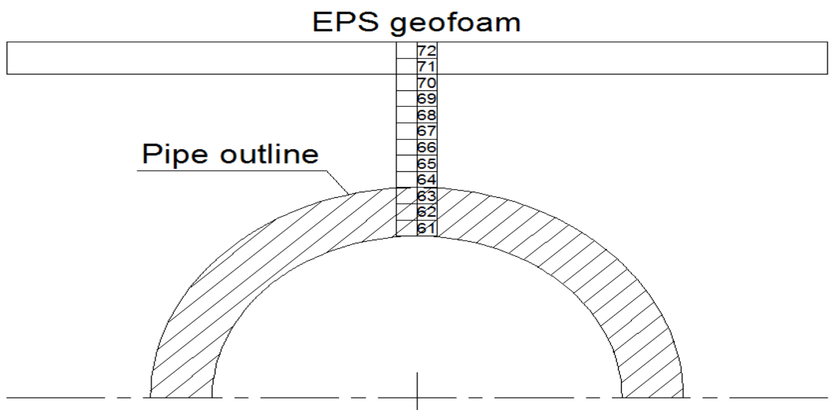

Fig. (9). Locations of displacement and stress results points above the pipe

4. Results and Discussion

The following figures show the results from numerical analysis utilizing FLAC software. Five cases were analyzed to investigate the effect of using the EPS geofoam on reducing the stresses on buried rigid pipes.

i. Pipe without EPS geofoam.
ii. Using a 4 m wide and 20 cm thickness EPS geofoam at distance 0.7 m from pipe.
iii. Using a 2 m wide and 20 cm thickness EPS geofoam at distance 0.7 m from pipe.
iv. Using a 2 m wide and 10 cm thickness EPS geofoam at distance 0.7 m from pipe.
v. Using a 10 cm thickness EPS geofoam around the pipe.

- The deformations for the model of pipe without foam and the deformations for the model of pipe with foam of 4 m wide and 20 cm thickness are shown in Figures (10 and 11) respectively. It can be seen that the increase in the maximum deformations due to the presence of foam is 9.3 %.
- Figures (12 and 13) show the vertical stress contours for model of pipe without foam and the vertical stress contours for the model of pipe with foam of 4 m wide and 20 cm

thickness. The result indicates that the presence of EPS foam decreases the vertical stresses by 20 %.

- The vertical overburden pressures and the horizontal stresses for the model of pipe without foam at locations (61, 62, 63, 64, 69, 70, 71 and 72) are shown if Figures (14 and 15).
- The vertical overburden pressures and the horizontal stresses for the model of pipe with foam of 4 m wide 20 cm thick at locations (61, 62, 63, 64, 69, 70, 71 and 72) are shown if Figures (16 and 17).
- The vertical overburden pressures and the horizontal stresses for the model of pipe with foam of 2 m wide 20 cm thick at locations (61, 62, 63, 64, 69, 70, 71 and 72) are shown if Figures (18 and 19).
- The vertical overburden pressures and the horizontal stresses for the model of pipe with foam of 2 m wide 10 cm thick at locations (61, 62, 63, 64, 69, 70, 71 and 72) are shown if Figures (20 and 21).
- The vertical overburden pressures and the horizontal stresses for the model of pipe with foam of 10 cm thickness around the pipe at locations (61, 62, 63, 64, 69, 70, 71 and 72) are shown if Figures (22 and 23).

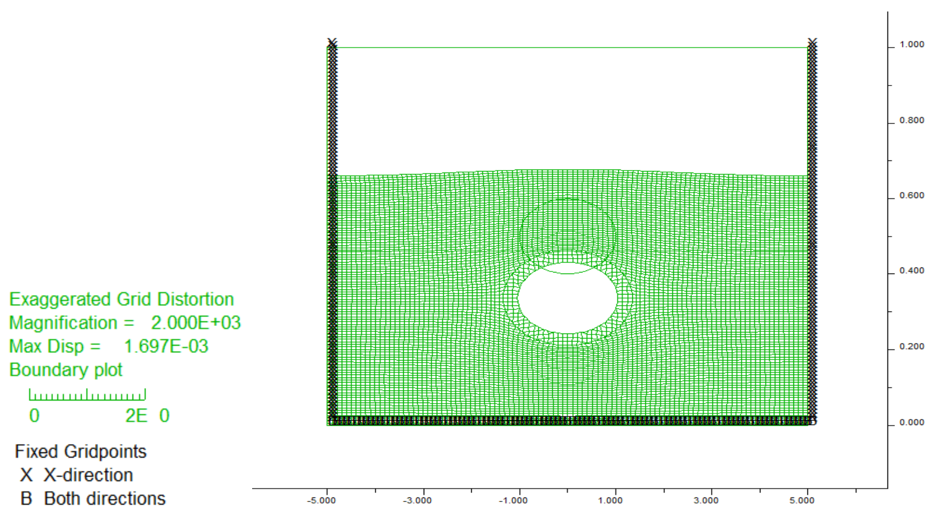

Fig. (10). Deformations for pipe model without foam

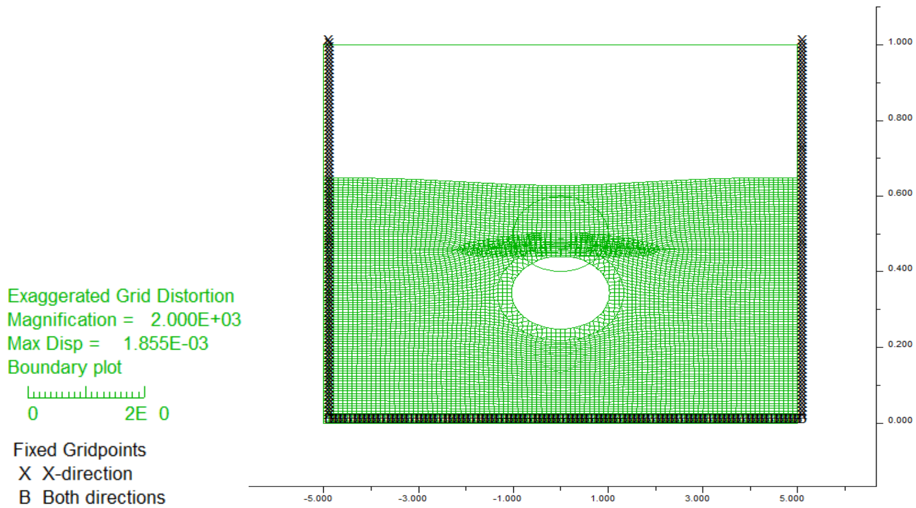

Fig. (11). Deformations for pipe model with foam 4m wide

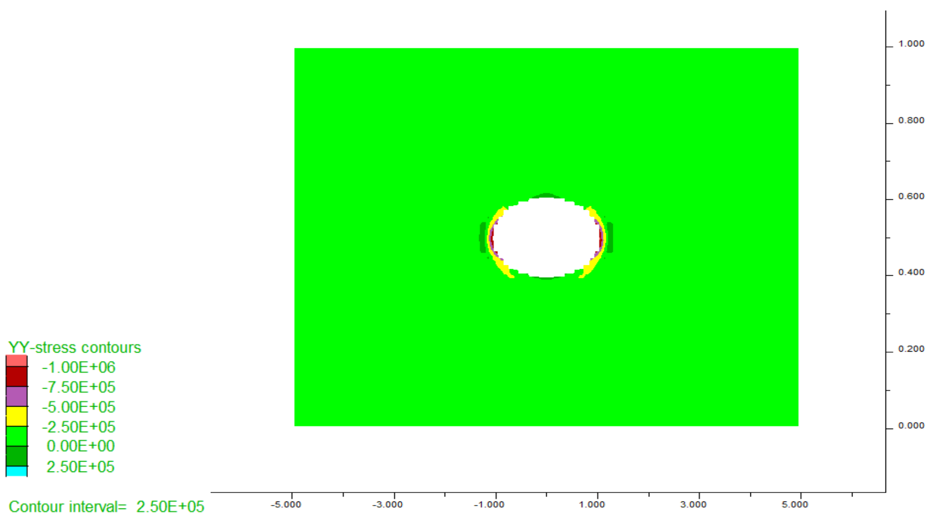

Fig. (12). Vertical stress contours for pipe without foam

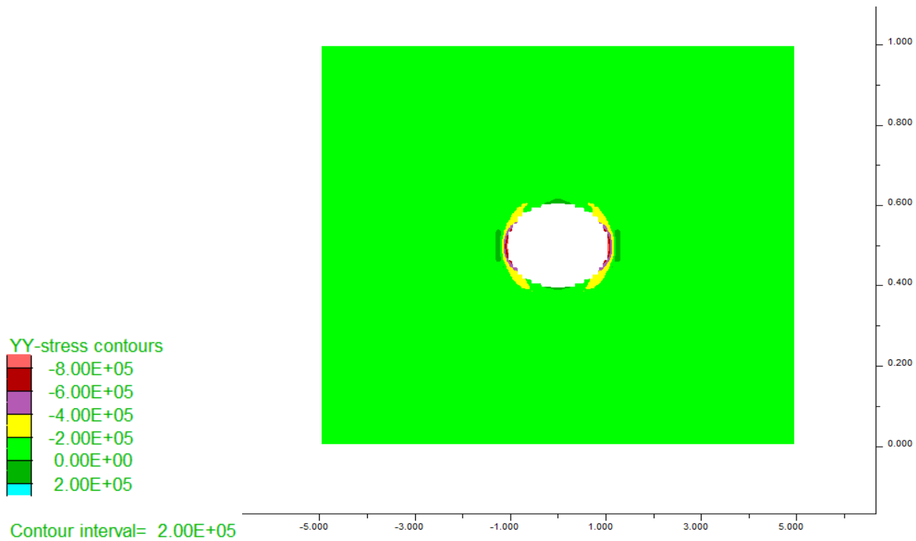

Fig. (13). Vertical stress contours for pipe with foam 4m wide 20 cm thick

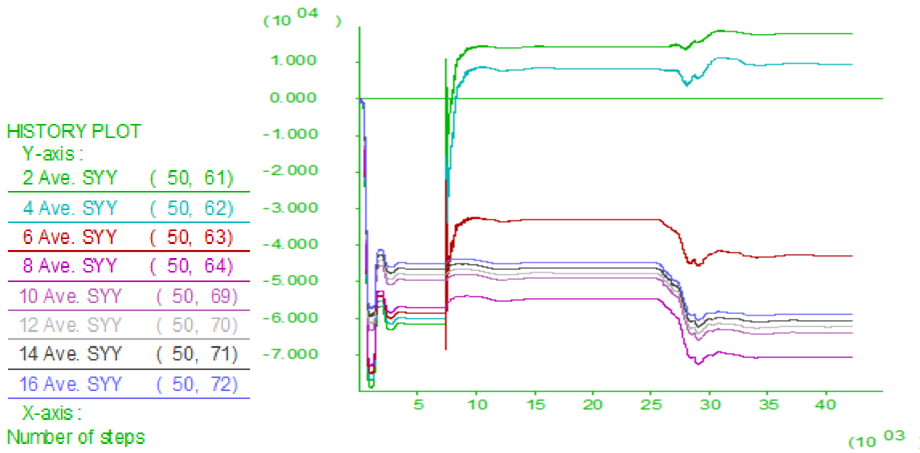

Fig. (14). Vertical overburden pressures for the model of pipe without foam at locations (61, 62, 63, 64, 69, 70, 71 and 72)

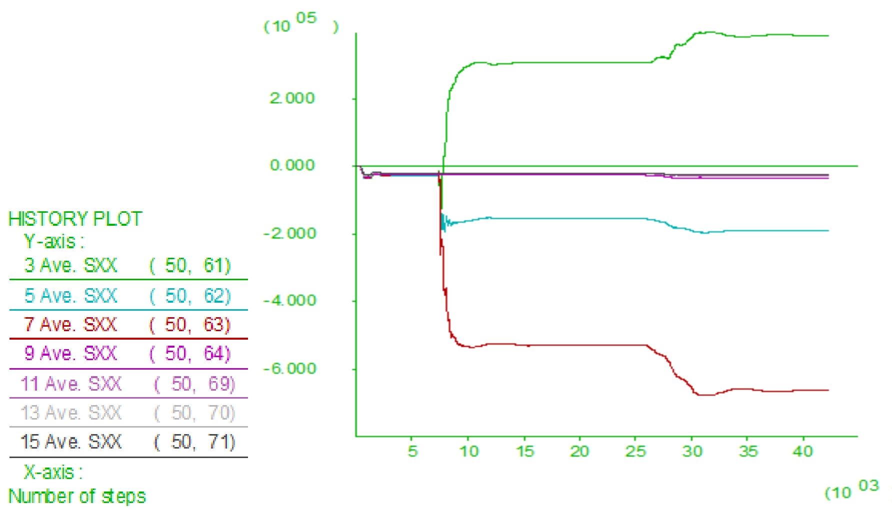

Fig. (15). Horizontal stresses for the model of pipe without foam at locations (61, 62, 63, 64, 69, 70, and 71)

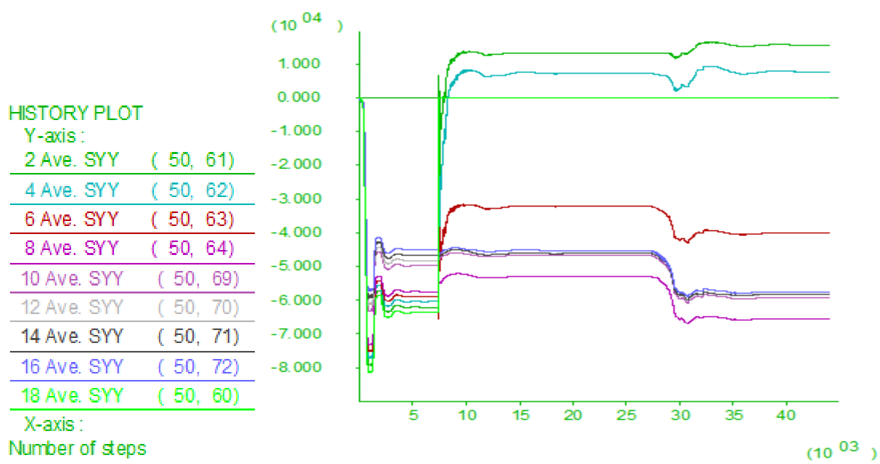

Fig. (16). Vertical overburden pressures for the model of pipe with foam 4m wide 20 cm thick at locations (60, 61, 62, 63, 64, 69, 70, 71, and 72)

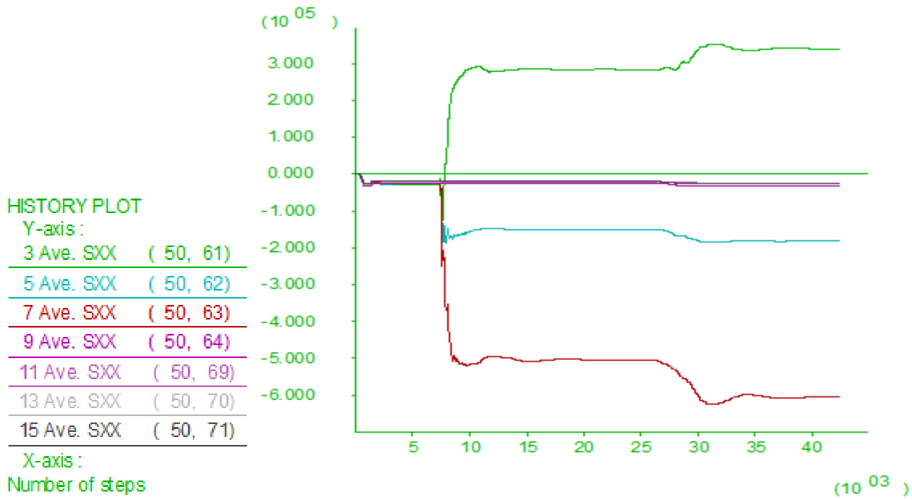

Fig. (17). Horizontal stresses for the model of pipe with foam 4m wide 20 cm thick at locations (61, 62, 63, 64, 69, 70, and 71)

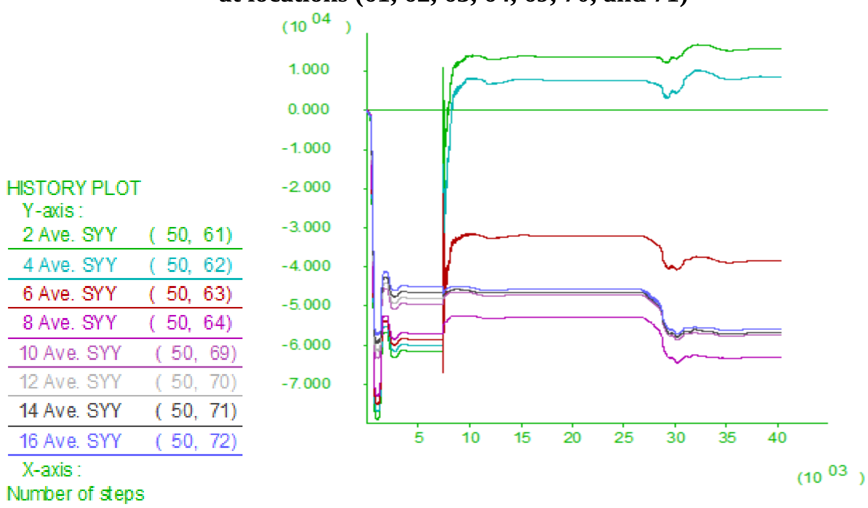

Fig. (18). Vertical overburden pressures for the model of pipe with foam 2m wide 20 cm thick at locations (61, 62, 63, 64, 69, 70, 71 and 72)

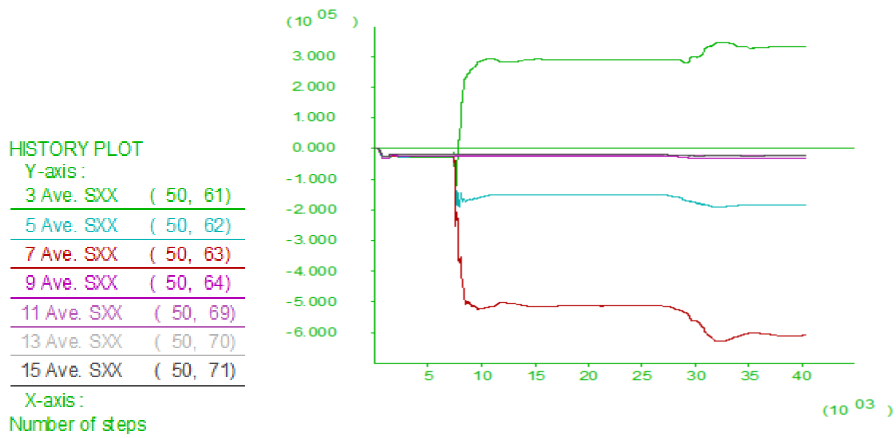

Fig. (19). Horizontal stresses for the model of pipe with foam 2m wide 20 cm thick at locations (61, 62, 63, 64, 69, 70, 71 and 72)

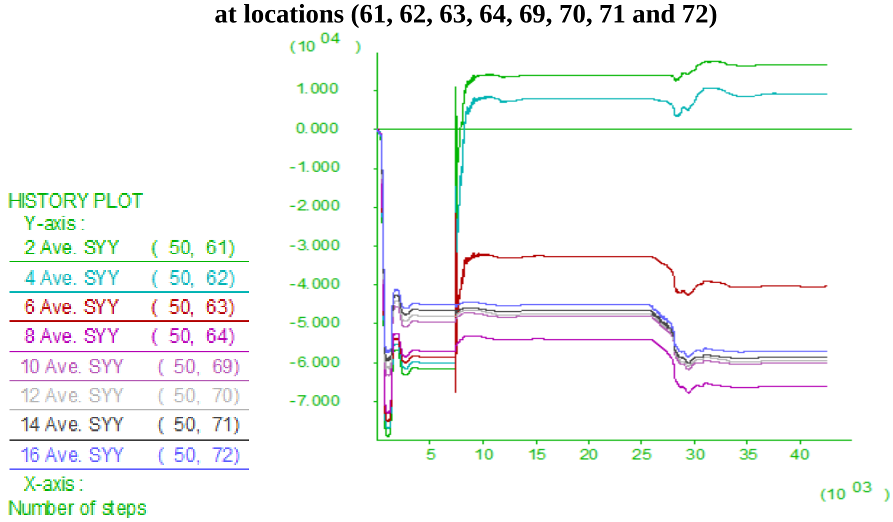

Fig. (20). Vertical overburden pressures for the model of pipe with foam 2 m wide 10 cm thick at locations (61, 62, 63, 64, 69, 70, 71 and 72)

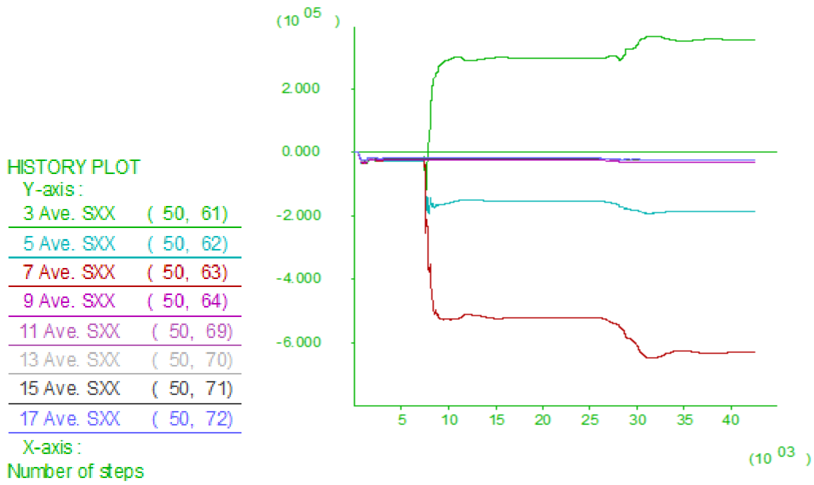

Fig. (21). Horizontal stresses for the model of pipe with foam 2 m wide 10 cm thick at locations (61, 62, 63, 64, 69, 70, 71 and 72)

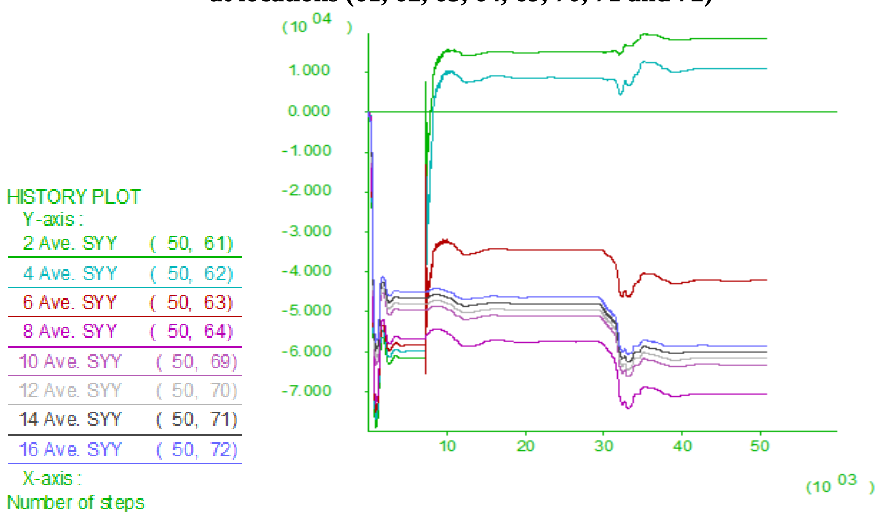

Fig. (22). Vertical overburden pressures for the model of pipe with foam 10 cm round at locations (61, 62, 63, 64, 69, 70, 71 and 72)

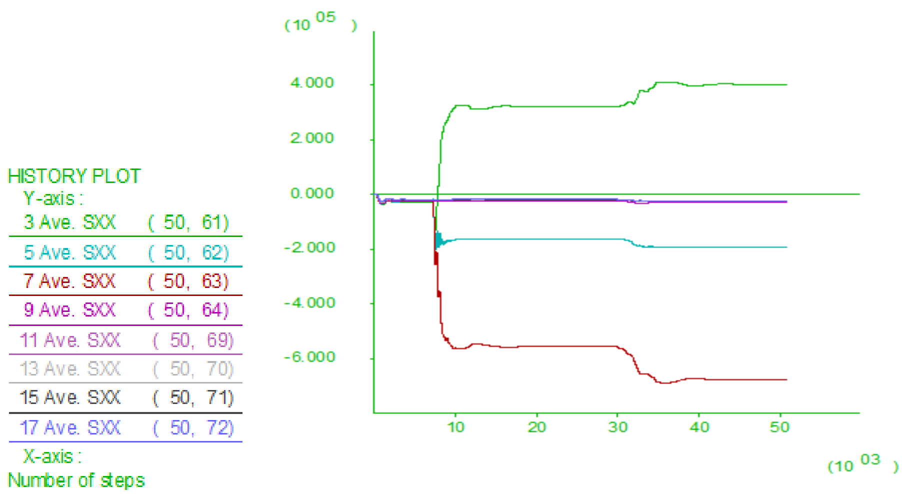

Fig. (23). Horizontal stresses for the model of pipe with foam 10 cm round at locations (61, 62, 63, 64, 69, 70, 71 and 72)

5. Conclusions

This report presents the modeling results of the investigation of the stress on buried rigid pipes and the various parameters that may affect the performance of these pipes under loading using FLAC, a finite difference program. In general, FLAC produced reasonable estimates of the field measurements, both in terms of pressure distribution and vertical strain.

The five cases were analyzed to investigate the effect of using the EPS geofoam on reducing the stresses on buried rigid pipes are: a. pipe without EPS geofoam, b. using a 4 m wide and 20 cm thickness EPS geofoam at distance 0.7 m from pipe, c. using a 2 m wide and 20 cm thickness EPS geofoam at distance 0.7 m from pipe, d. using a 2 m wide and 10 cm thickness EPS geofoam at distance 0.7 m from pipe, and e. using a 10 cm thickness EPS geofoam around the pipe.

The results of the study have shown that EPS Geofoam from SABIC help motivating arch action hence helping in increasing the allowable buried depth of concrete pipes hence highlighting the significance of using concrete pipes as green building materials trying to overcome the problem of using concrete pipes as deep it can so as to replace other non-green materials such as steel and plastics. The pressure on buried pipes can be reduced with the appropriate selection of thickness and length of used EPS geofoam.

The conclusions may be summarized as follows:

1- Concrete pipes are much more durable than any other kind of pipes, will last you a lifetime and they are not easily damaged as well.
2- Concrete pipes are extremely cheap and environmentally safe and friendly since it is made of all natural local materials, which are also recyclable.
3- Expanded polystyrene (EPS) geofoam is a lightweight material that can be utilized in reducing stresses on buried rigid pipes.
4- Expended polystyrene can be used as a compressible sheet for all types of underground structures against those faces in contact with earth.
5- The vertical deformations on the section without EPS geofoam was measured as 0.91 times the vertical deformations on the section with EPS geofoam.
6- The vertical overburden pressure on the section without EPS geofoam was measured as 1.25 times the overburden pressure on the section with EPS geofoam.

6. References

[1] Concrete Pipe Association of Australia website (http://www.cpaa.asn.au), (2016).

[2] UNEP, "Sourcebook of Alternative Technologies for Freshwater Augmentation in West Asia ،" (2002).

[3] Yoo, C.H., Kang, J., "Soil-Structure Interaction for Deeply Buried Corrugated PVC and Steel Pipes", Thesis, Auburn University, May (2007).

[4] Mohamed, N., "Experimental and Numerical Study on Full-Scale Precast Steel Fibre-Reinforced Concrete Pipes", Thesis, University of Western Ontario, May (2015).

[5] Steven, F. B, Bret, N.L., Jan,V., "Methods of Protecting Buried Pipelines and Culverts in Transportation Infrastructure Using EPS Geofoam", Geotextiles and Geomembranes journal, Volume 43, Issue 5, October (2015), Pp. 450-461.

[6] Elragi, A.F., "Selected Engineering Properties and Applications of EPS Geofoam", Book,530 pages, State University of New York, NY, USA, (2000).

[7] Liu, C., "Stress Strain Behavior by Image Analysis, Mix Density and Pre-Strain Effects of EPS Geofoam", Thesis, Syracuse University, May (2015).

[8] Horvath, J.S., "The compressible inclusion function of EPS geofoam", Geotextiles and Geomembranes journal, Volume 15, Issue 1-3, February - June (1997), Pp. 77-120.

[9] Aabøe, R., "Deformation characteristics and stress conditions in fills of EPS", 3rd International Conference, Salt Lake City, December (2001) .

[10] Amsalu, B., "Effect of Confinement and Temperature on the Behavior of EPS Geofoam", Thesis, Syracuse University, May (2014).

[11] Awol, T.A., "A Parametric Study of Creep on EPS Geofoam Embankments", Thesis, Norwegian University of Science and Technology, June (2012).

[12] Timothy, D.S., Arellano, D., Horvath, J.S., Leshchinsky, D, "Geofoam Applications in the Design and Construction of Highway Embankments", Book, July (2004).

[13] Anirban, D., Alberto, N.M., Thomas, F.Z., "Numerical and Physical Modeling of Geofoam Barriers as Protection against Effects of Surface Blast on Underground Tunnels", Geotextiles and Geomembranes journal, Volume 44, Issue 1, February (2016), Pp. 1-12.

[14] Mohsen, R.A., "Investigation of Reinforced Polystyrene Foam Waste with Natural or Synthetic Fibers", Thesis, American University in Cairo, Jan (2014).

[15] Ozgür, A., Erdem, R.T., Kantar. K, "Improving the Impact Behavior of Pipes Using Geofoam Layer for Protection", Geotextiles and Geomembranes journal, Volume 132-133, August - September (2015), Pp. 52-64.

تخفيض ضغط التربة على المواسير الخرسانية المدفونة باستخدام منتجات بوليستيرين "سابك" فى المملكة العربية السعودية

هانى داهش٣،١، عبد الله الصويان٢، أحمد الراجي٣،١، شريف الخولى١

١ قسم الهندسة المدنية –كلية الهندسة – جامعة القصيم – المملكة العربية السعودية

٢ قسم الهندسة الميكانيكية –كلية الهندسة – جامعة القصيم – المملكة العربية السعودية

٣ قسم الهندسة المدنية –كلية الهندسة – جامعة الفيوم – جمهورية مصر العربية

ha.dahish@qu.edu.sa

ملخص البحث. المواسير المدفونة المصنعة من الخرسانة كأحد مواد البناء الخضراء، لها بعض العيوب عندما تستخدم وذلك مقارنة بغيرها من المواسير المصنعة من المواد المرنة الأخرى مثل المواسير البلاستيك والمصنعة من المواد غير الخضراء أو المواسير الصلب. وللتغلب على هذه المشكلة، طبقة من منتجات البوليستيرين التى تصنعها شركة سابك القابلة للانضغاط تحيط بالمواسير المدفونة للمساعدة فى تكوين السطح المقوس أعلى الماسورة (Arch Action). هذا الاسلوب يساعد فى تخفيف الاجهادات على المواسير الخرسانية المدفونة وبالتالى زيادة العمق المسموح به لاستخدام هذه المواسير ومن ثم نشر استخدام هذه المواد الخضراء والمساعدة فى نشر ثقافة مفهوم المبانى الخضراء. تم إنشاء نموذج عددى لدراسة المشكلة وتأثير العوامل المختلفة التى تؤثر علها عن طريق دراسة بارامترية لتأثير هذه العوامل. عوامل مثل عرض وسمك طبقة الجيوفوم–بوليسترين ومكان وضعها حول المواسير لتقديم أفضل الحلول للمشكلة.

أظهرت النتائج أن مواسير الخرسانة المدفونة لها قوة تحمل ومدة خدمة تفوق المواسير المصنعة من المواد الأخري وليس من السهولة كسرها كما أنها الأرخص سعراً والأمن بيئياً حيث أنها مصنعة من مواد صديقة للبيئة وقابلة للتدوير. أظهرت نتائج التحليل العددي للنموذج أن طبقة الجيوفوم–بوليسترين تساهم فى تخيف الاجهادات على المواسير الخرسانة الصلبة والمنشأت الأخرى المدفونة فى التربة.