

Design and production of stopper made of concrete foam composite used for open channel conduit cover and parking bumper

BustamiSyam¹, Alexander Sebayang¹, Septian Sebayang², MaraghiMuttaqin¹, Harry Darmadi¹, Basuki WS³, M. Sabri¹ and S. Abda⁴

¹ Impact and Fracture Research Center, Dept. of Mechanical Engineering, Faculty of Engineering, Universitas Sumatera Utara, Jl. Dr. Mansyur Kampus USU Medan 20155

² Undergraduate Student, Dept of Mechanical Engineering Study, Universitas Sumatera Utara, Jl. Dr. Mansyur Kampus USU Medan 20155

³ Dept. of Chemistry, Faculty of Science, Universitas Sumatera Utara, Jl. Dr. Mansyur Kampus USU Medan 20155

⁵ Graduate student, Dept. of Mech. Engr, Faculty of Engineering, Universitas Sumatera Utara, Jl. Dr. Mansyur Kampus USU Medan 20155

E-mail : bstsyam@gmail.com

Abstract. Open channel conduit is designed and produced with the aims to reduce excess water, whether from rain, seepage, or excess irrigation water in an area. It is also included in one of the important components of urban infrastructure in tackling the problem of flooding and waterlogging. On the roadway, e.g. housing complex the open channel conduits should function the same, however conduit covers are needed. The covers should be also designed to function as parking bumper. This paper discusses the design and production of the stoppers using our newly invented materials; the stoppers are structurally tested under static, dynamic, and bump test. Response of the conduit cover are found from structural analysis using finite element software ANSYS MECHANICAL version 17.5. Two types of stoppers are introduced: flat and curvy configuration. It was obtained that both types are suitable for open channel conduit cover and parking bumper.

Keywords: Conduit cover, stopper, parking bumpers, concrete foam, impact strength, Fiber Oil Palm Empty Fruit Bunch (EFB).

Introduction

1. Introduction

Open channel conduit is one of ways to reduce excess water, whether from rain, seepage, or excess irrigation water in an area, drainage is included in one of the important components of urban infrastructure in tackling the problem of flooding and waterlogging. On the roadway [1], open channel



conduits should function the same; however conduit covers are needed, other wise accidents as shown in Figures 1 and 2 may occur.

In our previous research, conduit covers with 200mm in width has been reported [2]. It was suggested that the width of the cover should be made wider to make it easy during assembling. Thus, in this paper we discuss a new dimension using the same model as has been used before. Study is cover materials. Geometry and overall dimensions of conduit covers are shown in Figure 3. The conduit covers were subjected to impact load using a free-fall apparatus. We also consider the impact test with the assumption that the covers are also to functioned as parking bumper at the moment vehicles bump on kerb line and jump on to the conduit cover.



Figure 1. Accident due to open conduit (without cover)



Figure 2. Conduit covers

(a) flat cover (type 1) (b) curvy cover (type 2)

2. Materials and Method

2.1 Material

As shown in Figure 2, two types of conduit cover are used to function as walk way as well as parking bumper. Both covers should meet technical specifications, e.g. strong enough to sustain loadings from vehicles passing on it. In addition, the covers should look good and do not endanger pedestrians

walking or crossing over it. To achieve the technical specs, we select the newly developed concrete foam (confoam) material that is light weight and strong enough to withstand a static load and impact.

There are several classes of materials confoam [3]. In this study we choose the type B4 [2] in which the physical and mechanical properties of the material shown in Table 1. The material has been extensively used of some light structures, such as tiles [3] and speed bump [4].

Table1.Confoam mechanical properties

Specimen	Age (day)	Berat (g)	Compressive Strength (MPa)	Tensile strength (MPa)	Modulus Elastisitas (MPa)
B4	28	4.85	5.49	0.025	43.824

2.2. Geometry and Dimensions

Geometry and dimensions of the conduit covers are shown in Figures 3 and Figure 4,

respectively. width: 400mm



Figure 3. Flat (type 1)

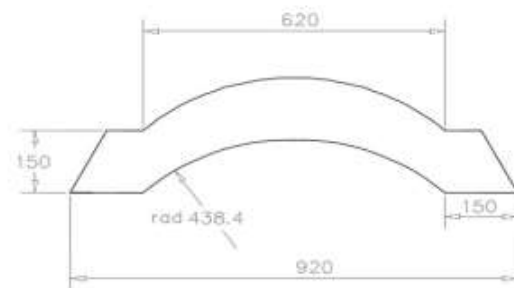


Figure 4. Curvy (type 2)

3. Design and Production

3.1. Model

The geometry and dimensions of conduit covers were modelled using ANSYS 17.0, as shown in Figure 5. The models should withstand static load of 3,290 Newton per contact area of 2.000 mm². The static load, applied to the side section (x-direction) of conduit cover is focused on the calculation of the stress distribution in the x, y, and z, using commercial FEM software, with a 3-D element model; we also calculate the principle stress (σ_1). All calculations of stresses are shown in Table 2. As shown in Fig. 6, the stress contour are dominantly in compressive. So, the flat covers are safe under compressive static load. However, as shown in Fig. 7, tensile stresses of 0.143 MPa accumulated on the the curvy surface of the covers. Thus, the covers are not able to withstand static load from x-direction. It is interesting to note that the two covers should be checked also under impact load. This part will be left for our further study.

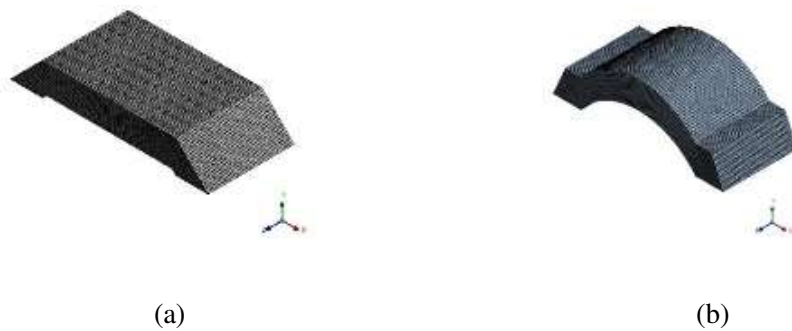


Figure 5. Cover model: (a) type 1 and (b) type 2

Table 2. Max stress in x, y, z, and principle direction (in MPa)

Model type	σ_x (Mpa)	σ_y (Mpa)	σ_z (Mpa)	σ_1 (Mpa)
1	-0,829	7,451	-2,737	0,759
2	0,143	3,420	2,769	0,174

Side Impact (X- direction) Type 1 (static)

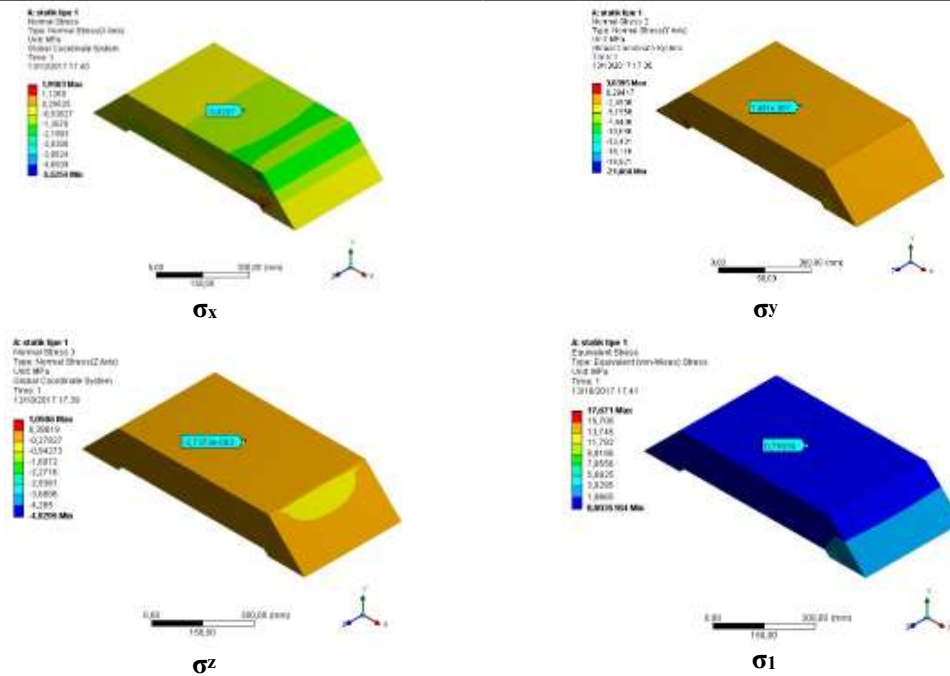


Figure 6. Stress contour for flat covers (type 1)

Side Impact (X- direction) Type (static)

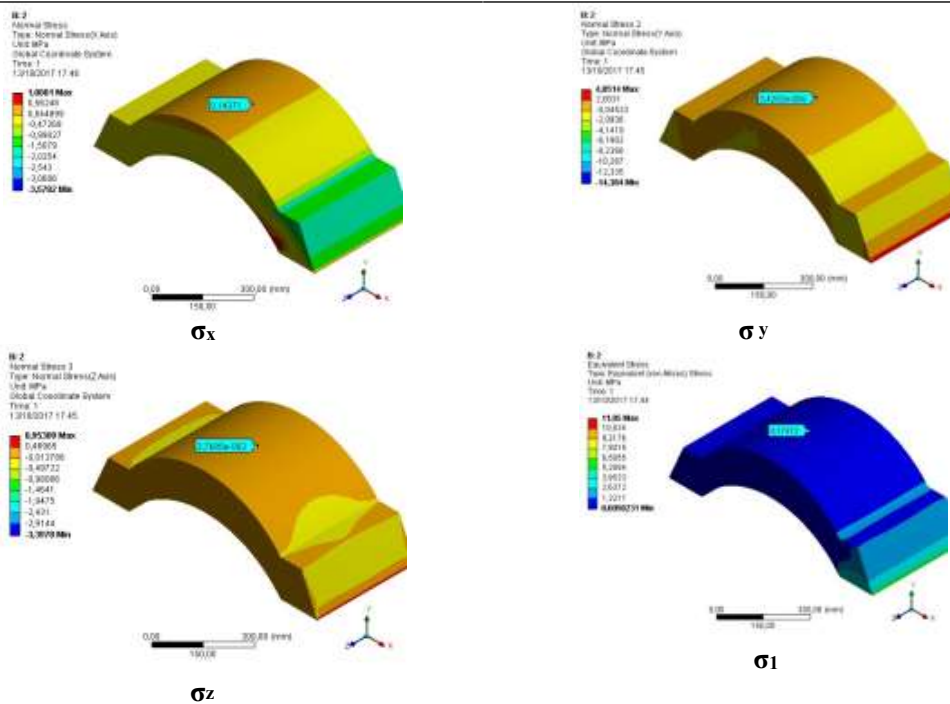


Figure 7. Stress contour for curvy covers (type 2)

3.2 Production

The following is the stage of the production process of the cover bump. For this, a mold (Figure 8) was prepared and lubricated with oil surrounding the inner area of the mold. Next, concrete foam composite materials are prepared and poured to produce conduit covers as shown in Figure 9. We use the B4 type specimen to produce the concrete foam covers.



Figure 8. mortar in the mold



Figure 9. product cover bump

Conclusions

From the results of this study we can conclude that the flat cover bumper products made of concrete foam composite meet the needs of open channel conduit covers: easy to produce, light weight, and strong enough to function as stopper and cover. Further study for impact loading subjected to conduit covers is needed.

Acknowledgements

The authors acknowledge the research fund obtained from Kemenristekdikti under BPPTN scheme 2016.

References

- [1]. Guidance Notes on Road Pavement Drainage Design, RD/GN/035, May 2010
- [2]. Syam, Bustami, B. Wirjosentono, dan S. Rizal, "Pengembangan Bahan Komposit Busa Polimer (Polymeric Foam Composite) Diperkuat Serat Tandan Kosong Kelapa Sawit

(TKKS) untuk Pembuatan Berbagai Produk Industri Transportasi dan Olah Raga”, Laporan Akhir PENPRINAS MP3EI, DIKTI, 2013.

- [3]. Ade Irwan, Bustami Syam, dan Basuki W.S, Analisa Respon Mekanik Genteng dari Bahan Confoam Diperkuat Serat TKKS Akibat Beban Impak Hujan Es, Prosiding Seminar DIES USU 2016
- [4]. Syam, Bustami, Marari Muttaqin, Dino Hastrino, Alexander. Sebayang, Basuki WS, M. Sabri, and Syahrul Abda, Analysis of Power Generating Speed Bumps Made of Concrete Foam Composite, International Journal IOP, 2016 (in progress).