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STEEL DOME PROJECT DESIGN BOGOR CONVENTION CENTER OPTIMIZATION FOR BUDGET AND AESTHETIC ARCHITECTURE

Hamonangan, GIRSANG
Faculty of Engineering,
University of Mercu Buana Jakarta, Indonesia
hamongirsang@gmail.com

Cecep Indra, LESMANA
Faculty of Engineering,
University of Mercu Buana Jakarta, Indonesia
chep_indra@ymail.com

ABSTRACT

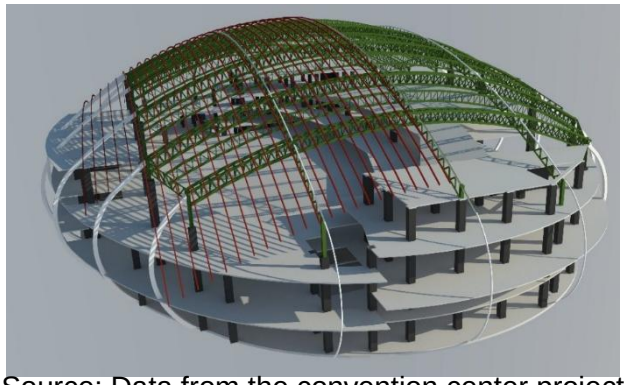
A building needs to be considered various aspects to meet the values - both economic value, cost, durability, impact on the environment to aesthetics or beauty. This research was conducted to make a comparison of the Bogor Convention Center project which was built using the Dome structure with the WF Steel Profile which will be replaced by using steel pipe material. The software used in designing steel is SAP2000 Analysis. SAP2000 is a 3D modeling application that is able to design steel structures that produce analysis and calculation results include static analysis, finite element dynamics analysis, as well as images, reports or other outputs from one structural model. As for the depiction using Autocad where Autocad functions to detail the connections that are in the dome frame of the study. Analysis and Design of a spherical dome structure with building functions as a convention center. The structure of the shell is used as the roof of the building so that the aesthetic elements and values of the architecture of the shell structure can be seen its beauty from the inside of the building. The analysis conducted is an analysis of the internal forces and design of reinforcement in the structure..

Keywords: *Dome, Aesthetics, WF Steel, Steel Pipes, Architecture*

INTRODUCTION

Structure dome / shell has architectural value and high art. The inside of the shell structure shows the shape of a beautiful arch and spans a column in it is designed with a large span so as to provide a space that is open and large at the bottom of the shell structure. This provides more value for the use of the room below. Shell structure is used as the roof of the building in order to aesthetics and architectural value of the shell structure can be seen the beauty of the inside of the building. Analysis is conducted analysis of internal forces and reinforcement design in the structure. At first the center of Bogor conventional project using dome structure with Profiles Steel WF and the present study will try to replace the material of the steel profile WF into Steel Pipe. As well as to compare the value of the aesthetic and economical prices for conventional building center Bogor.

Figure 1. The steel dome roof framework convention center

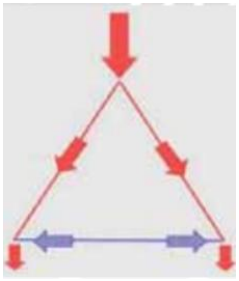


Source: Data from the convention center project

Geodesic dome structure was first built by Zeiss Optical Company with head engineer Walter Bauersfeld in 1926. But who popularized the geodesic dome structure is Richard Buckminster Fuller, an architect, designer, writer, and scientist. Fuller is the man who coined the term "geodesic" in the dome structure in 1948.

The expenses incurred on the geodesic dome is the axial load tap and drag. Both types of loads that occur in every frame triangles that form the structure of the geodesic dome [2], Expenses incurred in the framework of the triangle can be seen in the following figure:

Figure 2.Triangular load distribution frame geodesic dome



Source:Fahrurrazzi 2011

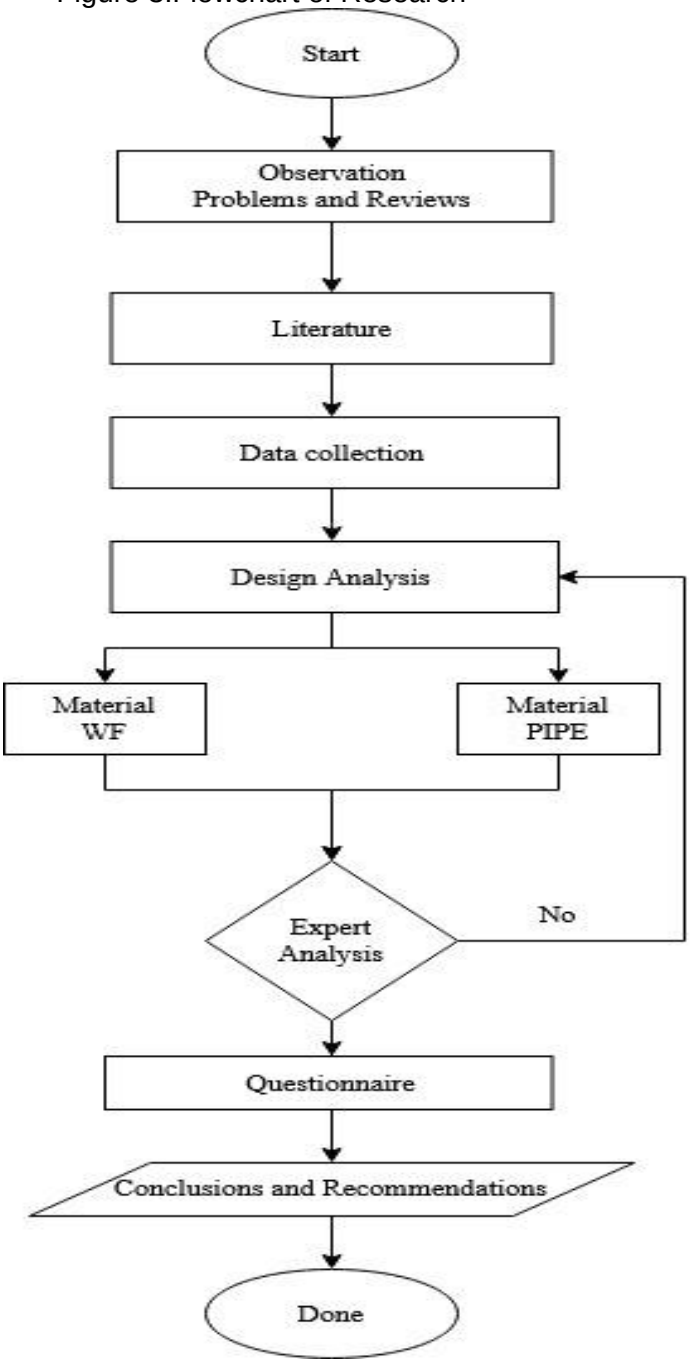
Figure 3.The load distribution of the

Source:Fahrurrazzi 2011

RESEARCH METHODOLOGY

The method used in this research is descriptive method with case study (case study). Is a case study research on the status of research subjects that relate to a specific phase or typical of the whole personality. The purpose is to give an overview of case studies in detail about the background, nature and typical of a case characterized the later of the above characteristics will be a matter of a general nature. In accordance with the background research and the formulation of the problem to be achieved then the required primary data and secondary data. From the data collected will be processed and produce data analysis. From the results of this analysis can be concluded as well as suggestions that will answer the purpose of this study.

Figure 3.Flowchart of Research



Source: researchers output ,2019

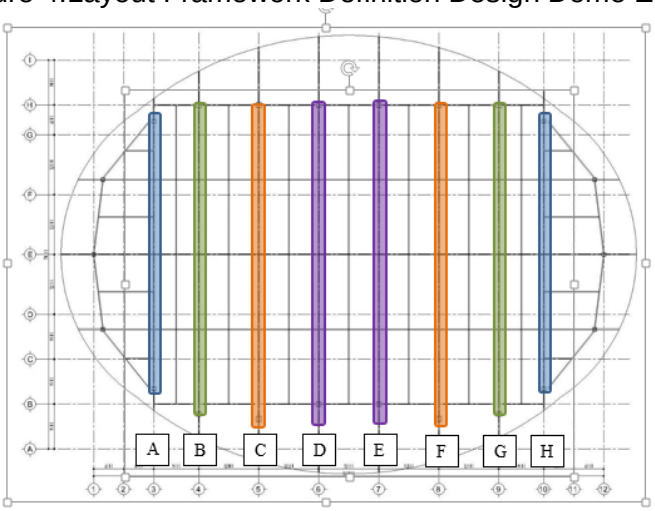
RESULTS AND DISCUSSIONS

Early Design

a. *Preliminary design Frame Dome*

Steel framework of this thesis have the symmetry, where each element in the same order saddled with the same style. From Figure 4 it can be seen that:
A = H, B = G, C = F, D = E
Thus, in the calculation only reviewed one frame only[3],

Figure 4.Layout Framework Definition Design Dome Early



Source: project documentation ,2019

b. Imposition Trunk under review

1. Dead load (DL)

Dead load Evenly = 15kg / m

2. Living Expenses (LL)

Centralized Living Expenses - Expenses Person (P-II) = 100,00kg

3. Expenses Rain

R = 0.0098 (ds + dn) = 5.2 X (0,020 + 0,025)
= 0.230 Kg / m

So that the load per meter is

q - Rain = RX Length Loading
= 0.23 X 63.27

Number q - R = 14.55 Kg / m

4. Wind load

Another structure design wind force should not be less than 0.77 kN / M2 multiplied by Af

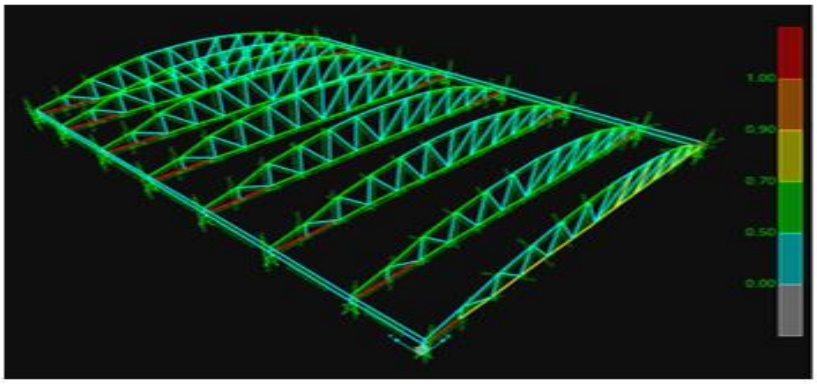
q = Wind = 0.77 X af
= 0.77 X 1 X 1 = 0.77 kN / m^2

q - Wind Total = Wind Koef X q - Wind
= 3 X 0.77

Q Number - Wind Total = 2.31 kN / m^2

c. Early Dome Frame Structure Analysis

Figure 5.Results of Preliminary Design Calculation SAP



Source: project documentation ,2019

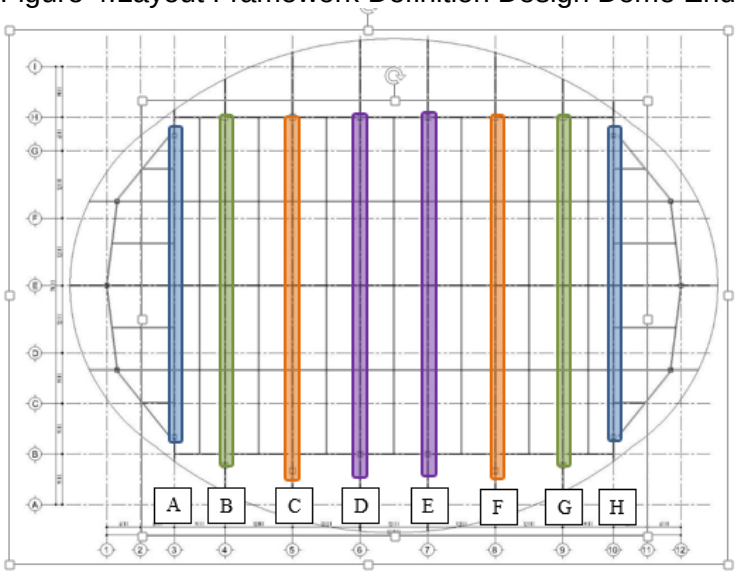
SAP peritungan of the results can be seen there are a few stems PM ratio is more than 1 (one), it can lead to failure of the profile, so that the initial structure design can not be used on the Project Convention Center in Bogor and needed a new design with the PM ratio below 1. Then made a final design.

Final Design

a. *Frame Design Dome End*

Steel framework of this thesis have the symmetry, where each element in the same order saddled with the same style. From figure 4.9 it can be seen that:
A = H, B = G, C = F, D = E
Thus, in the calculation only reviewed one frame only

Figure 4.Layout Framework Definition Design Dome End



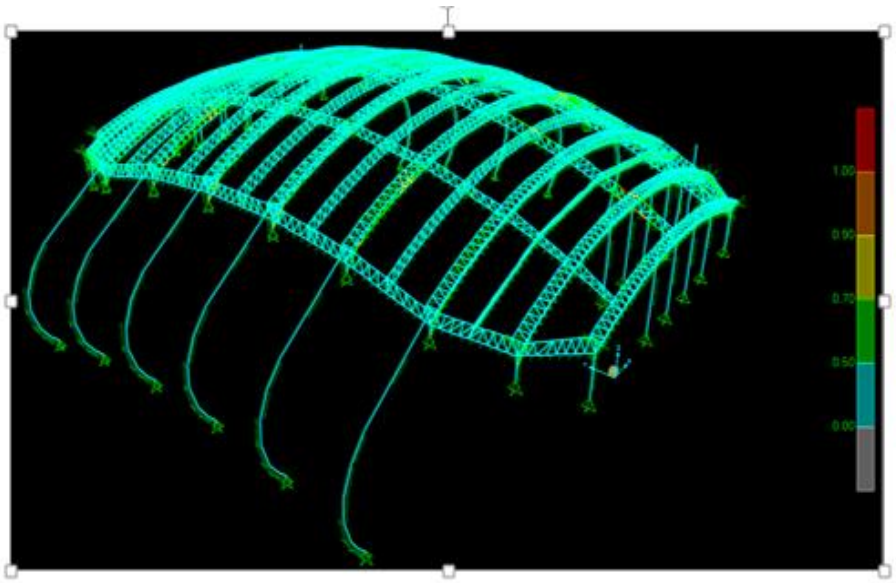
Source: researchers output ,2019

b. Imposition Trunk under review

1. Dead load (DL)
   Dead load Evenly = 15kg / m
2. Living Expenses (LL)
   Centralized Living Expenses - Expenses Person (P-II) = 100,00kg
3. Expenses Rain
   R = 0.0098 (ds + dn) = 5.2 X (0,020 + 0,025)
   = 0.230 Kg / m
   So that the load per meter is
   q - Rain = RX Length Loading
   = 0.23 X 63.27
   Number q - R = 14.55 Kg / m
4. Wind load
   Another structure design wind force should not be less than 0.77 kN / M2 multiplied by Af
   q = Wind = 0.77 X af
   = 0.77 X 1 X 1 = 0.77 kN / m^2
   q - Wind Total = Wind Koef X q - Wind
   = 3 X 0.77
   Q Number - Wind Total = 2.31 kN / m^2

c. Dome Final Frame Structure Analysis

Figure 6.Calculation of Final Results of SAP Design



Source: researchers output ,2019

SAP peritungan of the results can be seen there are a few stems PM ratio below 1 (one). Thus this design can be used.

Estimated Cost Analysis

a. Analysis Preliminary Design Cost Estimation

Figure 6.Preliminary Cost Estimates Table Design

NO	URAIAN	SAT	DESIGN AWAL			KET
			VOL	HRG SAT	JML	
1	**PEKERJAAN STRUKTUR BAJA ATAP**					
	Pekerjaan Instalasi & Pabrikasi Baja Atap, menggunakan Baja BJ 41 fy 250 Mpa, dilaksanakan sesuai spesifikasi dan gambar					
	HB 400x400x13x12	Kg	10.576,28	42.160	445.895.965	
	HB 300x300x10x16	Kg	143.448,05	42.160	6.047.769.785	
	WF 500x200x10x16	Kg	196.321,78	44.210	8.679.385.737	
	WF 400x200x8x3	Kg	182.890,56	44.210	8.085.591.602	
	CNP 100x50x20x3,2	Kg	28.074,29	40.310	1.131.674.549	
	PLATE, T = 25	Kg	10.370,01	40.000	414.800.531	
	PLATE, T = 15	Kg	23.485,94	40.000	939.437.760	
	PLATE, T = 10	Kg	7.952,44	40.000	318.097.524	
	PLATE, T = 8	Kg	354,49	40.000	14.179.738	
	Anchor M - 20	Pcs	440,00	210.000	92.400.000	
	Bolt M20 (3/4" L 3")\	Pcs	4.070,00	26.000	105.820.000	
	GROUTING, T = 35	M3	1,85	11.744.000	21.719.696	
	Cat finishing 2 x 35 micron ex Danapaint	Kg	603.473,84	4.200	2.534.590.136	
	2.4 - PEKERJAAN STRUKTUR BAJA				**28.831.363.023**	
	Dipindahkan ke Rekapitulasi Akhir Bill No. 2.4					

Source: project documentation ,2019

Estimated Cost Design Dome old Steel Works is RP. 28,831,363,023 (Twenty-Eight Billion Eight Hundred Thirty-One Million Three Hundred Sixty Three Thousand and Twenty-Three Rupiah).

b. Final Design Cost Estimation Analysis

Figure 7. Final Design Cost Estimation Table

NO	URAIAN	SAT	DESIGN AKHIR			KET
			VOL	HRG SAT	JML	
1	PEKERJAAN STRUKTUR BAJA ATAP					
	Pekerjaan Instalasi & Pabrikasi Baja Atap, menggunakan Baja BJ 41 fy 250 Mpa, dilaksanakan sesuai spesifikasi dan gambar					
	Profil Baja WF 500.200	Kg	50.752,72	44.210	2.243.777.788	
	Profil HB 400.400	Kg	10.576,28	42.160	445.895.965	
	Gording Pipa Baja SCH 40 - Dia 3"	Kg	57.679,90	38.830	2.239.710.548	
	SCH 40 - P 4"	Kg	135.294,95	39.190	5.302.209.106	
	SCH 40 - P 6"	Kg	27.664,54	39.320	1.087.769.870	
	SCH 40 - P 8"	Kg	52.225,89	39.400	2.057.700.145	
	SCH 40 - P 10"	Kg	59.545,73	40.280	2.398.501.924	
	SCH 40 - P 12"	Kg	39.378,64	40.430	1.592.078.253	
	Stiffener Gording Plat Baja T 8	Kg	354,49	40.000	14.179.738	
	Plat Baja T 10	Kg	6.468,79	40.000	258.751.524	
	Plat Baja T 15	Kg	5.682,14	40.000	227.285.760	
	Plat Baja T 25	Kg	10.370,01	40.000	414.800.531	
	Angkur Baja M20 L = 60cm	Pcs	440,00	210.000	92.400.000	
	Bolt M20 (3/4" L 3")\	Pcs	1.550,00	26.000	40.300.000	
	Grouting T = 35mm	M3	1,85	11.744.000	21.719.696	
	Cat finishing 2 x 35 micron ex Danapaint (Provisional)	Kg	455.994,09	4.200	1.915.175.182	
	2.4 - PEKERJAAN STRUKTUR BAJA				20.352.256.029	
	Dipindahkan ke Rekapitulasi Akhir Bill No. 2.4					

Source: researchers output ,2019

Estimated Cost Design Dome old Steel Works is RP. 20,352,256,029 (Twenty Billion Three Hundred Fifty Two Million Two Hundred and Fifty Six Thousand Twenty-nine Rupiah).

CONCLUSION

From the results of Project Design, Steel Dome Convention Center in Bogor can be concluded as follows:

1. Design Dome initial use Profiles Steel WF as a structural material, with appropriate modeling tender image. After analysis of structure, obtained PM ratio exceeds 1 (one), this can cause failure which led to design profile can not be used.
2. Estimated price Structural Work on the preliminary design produces PricesRP. 28,831,363,023 (Twenty-Eight Billion Eight Hundred Thirty-One Million Three Hundred Sixty Three Thousand and Twenty-Three Rupiah).
3. After looking from the side Structural Strength, Estimated Price & Aesthetics, then dicobalah separately redesign the frame using the Profile Pipe Steel as a structural material. After dikalukan anailsa structure, didaptlah PM ratio below 1 (one), thus the final design can be used.
4. Estimated price Structural Work on the final design resulted in price RP. 20,352,256,029 (Twenty Billion Three Hundred Fifty Two Million Two Hundred and Fifty Six Thousand Twenty-nine Rupiah). This value is smaller than the initial design to the value of savings ofRP. 8,479,106,994 (Eight Billion Four Hundred Seventy Nine Million One Hundred Six Thousand Nine Hundred Ninety Four Rupiah).
5. Design end rated better meet the aesthetic value to the shape of the structure is not rigid.

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