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Research Paper

Structural Analysis of the Bailey Bridge On The Serang - Panimbang Toll Project Section 3

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Abstract. *Bailey Bridge is a type of temporary emergency bridge in the form of a steel frame. Bailey bridge truss consists of panels that can be arranged in various truss formations for various spans and number of lanes. Several Bailey bridge products are offered in the market. However, it is not known for certain whether this type of bridge is safe against loads based on the latest loading regulations. In this study, the Bailey bridge safety evaluation was carried out based on the Load Resistance Factor Design (LRFD). The case study used in this study is the Bailey bridge produced by PT Bukaka Teknik Utama at the SerangPanimbang Toll Project Section 3. In this study, an analysis was carried out with the loading conditions due to heavy vehicles reaching 80 tons with a design span of 42 meters. The analysis carried out includes an analysis of the internal forces of the bridge structural components as well as the analysis of deflections for each bridge configuration. The modeling of the bridge structure is carried out using the CSi Bridge program and the structural analysis calculations are carried out using the Etabs program. Based on the results of the study, it was found that the maximum length met the safe limit based on applicable guidelines and standards. On the bridge with loading conditions, it was found that the panel bridge structure that will be used to be traversed by heavy equipment reaches 80 tons with a span of 42 meters capable of withstanding the loads that occur where the deflection is 41.43mm < L/800 = 52.5mm, and the ratio maximum bar design 0.92<1.*

Keywords: *Bailey Bridge, Deflection Analysis, BaileyTipeTSR*

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I. INTRODUCTION

Bailey Bridge is very strategic in supporting temporary needs or for areas that are difficult to reach and also very quickly installed to assist project implementation. In the SerangPanimbang Toll Project there is no or difficult to reach, so that all activities will be disrupted and even cannot be carried out as a whole on the project, therefore, the Bailey bridge which is strong, fast, and able to withstand large loads is suitable to be applied, even though it is temporary in nature after When the project is completed, the Bailey bridge can be dismantled and used again in other projects. Bailey's base bridge consists of three main parts. The strength of the bridge is supported by panels on the side. The panels are 10 feet (3.0 meters) long, 5 feet (1.5 meters) high, each cross weighs 570 pounds (260 kilo grams), and can be lifted with easy tools. The panels are made of welded steel. The top and bottom chords of each panel have interlocking male and female latches on which engineers can attach panel connecting pins. A useful feature of the Bailey bridge is its ability to be launched from one side of the gap. In this system, most of the front of the bridge is tilted with wedges into a “launch nose” and most of the bridge is left without struts and ribs. The bridge is placed on rollers and pushed through the gap, using a handy tool available at the project site, at which point the roller is removed (with the aid of a jack) and ribs and road bed are installed, along with any additional panels and transoms that may be required. In the plan, it will be used as a link on the Ciliman river with a span of 42 meters to be part of the construction of the Serang-Panimbang Toll Road Section 3 which is intended as a temporary bridge to be passed by vehicles transporting materials and heavy equipment for the project. Furthermore, in checking the structural elements of the bridge, the "load Resistance Factor Design" (LRFD) approach is used, also carried out with the "Allowable Stress Design" (ASD) approach. (both for the planning of truss bridge structural elements and deck element planning (cross girders and stringers) as well as bridge support elements. The loading specifications for this bridge design refer to the SNI-

1725-2016 regulations with the live load of the project-specific heavy equipment as a reference as a calculation analysis of this bridge.

II. METHODOLOGY

The loading specifications for this bridge design refer to the SNI-1725-2016 regulations with the live load of the project-specific heavy equipment:

2.1. Permanent Load

Self Weight is the load caused by the weight of the structure itself. The values can be seen in the following table:

Table 2.1. Load factor in Service and Ultimate conditions

Tipe Beban	Faktor Beban			
	Keadaan Batas Layan		Keadaan Batas Ultimit	
	Bahan		Biasa	Terkurangi
Tetap	Baja	1.0	1.1	0.9
	Aluminium	1.0	1.1	0.9
	Beton Pracetak	1.0	1.2	0.85
	Beton dicor di tempat	1.0	1.3	0.75
	Kayu	1.0	1.4	0.7

2.2. Traffic Load

Because this bridge is intended for project transport traffic, the traffic load for checking the structure of the bridge used is tools for project purposes including:

- Dump Truck 40 Tons
- Crawler crane capacity 250 Tons
- Crawler crane capacity 150 Tons
- Crane service capacity 50 Tons
- Rig Machine Soilmec capacity 59.4 Tons
- Drill Machine SR155C10 capacity 46 Tons
- PCI Girder 40.8meter capacity 83 ton

The capacity of the plan is the largest load that will pass through the bailey bridge so that in its implementation there will be restrictions on transportation or the flow of vehicle use when passing through the bailey bridge so that the bridge remains safe and its strength is maintained from damage or deterioration in quality.

2.3. Environmental Load

Environmental influence loads are loads caused by temperature, wind, flood, earthquake or other natural effects. The value of this load is given by a rule based on a static analysis of the incident record. Temperature load due to temperature variations on the bridge. This value is used to take into account the movement of the supports and floor connections, and also takes into account the reaction at the supports caused by restraints on the supports. The average temperature variation that occurs in the truss bridge is 25 degrees Celsius. The specified wind pressure is assumed by the design wind with a base speed (Vs) of 90 to 126 km/hour. Wind loads shall be assumed to be uniformly distributed over the wind-exposed surface. The area taken into account is the area of all components, including the floor and railing system which is taken perpendicular to the wind direction..

Table 2.2. Rated Wind Load on Structure

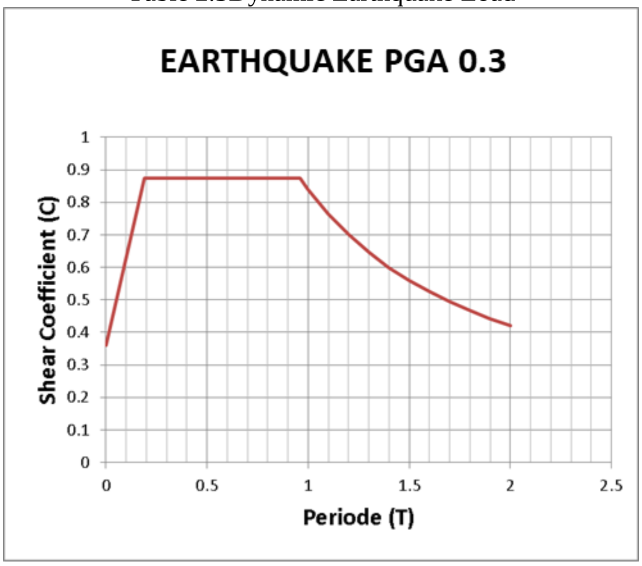
Width/Depth Ratio Solid Superstructure	Limit State Type	Wind Pressure (kPa) ((within 5 km of the coast)	Inland (greater than 5 km to the coast)
b/d < 1.0	SLS	1.13	0.78
	ULS	1.85	1.36
1.0 < b/d < 2.0	SLS	1.46 - 0.32 b/d	1.01 - 0.23 b/d
	ULS	2.38 - 0.53 b/d	1.75 - 0.39 b/d
2.0 <= b/d <= 6.0	SLS	0.88 - 0.038 b/d	0.61 - 0.02 b/d
	ULS	1.43 - 0.06 b/d	1.05 - 0.04 b/d
b/d > 6.0	SLS	0.68	0.47
	ULS	1.10	0.81
Truss Superstructure	SLS	0.65	0.45
(all b/d)	ULS	1.06	0.78
b = Overall width of the bridge between outer faces of parapets			
d = Depth of the superstructure, including the depth of a solid parapets			

If the vehicle is above the bridge floor, then there is an additional horizontal load on the bridge floor, which is given with the following formulation:

TEW =0.0012 Cw x Vw2 KN

Earthquake load is a load that acts on a structure as a result of ground movement caused by earthquake vibrations. In general, there are two methods in analyzing earthquake loads, namely equivalent static analysis and dynamic analysis. Earthquake effects adjusted to the location of the bridge will be based on SNI 2833:2016 Bridge Planning on Earthquake Loads and 2017 Indonesia Earthquake Hazard Maps and Sources Appendix D:D6-Map of peak acceleration in bedrock (SB) for a probability of exceeding 10% in 50 years with a hazard PGA = 0.3 g.

Table 2.3Dynamic Earthquake Load



Unlike Design Stress where each nominal load can be combined directly with another nominal load to achieve a critical result, in Limit State Design, only factor load combinations with a high probability of occurrence at the limit state are specified. The critical load combinations allowed for ULS and SLS.

Table 2.4.Load Combination

Action	S.L.S						U.L.S					
	1	2	3	4	5	6	1	2	3	4	5	6
Permanent Action : Berat Sendiri Berat Mati Tambahan	x	x	x	x	x	x	x	x	x	x	x	x
Transient Action : "D" atau "T"	x	○	○	○	○		x	○	○	○	○	
Beban Rem	x	○	○	○	○		x	○	○	○		
Beban pejalan kaki		x						x				
Suhu	○	○	x	○	○	○	○	○	○	○		○
Angin			○	○	x	○	○		○	x		○
Special Action : Beban Gempa											x	
Beban Konstruksi						x						x

Note : "x" menunjukan beban selalu aktif
"○" menunjukkan beban yang mungkin digabungkan dengan beban aktif secara tunggal atau seperti yang ditunjukkan.

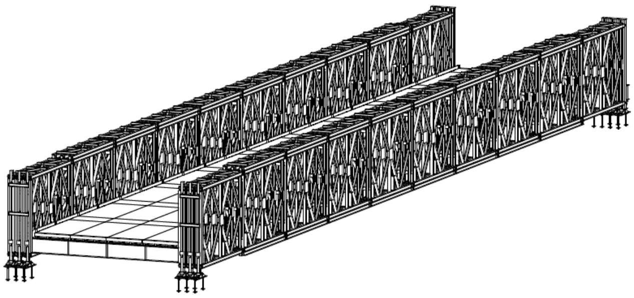
III. RESULTS AND DISCUSSION

Specifications The materials used in the planning of this bridge use materials that are readily available domestically, so it is expected to provide more value than this building itself..

3.1. Technical Spesifications

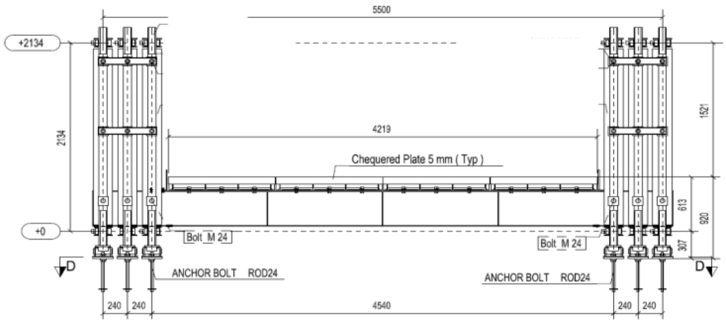
Specifications The materials used in the planning of this bridge use materials that are readily available domestically, so it is expected to provide more value than this building itself.

Picture 3.1. Bailey Bridge TSR.3

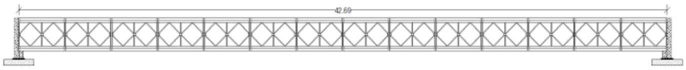


Type : Panel Bridge TSR3
Span : 42 Meters
Traffic width : 4.2 Meters
Bridge width : 5.5 Meters
Panel height : 2.5 Meters
Panel length : 3.0Meters

Picture 3.2. View Across The Bridge



Picture 3.3. View Long The Bridge



3.2. Material Specification

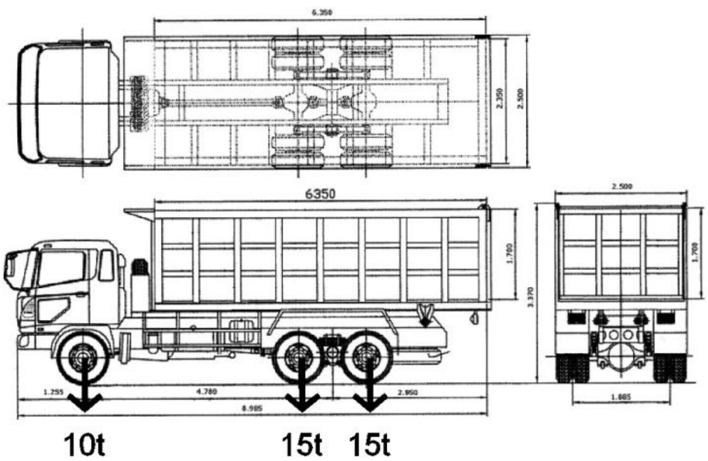
- Quality Steel SS 400 or JIS 3101

Minimum Strength	fu	= 400 Mpa
Minimum Melting	fy	= 245 Mpa
Thickness	t	≤ 40 mm
Modulus Elasticity	E	= 210.000Mpa
Modulus Shear	G	= 80.770 Mpa
Poisson's ratio	π	= 0.3
Coefficient linier	α	= 11.7 x 10-6 °C
Specific Grafity	w	= 7.850 kg/m3

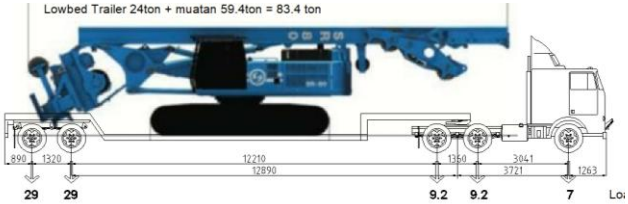
3.3. Plan Load

Loading Planning for Bridges is divided into dead loads and live loads which will have an impact on the structure in this journal. The calculation reference used is the National Standardization Agency, SNI 1725-2016 with special live loads. The permanent steel truss bridge is designed to be able to carry the maximum possible beam force from various combinations with the appropriate load factor. Load factors and combinations that are in accordance with: Bridge Management System (BMS) 1992 section Bridge Design Code (BDC) with revisions in section 2 with loading for bridges (SNI 1725:2016) Planning load here is an examination of the load applied in the model as a load 3 Dimensions, to simulate load conditions that may occur in actual conditions. The design of the structural elements of this bridge is based on the LRFD (Load Resistance Factor Design) approach so that the load planning is also based on the loads that work in service and ultimate conditions in accordance with the load combinations required in SNI 1725:2016. The dead load of the bridge consists of the weight of each structural member and non-structural elements. Each of these elements must be considered as an integrated action when applying normal and reduced load factors. The self-weight of a structural member is the weight of the material of that part and other structural elements. Included in this is the weight of the bridge material and parts which are structural elements, plus non-structural elements which are considered fixed. Nominal weight and load factor for a variety of materials commonly used in steel frame bridges, while the live load on the bridge that must be reviewed in two types, namely the "T" load which is a concentrated load for the vehicle floor and the "D" load for the girder path on the bridge. bailey. For the calculation of the strength of the vehicle floor or bridge vehicle floor system, "T" must be used. One example of a vehicle that will pass through the bailey bridge is a vehicle with high intensity passing through this bailey bridge so that the calculations on the girder and frame are adjusted to the heaviest load from the plan.

Picture 3.4. Dump Truck Vehicle Load



Picture 3.5. Rig Machine Soilmec load 59.4 Tons + trailer



The results of the design and calculation of the bridge profile using ETABS are as follows:

Picture3.6. Determination of the Material On the Bridge

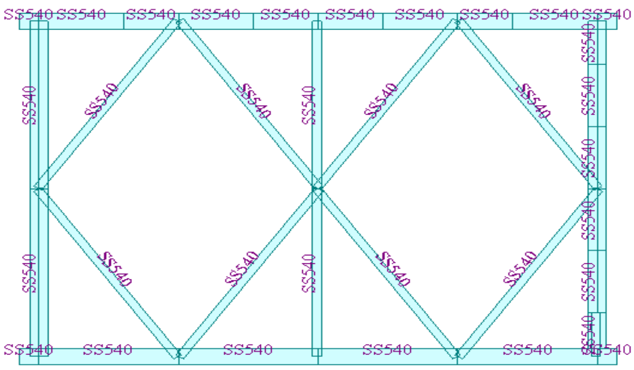
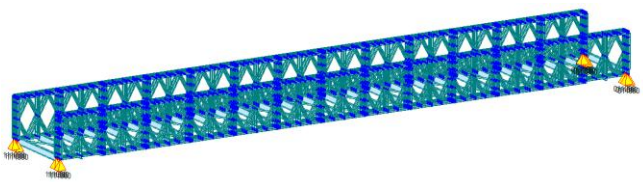


Table 3.1 Bridge Member Profile

No	Nama Profil	Tipe	Area	Ix	Iy
			mm2	mm4	mm4
1	CG : WF 350.175.8.10	I	6140	174693.3	1.25E+08
2	TC : 2C 100.51,5.7,5	2C	2650	44075.83	3977396
3	BC : 2C 100.51,5.7,5	2C	2650	44075.83	3977396
4	TG1 : 2C 80.45.6.8	2C	2208	72192	2136064
5	TG2 : C 80.45.6.8	C	1104	19520	1068032
6	END : 2C 120.55.7.9	2C	3408	75440	7350336
7	DG : C 80.45.6.8	C	1104	19520	1068032
8	BR1 : C 80.45.6.8	C	1104	19520	1068032
9	BR2 : C 80.45.6.8	C	1104	19520	1068032
10	BR3 : L 75.75.7	L	864	10368	468827.2

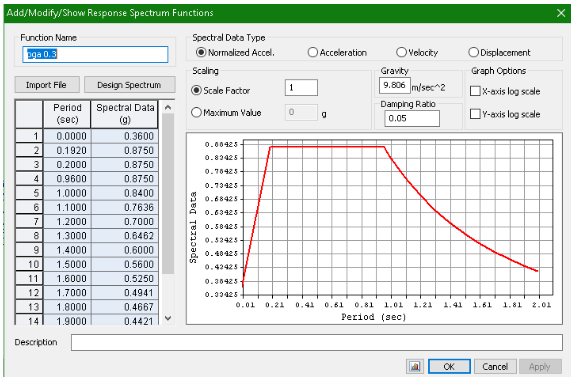
The profile consists of 10 different types which are taken in drawing specifications from the supplier or sub-contractor of the SerangPanimbang toll road project section 3.

Picture3.7. Determination of Bridge Position



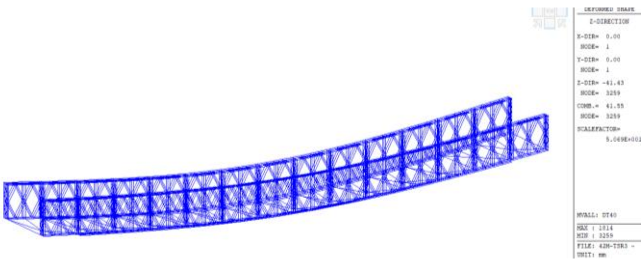
Earthquake effects adjusted to the location of the bridge will be based on SNI 2833:2016 Bridge Planning on Earthquake Loads and 2017 Indonesia Earthquake Hazard Maps and Sources Appendix D:D6-Map of peak acceleration in bedrock (SB) for a probability of exceeding 10% in 50 years with a hazard PGA = 0.3 g.

Picture3.8. Dynamic Earthquake

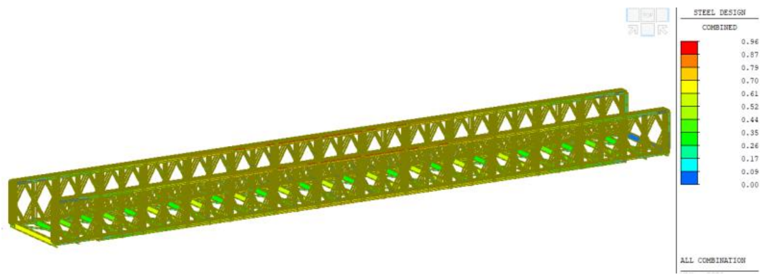


3.4. Structural Analysis

Picture 3.8 Deflection Control



Picture 3.9 Design Ratio



Main Structure Design Ratio < 1.0 OK (AASHTO LRFD 2012)

Tabel 3.2 Ratio Design

No	Section / Material	CHK / CHK	MEMB / COM	SECT / SHR	Pu / pPn	Muy / pMny	Muz / pMnz	Vuy / pVny	Vuz / pVnz
1	CG : WF 350.175.8.10	OK	2752	1	-368.40	-38.79	-0.16	0.00	-58.96
	SM490Y	OK	0.58	0.10	984.12	174.75	42.52	493.97	592.76
2	TC : 2C 100.51,5.7,5	OK	9596	2	-634.73	2.21	-0.27	0.46	-4.67
	SS540	OK	0.94	0.02	714.51	37.98	59.75	238.96	301.60
3	BC : 2C 100.51,5.7,5	OK	5780	3	-4.83	-20.91	-2.74	1.59	297.62
	SS540	OK	0.60	0.99	943.83	37.98	59.75	238.96	301.60
4	TG1 :2C 80.45.6.8	OK	5786	4	-305.94	0.02	-2.57	1.94	-2.11
	SS540	OK	0.56	0.01	769.40	25.65	13.88	222.72	222.72
5	TG2 :C 80.45.6.8	OK	10379	5	60.68	0.09	-2.46	48.17	-0.96
	SS540	OK	0.60	0.43	419.52	12.83	4.76	111.36	111.36
6	END : 2C 120.55.7.9	OK	10142	6	-220.30	2.23	-15.04	13.87	-7.65
	SS540	OK	0.41	0.05	1065.22	58.52	78.31	306.24	389.76
7	DG : C 80.45.6.8	OK	137	7	-216.87	0.00	0.00	0.00	0.00
	SS540	OK	0.96	0.00	226.51	11.22	4.76	103.68	103.68
8	BR1 :C 80.45.6.8	OK	2767	8	-15.96	0.39	-0.03	0.02	-0.41
	SS540	OK	0.26	0.01	73.44	8.92	4.76	111.36	111.36
9	BR2 :C 80.45.6.8	OK	4161	9	-10.12	4.81	0.00	-0.01	-74.03
	SS540	OK	0.39	0.67	394.15	12.83	4.76	111.36	111.36
10	BR3 :L 75.75.7	OK	7572	10	-142.14	0.00	0.00	0.00	-0.03
	SS540	OK	0.96	0.00	148.30	7.94	3.84	64.80	69.60

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IV. CONCLUSION

From the results of the modeling analysis above, it can be concluded that the panel bridge structure that will be used to be traversed by special heavy equipment, in accordance with the design checks based on AASHTO 2016 is able to withstand the loads that occur. Where the deflection occurs is 41.43mm < L/800 = 52.5mm, and the maximum bar design ratio is 0.92 <1.

Table 3.2 Structure Weight

BILL OF MATERIAL

BEAM & TRUSS BOM TYPE1 SECT ID,SECT NAME, MATERIAL — Unit System : tonf , m

SECT ID	SECTION NAME	MATERIAL ID	MATERIAL NAME	DENSITY	LENGTH	PAINT AREA INNER	PAINT AREA OUTER	WEIGHT
2	TC : 2C 100.51,5.7,5	1	SS540	7.850e+000	5.040e+002	0.000e+000	3.961e+002	1.048e+001
3	BC : 2C 100.51,5.7,5	1	SS540	7.850e+000	4.680e+002	0.000e+000	3.678e+002	9.735e+000
4	TG1 : 2C 80.45.6.8	1	SS540	7.850e+000	2.248e+002	0.000e+000	1.115e+002	3.896e+000
5	TG2 : C 80.45.6.8	1	SS540	7.850e+000	4.608e+002	0.000e+000	1.511e+002	3.993e+000
6	END : 2C 120.55.7.9	1	SS540	7.850e+000	2.990e+001	0.000e+000	2.667e+001	7.999e-001
7	DG : C 80.45.6.8	1	SS540	7.850e+000	9.727e+002	0.000e+000	3.191e+002	8.430e+000
8	BR1 : C 80.45.6.8	1	SS540	7.850e+000	1.524e+002	0.000e+000	4.998e+001	1.320e+000
9	BR2 : C 80.45.6.8	1	SS540	7.850e+000	5.098e+002	0.000e+000	1.672e+002	4.418e+000
10	BR3 : L 75.75.7	1	SS540	7.850e+000	1.092e+002	0.000e+000	3.276e+001	7.406e-001
12	TG1*	1	SS540	7.850e+000	1.500e+000	0.000e+000	8.280e-001	4.691e-002
1	CG : WF 350.175.8.10	2	SM490Y	7.852e+000	1.317e+002	0.000e+000	1.822e+002	6.347e+000
13	CG*	2	SM490Y	7.852e+000	2.784e+001	0.000e+000	3.296e+001	1.102e+000
SUMMATION :					3.593e+003	0.000e+000	1.838e+003	5.131e+001

For the total weight of the overall structure of the modeling is 51.31 tons x 1.4 (floor weight + lose part) = 71.834 tons.

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