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Lashing For Cargo Transportation Onshore

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Abstract
Abstract. Lashing for cargo securing transportation onshore is to secure the heavy module GTC Gas Turbine Compressore module P1 and module S1 during transported by using trailer SPMT Self Propelled Module Transporter is safely. The analysis of lashing should consider for the transverse force in turning condition, Longitodinal force in breaking and acceleration condition.The weight of P1 is 511.48 mt metric ton and S1 429.18 mt metric ton will transported by SPMT with 20 axle, has speed 0.5 km/h and acceleration 0.07 m/s^2, time taken to accelerate is 2 s. The environment condition is the wind speed is 10 m/s. The capacity of lashing is 5 mt. The result from the site activity of the transportation of Module P1 and S1 with using SPMT is succsessfuly and safely. The module P1 has the total transverse securing force 66.72 greater than total transverse sliding force 17.7, the longitudinal securing force 85.12 is greater than total longitudinal sliding force 20.05 mt. The module S1 has the total transverse securing force is 45.30 greater than total transverse sliding force 15.37 mt, and total longitudinal securing force 62.7 mtgreater than total longitudinal sliding force 17.02 mt.
Keywords: *lashing, Transverse, Longitudinal, SPMT.*

I. INTRODUCTION

The content of this document forms the Lashing [2] for Cargo Transportation Onshore for the Heavy Module GTC Gas Turbine Compressor. Its weight is 511 ton, it will be transported by using SPMT Self Propelled Modular Transporter.

The aim of this document is to provide an overview on the proposed concept of handling to enable the safe and smooth transportation of the cargo. Details of the cargo are stated in this document.

Lashing analysis [1] of the transportation is included in this document. All relevant studies have been performed for the cargo transportation for the above-mentioned analysi

This report summarises the acceleration results caused by the motion of the trailer with cargo during transportation. The analysis is to ensure that the lashing is adequate to resist the accelerations during the transportation.

II. METHODE OF RESEARCH

The method used is to compare the analysis calculations with the facts in the project field. The results of the calculations are applied in the project field to ensure that the results of the Hirungan are safely used for project work in the fiel

This document [4] is to provide a plan for the transportation of the GTC Gas Turbine Compressor withSPMT Self Propelled Module Transporter. The Module that will be transported are two piecies, namely GTC P1 and GTC S1.

This document will clarify the various phases and steps of the transportation wich is scured by lashing. It should be demonstrated that lashing for transportation in accordance with code and specification will not impart overload or cause damage to the lashing system.

This document will provide confirmation that the transportation will be a controlled operation leading to an as lashing system comparable to the approved design and that sufficient means of inspection, measurement and recording are performed to confirm the actual lashing configuration.

2.1 Prototype and Instrumentation

The transportation plan with the lashing arrangement can be seen in fugure Figure 1, 2.3,4,5 and Table 1,2,3,4 and 5

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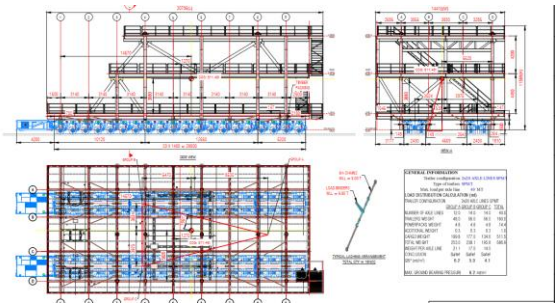

Figure 1. Module P1 Lashing Plan

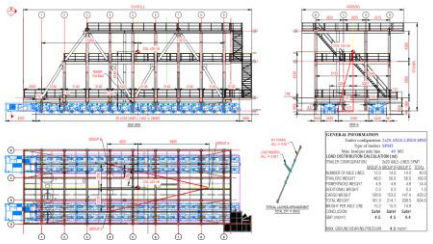

Figure 2. Module S1 Lashing Plan

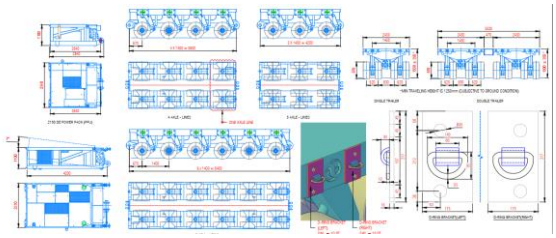

Figure 3 . SPMT

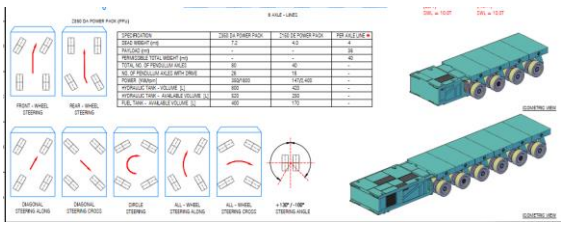

Figure 4. SPMT

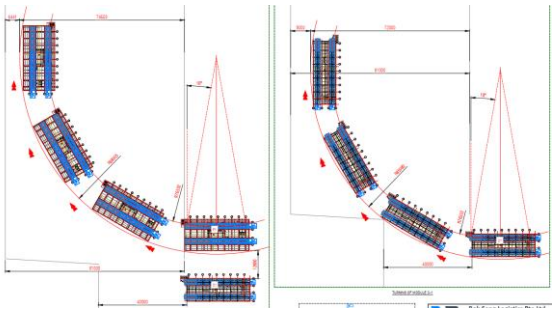

Figure 5. Turning of Module P1 and S1

2.2 Lashing Calculation Module P1

5T lashings will be used to secure [2] the cargo in both transverse and longitudinal directions. Lashing calculation [3] is based on 2x20 axle lines SPMT. Proposed lashing arranggement as shawn in figure 6.

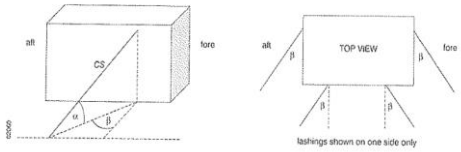

Figure 6. Lashing arrangement

The Cargo detail, cargo dimension, Trailer Detail , Road Inclination as shawn in Table 1.

Table 1. Cargo, Trailer, Road, Detail

Description	Unit	Quantity
Cargo Detail		
Weight	MT	511.48
Lashing Capacity	MT	5
Coeficient of friction		0.1
Cargo Dimension		
Length	m	30.80
Width	m	14.42
Height	m	11.57
Trailer Deatail		
Type SPMT	EA	2
No Axle Lines	EA	20
Road Inclination		
Longitudinal Road Gradient	deg	1.72 0r 3 %
Transverse Road Gradient	deg	1.72 or 3 %

The Wind Force shawn in Table 2. ;

Table 2. Wind Force

Descrption	Unit	Quantity
Wind Speed	m/s	10
Mass Density of Air	Kg/m^3	1.228

International Journal of Engineering, Management and Humanities (IJEMH)
Volume 5, Issue 2, Mar.-Apr., 2024 pp: 311-316 ISSN: 2584-2145
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Longitudinal Wind Force	kN	10.24
Transverse Wind Force	kN	21.88

The acceleration force as Longitudinal direction shawn in Table 3;

Table 3. Acceleration Force

Description	Unit	Quantity
Trailer Speed	Km/h	0.5
Time taken to accelerate	s	2
Acceleration	m/s^2	0.07
Sliding Force due to acceleration	MT	3.65
Sliding Force due to inclination	MT	15.35
Longitudinal Wind Force	MT	1.05
Total Sliding Force	MT	20.05

The Lashing Arrangement as shawn in Table 4.

Table 4. Lashing Arrangement

Description	Unit	Quantity
Transverse plan angle, α	deg	13.3
Longitudinal plan angle, β	deg	58.0
Longitudinal Force Value, fx		0.85
Lashing number	EA	8
Lashing securing force	MT	34
Securing force due to friction	MT	51.12
Total Securing force	MT	85.12
Conclusion		SAFE

The Breaking Force as Longitudinal direction, as shawn in Table 5.

Table 5. Breaking Force

Description	Unit	Quantity
Trailer Speed	Km/h	0.5
Time taken to accelerate	s	2
Acceleration	m/s^2	0.07
Sliding Force due to acceleration	MT	3.65
Sliding Force due to inclination	MT	15.35
Longitudinal Wind Force	MT	1.05
Total Sliding Force	MT	20.05

The Lashing Arrangement as shawn in Table 6.

Table 6. Lashing Arrangement

Description	Unit	Quantity
Transverse plan angle, α	deg	13.3
Longitudinal plan angle, β	deg	58.0
Longitudinal Force Value, fx		0.85
Lashing number	EA	8
Lashing securing force	MT	34
Securing force due to friction	MT	51.12
Total Securing force	MT	85.12
Conclusion		SAFE

The Breaking Force as Transverse direction, as shawn in Table 7

Table 7. Centrifugal Force

Description	Unit	Quantity
Trailer Speed when turning	Km/h	0.5
Turing radius	m	8.6
Centrifugal force	MT	0.12
Sliding Force due to inclination	MT	15.35
Transverse Wind Force	MT	2.23
Total Sliding Force	MT	17.70

The Lashing Arrangement as shawn in Table 8.

Table 8. Lashing Arrangement

Description	Unit	Quantity
Transverse plan angle, α	deg	13.5
Longitudinal plan angle, β	deg	68.1
Longitudinal Force Value, fx		0.39
Lashing number	EA	8
Lashing securing force	MT	15.6
Securing force due to friction	MT	51.1
Total Securing force	MT	66.7
Conclusion		SAFE

2.3 Lashing Calculation Module S1

5T lashings will be used to secure [2] the cargo in both transverse and longitudinal directions. Lashing calculation [3] is based on 2x20 axle lines SPMT. Proposed lashing arranggement as shawn in figure 7.

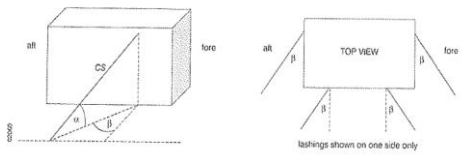

Figure 7. Lashing arrangement

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The Cargo detail, cargo dimension, Trailer Detail , Road Inclination as shawn in Table 9.

Table 9. Cargo, Trailer, Road, Detail

Description	Unit	Quantity
Cargo Detail		
Weight	MT	429.18
Lashing Capacity	MT	5
Coeficient of friction		0.1
Cargo Dimension		
Length	m	31.42
Width	m	14.00
Height	m	12.12
Trailer Deatail		
Type SPMT	EA	2
No Axle Lines	EA	20
Road Inclination		
Longitudinal Road Gradient	deg	1.72 0r 3 %
Transverse Road Gradient	deg	1.72 or 3 %

The Wind Force shawn in Table 10. ;

Table 10. Wind Force

Descrption	Unit	Quantity
Wind Speed	m/s	10
Mass Density of Air	Kg/m^3	1.228
Longitudinal Wind Force	kN	10.42
Transverse Wind Force	kN	23.39

The acceleration force as Longitudinal direction shawn in Table 11;

Table 11. Acceleration Force

Description	Unit	Quantity
Trailer Speed	Km/h	0.5
Time taken to accelerate	s	2
Acceleration	m/s^2	0.07
Sliding Force due to acceleration	MT	3.07
Sliding Force due to inclination	MT	12.88
Longitudinal Wind Force	MT	1.07
Total Sliding Force	MT	17.02

The Lashing Arrangement as shawn in Table 12

Table 12. Lashing Arrangement

Description	Unit	Quantity
Transverse plan angle, α	deg	5.3
Longitudinal plan angle, β	deg	78.7
Longitudinal Force Value, fx		0.99
Lashing number	EA	4
Lashing securing force	MT	19.80
Securing force due to friction	MT	42.90
Total Securing force	MT	62.7
Conclusion		SAFE

The Breaking Force as Longitudinal direction, as shawn in Table 13.

Table 13. Breaking Force

Description	Unit	Quantity
Trailer Speed	Km/h	0.5
Time taken to accelerate	s	2
Acceleration	m/s^2	0.07
Sliding Force due to acceleration	MT	3.07
Sliding Force due to inclination	MT	17.88
Longitudinal Wind Force	MT	1.07
Total Sliding Force	MT	17.02

The Lashing Arrangement as shawn in Table146.

Table 14. Lashing Arrangement

Description	Unit	Quantity
Transverse plan angle, α	deg	5.30
Longitudinal plan angle, β	deg	78.70
Longitudinal Force Value, fx		0.99
Lashing number	EA	4
Lashing securing force	MT	19.80
Securing force due to friction	MT	42.90
Total Securing force	MT	62.70
Conclusion		SAFE

The Breaking Force as Transverse direction, as shawn in Table 15

Table 15. Centrifugal Force

Description	Unit	Quantity
Trailer Speed when turning	Km/h	0.5
Turing radius	m	8.8
Centrifugal force	MT	0.10
Sliding Force due to	MT	12.88

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inclination		
Transverse Wind Force	MT	2.39
Total Sliding Force	MT	15.37

The Lashing Arrangement as shawn in Table 16.

Table 16. Lashing Arrangement

Description	Unit	Quantity
Transverse plan angle, α	deg	4.6
Longitudinal plan angle, β	deg	84.1
Longitudinal Force Value, fx		0.12
Lashing number	EA	4
Lashing securing force	MT	2.4
Securing force due to friction	MT	42.90
Total Securing force	MT	45.3
Conclusion		SAFE

III. RESULT AND DISCUSSION

3.1 Lashing analysis of Module P1

The modul P1 has weitgh 511.48 ton can be secured with 8 pieces Sling with 5 ton capacity. The arrangement of lasing has transverse plan anggle 5.3 deg and longitudinal plan angle 58 deg. During traveling with SPMT with 5 km/h speed and acceleration 0.07 $m/^{s}$affected the total sliding force 17.7 MT,ton.and the total securing force 66.72 MT. The Conclusion is Safe.

Summary of forces for securing module Pi on trailer as shawn in Table 17.

Table 17. Forces Securing Module P1

	Transverse (Turning)	Longitudinal (Breaking)	Longitudinal (Acceleration)
Total Secutin g Forces (MT)	66.72	85.12	85.12
Total Sliding Forces (MT)	17.7	20.05	20.05
Conclusion			
Total Transverse Securing Forces > Total Transver Sliding Fore (Safe)			
Total Longitudinal Securing Forces > Total Longitudinal Sliding Fore (Safe)			
Conclusion Safe			

Modul P1 Transported on Trailer SPMT onshore moving, shawn in Figure 8.

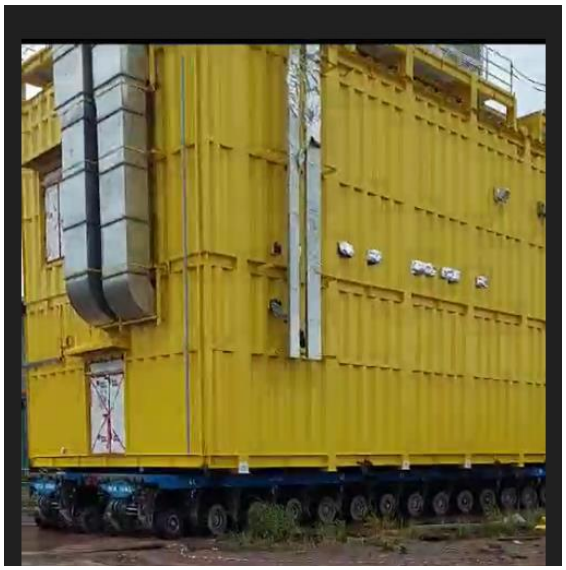

Figure 8. Modul P1 on SPMT

3.2 Lashing Analysis modul S1

The modul S1 has weitgh 429.18 ton can be secured with 4 pieces Sling with 5 ton capacity. The arrangement of lasing has transverse plan anggle 5.3 deg and longitudinal plan angle 78.7 deg. During traveling with SPMT with 5 km/h speed and acceleration 0.07 $m/^{s}$ affected the total sliding force 15.37 MT,ton.and the total securing force 45.30 MT. The Conclusion is Safe.

Summary of forces for securing module Pi on trailer as shawn in Table 18.

Table 18

	Transverse (Turning)	Longitudinal (Breaking)	Longitudinal (Acceleration)
Total Secutin g Forces (MT)	45.30	62.70	62.70
Total Sliding Forces (MT)	15.37	17.02	17.02
Conclusion			
Total Transverse Securing Forces > Total Transver Sliding Fore (Safe)			
Total Longitudinal Securing Forces > Total			

International Journal of Engineering, Management and Humanities (IJEMH)
Volume 5, Issue 2, Mar.-Apr., 2024 pp: 311-316 ISSN: 2584-2145
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Longitudinal Sliding Fore (Safe)
Conclusion Safe

Figure 8. Module S1 On SMPT

IV. CONCLUSIONS

1. Total Transverse Securing Forces > Total Transverse Sliding Fore , for turning condition it is Safe.
2. Total Longitudinal Securing Forces > Total Longitudinal Sliding Fore, for breaking condition , it is Safe.
3. Total Longitudinal Securing Forces > Total Longitudinal forces for accelaration condition it is Safe.

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