TRANSPORT CALCULATIONS

Client dependant

Client :	**Client Name**
Project :	**Project name**
Project description :	**Project Description**
Reference number :	**466023-9-K15**
Load description :	**Siemens Transformer**
Length :	
Width :	
Height :	
Weight :	
Location :	

Client approval (stamp/sign):

Client remarks :

Authorized name:

Project/file number :

0	23-Aug-03	For Bid	Marco J. van Daal	
Revision	**Date**	**Reason for issue**	**Project Manager**	**Remarks**

Magdenli

TRANSPORT CALCULATIONS

INPUT:	Siemens Transformer	ENG. No.	22e036	Rev.	0

Transporter configuration Goldhofer Single 12 Axle Lines Self Propelled

transporter heigth	(Th) =	1200	mm	load length	(Ll) =	9000	mm
transporter width	(Tw) =	3000	mm	load height (incl. beams)	(Lh) =	4500	mm
transporter length	(Tl) =	18000	mm	load width	(Lw) =	3000	mm
transporter axle lines	(n) =	12	Nos.	load weight	(Wl) =	150.0	mTon
axle distance	(Da) =	1500	mm	height CG (z) (incl. beams)	(CGh) =	2000	mm
transporter CG (z)	(CG) =	900	mm	transverse CG (+ towards AD)	(CGt) =	0	mm from CL
total transporter weigh	(Wt) =	53.0	mTon	longitudinal CG (+ towards CD)	(CGl) =	0	mm from CL
3 or 4 point susp.	(p) =	3	point	shape factor	(Sf) =	1	-
axle base transverse	(Dab) =	1800	mm	additional weight	(Wa) =	25.0	mTon
axle centre height	(Ah) =	381	mm	height CG (z) (add. weight)	(CGa) =	0	mm
axle capacity	(Ac) =	13.9	mTon	wind pressure 6 Beaufort	(Wp) =	11.8	kg/m²
transporter speed	(V) =	25.00	km/h	curve impact	(Ci) =	2.00	%
max. acceleration	(a) =	0.50	m/sec²	friction factor steel/wood	(Mu) =	0.20	-
max. deceleration	(d) =	2.50	m/sec²	transverse road gradient	(Mgt) =	0.00	deg.
Axles suspended	(Sn) =	8-0-8-8	Nos.	longitudinal road gradient	(Mgl) =	5.00	deg.
Safe hydr. stab. angle	(Shsa) =	8.00	deg.				
Safe struc. stab. angle	(Sssa) =	5.00	deg.				
lashing capacity	(Lc) =	5.00	mTon each				

Note: All assumptions are worst case

LASHING CALCULATION:

Longitudinal lashing angle with horizon (external forces		(ca1) =	30.0	deg.	y Account for friction (Y/N)?
Normal force	= (Wl + Wa) * cos (Mgl)	(Nl) =	174.33	mTon	
Gradient force	= (Wl + Wa) * sin (Mgl)	(Fhl) =	15.25	mTon	
Wind force	= Wp * (Longitudinal Load Surface * Sf)	(Fwl) =	0.16	mTon	
Deceleration force	= (((Wl + Wa) * d) / g)	(Fa/d) =	44.60	mTon	
Required lashing force	= Fhl+Fwl+Fa/d-(Mu*cos (Mgl)*(Wl+Wa+Wt)	(FL) =	14.58	mTon	
Lashing required	= (FL/Lc) / cos (ca1) (If FL<0, none required	(C1) =	4	in front **AND** rear direction	
Transverse lashing angle with horizon (external forces)		(ca2) =	30.0	deg.	y Account for friction (Y/N)?
Normal force	= (Wl + Wa) * cos (Mgt)	(Nt) =	175.00	mTon	
Gradient force	= (Wl + Wa) * sin (Mgt)	(Fht) =	0.00	mTon	
Wind force	= Wp * (Transverse Load Surface * Sf)	(Fwt) =	0.48	mTon	
Curve impact force	= Ci * (Wl + Wa)	(Fci) =	3.50	mTon	
Required lashing force	= Fht+Fwt+Fci-(Mu*cos (Mgl)*(Wl+Wa+Wt))	(FT) =	-41.62	mTon	
Lashing required	= (FT/Lc) / cos (ca2) (If FT<0, none requirec	(C2) =	0	in left **AND** right direction	
Total lashing required	= 2*C1 + 2*C2	(Ctot) =	8	lashing(s) required	
Vertical lashing angle with horizon		(ca3) =	60.0	deg.	y Combined CG (Y/N)?
					n Account for C1 & C2 (Y/N)?
Total lashing required	= (Wt / Lc) / sin(ca3)	(C3) =	13	lashing(s) required	

GROUND BEARING PRESSURE CALCULATION:

Wt + Wl + Wa = Wtot = 228.0 mTon

Load / line		mTon over	12	Lines =	19.00	mTon		
Load / axle		mTon over	24	Axles =	9.50	mTon		
Load / tyre		mTon over	96	Tyres =	2.38	mTon		
Load / width of tire	2.38	mTon over	8	inch =	0.32	mTon/inch =	697.5	lbs/inch
Ground Pressure (based on wheeled shadow area)				=	4.22	mTon/m²		

HYDRAULIC STABILITY:

CGtoth	= ((Wt*CG)+(Wl*(CGh+Th))+(Wa*(CGa+Th)))/Wtot				
		=	2446	mm	(CG of Transporter + Load + Beams)
CGtott	= ((Wl + Wa) * CGt) / Wtot	=	0	mm	out of center
CGtotl	= ((Wl + Wa) * CGl) / Wtot	=	0	mm	out of center
Lstab	= (0.5*Tl)	=	9000	mm	Length of triangle
Ltri	= SQRT((0.5*Dab)² + (0.5*Tl)²)	=	9045	mm	Length of hypotenuse

Longitudinal hydraulic stability angle

Aminl	= (0.5*Tl - 0.5*GroupD - CGtotl)	=	3000	mm	CGtotl towards 2 groups (C&D)
Lng. Cam	= Aminl / (CGtoth - Ah)	=	1.4527		Longitudinal Stability Camber
Lng. Grad	= arctan (Lng. Cam.)	=	55.5	deg.	Max. longitudinal Gradient on Stability
			OK !		

Transverse hydraulic stability angle

Amint	= ((0.5*Tl-Aminl)*sin(0.5*Dab/Ltri))-CGtott	=	600	mm	CGtott towards groups (A&D)
Tr. Cam.	= Amint / (CGtoth-Ah)	=	0.2905		Transeverse Stability Camber
Tr. Grad	= arctan (Tr. Cam.)	=	16.2	deg.	Max. Transverse Gradient on Stability
			OK !		

STRUCTURAL STABILITY:

CGtoth	= ((Wt*CG)+(Wl*(CGh+Th))+(Wa*(CGa+Th)))/Wtot				
		=	2446	mm	CG of Transporter + Load + Add. Weight
CGtott	= ((Wl + Wa) * CGt) / Wtot	=	0	mm	Transverse out of center
CGtotl	= ((Wl + Wa) * CGl) / Wtot	=	0	mm	Longitudinal out of center
Fwt	= Wp * (Transverse Load Surface * Sf)	=	0.48	mTon	Transverse Wind Force
Mwt	= Fwt * ((0.5 * Lh) + Th)	=	1.65	mTon * m	Moment due to Transverse Wind Force
Fwl	= Wp * (Longitudinal Load Surface * Sf)	=	0.16	mTon	Longitudinal Wind Force
Mwl	= Fwl * ((0.5 * Lh) + Th)	=	0.55	mTon * m	Moment due to Longitudinal Wind Force
Mt	= CGt * (Wl + Wa)	=	0.00	mTon * m	Moment due to transverse load offset
Ml	= CGl * (Wl + Wa)	=	0.00	mTon * m	Moment due to longitudinal load offset
Mci	= Ci * Wtot * (CGtoth - Ah)	=	9.42	mTon * m	Moment due to Curve Impact
Ma/d	= ((Wtot * d) / g) * (CGtoth - Ah)	=	119.99	mTon * m	Moment due to Acceleration / Decelaration
Mroadl	= tan(Mgl)*(CGtoth-Ah)*Wtot	=	41.19	mTon * m	Moment due to road gradient
Mroadt	= tan(Mgt)*(CGtoth-Ah)*Wtot	=	0.00	mTon * m	Moment due to road gradient

Longitudinal structural stability angle

Group A	9.50	Group B	0.00	Group C	9.50	Group D	9.50	mTon / axle (due to weights)
	2.25		0.00		1.12		1.12	mTon / axle (due to moments)
	11.75		0.00		10.62		10.62	mTon / axle (Fmax.)
	OK !		**OK !**		**OK !**		**OK !**	

Lng. Cam	= ((Ac/2*Tl/Fmax*2)-(0.5*Tl/2))/(CGtoth-Ah)	=	0.3949		Longitudinal Stability Camber
Lng. Grad	= arctan (Lng. Cam.)	=	21.5	deg.	Max. Longitudinal Gradient on strength
			OK !		

Transverse structural stability angle

Group A	9.50	Group B	0.00	Group C	9.50	Group D	9.50	mTon / axle (due to weights)
	0.00		0.00		0.77		0.77	mTon / axle (due to moments)
	9.50		0.00		10.27		10.27	mTon / axle (Fmax.)
	OK !		**OK !**		**OK !**		**OK !**	

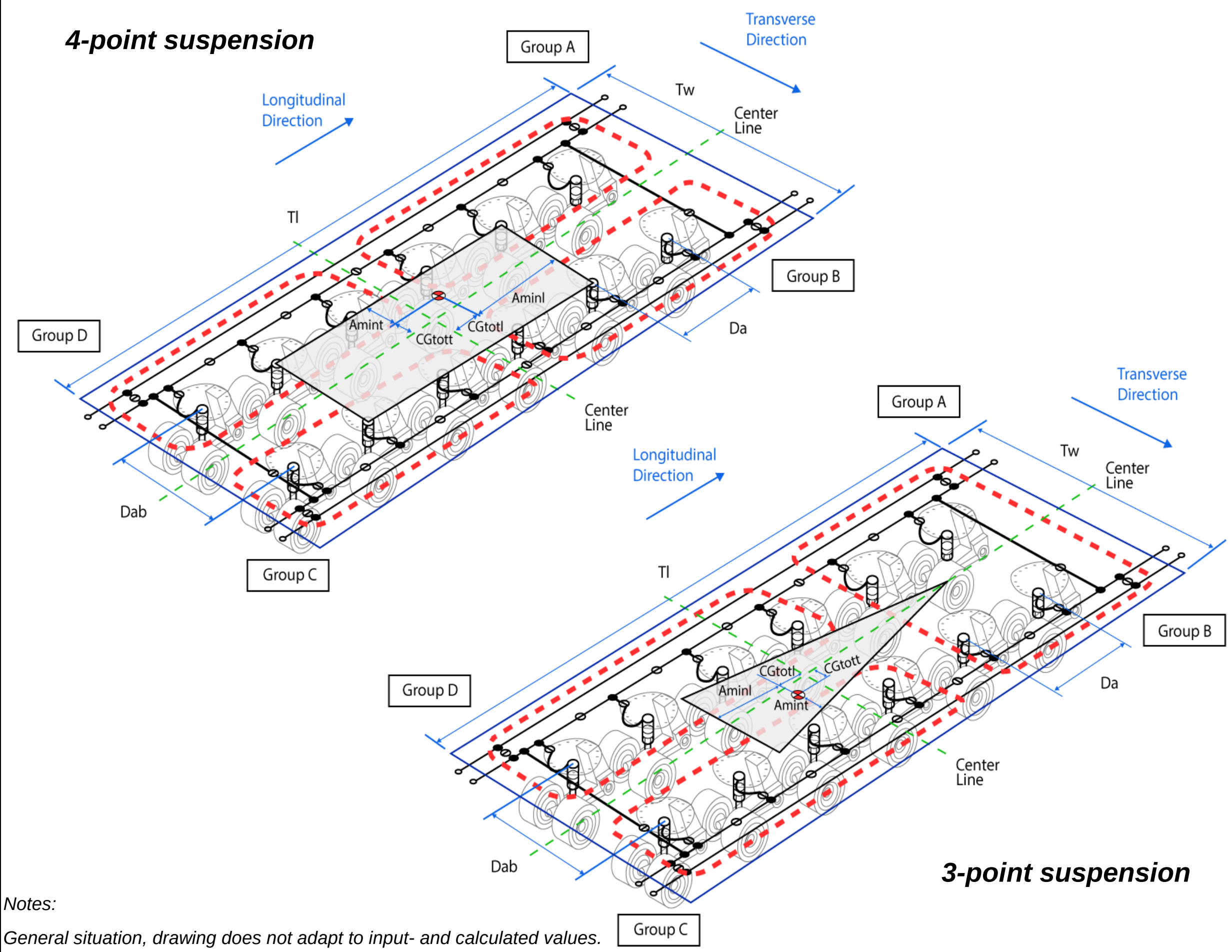
Tr. Cam.	= ((Ac*Dab/Fmax*2)-(0.5*Dab))/(CGtoth-Ah)	=	0.1531		Transeverse Stability Camber
Tr. Grad	= arctan (Tr. Cam.)	=	8.7	deg.	Max. Transverse Gradient on strength
			OK !		

OVERALL SUMMARY:

- STABILITY LIMIT: **STRUCTURAL STABILITY** | 8.7 | deg.
- LASHING REQUIRED (Ctot + C3): | 21 | Nos.
- GROUND BEARING PRESSURE : | 4.2 | mTon/m²

GENERAL SITUATION:

4-point suspension



3-point suspension

Notes:

General situation, drawing does not adapt to input- and calculated values.

Group A and B should have less axles than Group C and D if need be.

In case of 3-point suspension Group B = 0.

NOTES:

- Gooseneck and self propelled PPU are always at the Group A and B side of the transporter.
- The transverse transporter gradient will be kept within +4 and -4 degrees with the road by the transporter operator.
- Calculations are based on transporter driving in normal mode, not in transverse mode.
- All assumptions are highly estimated, and therefor not allways according to the drawings.
- Road gradient is included in lashing and structural calculation but not in hydraulics calculation.