Annex A

Senior Master’s standing orders numbers 8 and 23

SENIOR MASTER'S STANDING ORDERS

SMSO No. 23 - SECURING OF FREIGHT VEHICLES

The following extract from the Company Standing Orders and Operational Procedures Manual is to be followed at all times:-

2.3.7.1. Before putting to sea the Master is to satisfy himself that the cargo is safely stowed and secured with sufficient number of lashings for both the prevailing weather and swell and the official Meteorological Office weather forecasts.

2.3.7.2. The stowage and securing of vehicles is to be carried out in accordance with the Code of Practise and the approved Cargo Securing Manual.

The following shall apply to the **'Stena HSS'**:

I) when actual and forecast sea conditions are **giving significant wave height up to and including 2.5m,** accompanied freight need not be secured provided that the following requirements are complied with:

- a.) a tight stow athwartships is achieved.
- b.) the Passive Stabilising system is fully intact;
- c.) the vehicle's trailer legs are lowered.
- d.) The first and last vehicle in the stow are securely chocked with four chocks at all times.

ii) when the official Meteorological Office shipping forecast is indicating winds of **Significant wave height of 2.6 metres or above** freight vehicles are to be secured and as far as possible block stowed.

iii) freight vehicles in the immediate vicinity of the bow and stern doors must be lashed at all times irrespective of weather conditions.

iv) Four securing points should be used.

v) All automobiles stowed athwartships are to be lashed.

vi) **All vehicles containing dangerous goods** are to be lashed in accordance with 'M' Notice 1445, as should all vehicles immediately adjacent to them. See also S. M. S. O. 33.

vii) all **road tanker** vehicles must always be secured and block stowed.

viii) Every vehicle carrying **bloodstock** is to be securely lashed and block stowed throughout the voyage irrespective of weather conditions.

The Car Decks are to be attended throughout the voyage by the Deck Supervisor or his deputy and the cargo lashings are to be inspected at regular intervals during the sea passage. Any irregularities must be immediately reported to the 1st Officer and extra lashings applied if necessary.

Senior Master

SENIOR MASTER'S STANDING ORDERS

SMSO No. 23 - SECURING OF FREIGHT VEHICLES

The following extract from the Company Standing Orders and Operational Procedures Manual (High Speed Craft) is to be followed at all times

2.3.7 **Cargo Securing**

2.3.7.1 Before putting to sea the Master is to satisfy himself that the cargo is safely stowed and secure with sufficient number of lashings for both prevailing weather and swell and the official Meteorological Office weather forecasts.

2.3.7.2 The stowage and securing of vehicles is to be carried out in accordance with the Code of Practice and the MCA approved Cargo Securing Manual.

The following criteria is to be followed on HSS - Stena Explorer :-

i. when actual and forecast sea conditions are **giving significant wave height up to and including 2.5m,** accompanied freight need not be secured with the exception of any dangerous goods.
ii. when the official Meteorological Office shipping forecast is indicating winds of **Significant wave height of 2.6 metres or above** freight vehicles are to be secured and as far as possible block stowed.
iii. freight vehicles in the immediate vicinity of the bow and stern doors must be lashed at all times irrespective of weather conditions.
iv. Four securing points should be used.

8.1 Securing of Cargo

8.1.1 The Master should satisfy himself that all cargo is safely stowed and secured before proceeding to sea. In making the decision to sail, he / she should pay due regard to the prevailing weather conditions and to the Met. Office, North Channel, weather forecast.

The stowage and securing of cargo is to be in compliance with the Stena Voyager's, MCA approved "Cargo Securing Manual".

8.1.2 The following conditions shall apply to Stena Voyager:-

i) When actual and / or forecast sea conditions are indicating a significant wave height of 2.5 metres or less, freight vehicles need not be secured, provided that the following requirements are complied with:

a.) A tight athwarthships stow is achieved.
b.) The passive stabilisers (bilge keels) are fully intact.
c.) The first and last vehicles in the stow are securely chocked with four chocks at all times.

ii) When actual and / or forecast sea conditions are indicating a significant wave height of 2.6 metres or above, freight vehicles are to be secured, and as far as possible, stowed in a block.

iii) Freight vehicles at the forward end of the lanes and in the immediate vicinity of the stern doors must be lashed at all times irrespective of weather conditions.

iv) Four securing points should be used for lashing freight vehicles.

v) All cars stowed athwartships are to be chocked.

vi) All vehicles containing dangerous goods are to be secured. All vehicles immediately adjacent to them should also be secured.

vii) All road tanker vehicles must always be secured and block stowed.

viii) Every vehicle carrying bloodstock is to be securely lashed and block Stowed throughout the voyage irrespective of weather conditions.

Signature :	Signature :
Capt. Senior Master	Safety Manager

8.1.3 The vehicle decks are to be attended throughout the voyage by the vehicle deck watchman and the cargo lashings and chocks are to be inspected at regular intervals during the sea passage. Any irregularities must be immediately reported to the Bridge and extra lashings or chocks applied as necessary.

Signature :	Signature :
Capt. Senior Master	Safety Manager

Annex B

HSS 1500 cargo securing philosophy

Stena HSS Cargo Securing

The cargo securing philosophy of the Stena HSS 1500 is based on the following facts and assumptions:

- The vessel is structurally designed to operate at 40 knots in waveheights up to 5m H1/3 (maximum wave height 11m). The crew will be instructed in normal operation to adjust speed and heading to stay within the safe limits stipulated in the HSC code Annex 3 and 8.

- The vessel is expected to have good seakeeping characteristics, also compared to conventional ships. This has been indicated by model testing and computer simulations, and shall be verified by measurements in full scale.
For example: 4m H1/3 head seas in 40 knots gives a vertical acceleration of about 0.5 m/s2 rms (0.05 g).

- Due to the stability characteristics of the vessel, cargo shifting can not in itself jeopardize her survivability in intact or damaged condition. In the worst stipulated full load damage condition the heeling angle is approximately 5 degrees. If all cargo was made to shift maximally to one side this would increase by about 1 degree.
The remaining GZ would be approximately 9 m.

- The HSS fulfils the HSC code requirements for Category B Craft. The probability of total loss of propulsion should therefore be very remote.
The worst single failure situation would be loss of propulsion in one hull.
In that condition the HSS will be able to manouevre and make forward speed of about 20 knots.

- The normal operation of the vessel is based on short harbour turnaround times. It intended to operate only under conditions which would not require securing for normal cargo units - only for vehicles which are found to have insufficient fastening of cargo, high centres of gravity, insufficient wheel brakes, etc. Securing against collision is not envisaged.

- The transversal friction coefficient on the cargo decks is approximately 1,0 when wet.
This is due to longitudinal extruded serrations on the vehicle deck and antislip surface protection on the platform deck.
Sliding will therefore occur at a relative heeling angle (RHA) of about 45 degrees.

- The normal cargo unit has been assumed to be a trailer or semitrailer of 35 tons with vcg=2m . The static tilting angle will then be about 25 degrees (based on data from tests and manufacturers).

- The worst case cargo unit has been assumed to be a trailer or semitrailer of 35 tons with vcg= 3 m . The static tilting angle will then be about 16 degrees (based on data from tests and manufacturers).

Report on the condition of the failed lashings and the cause of failure

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REPORT
Investigation to establish the causes of vehicle lashing failures involved in an accident on board a passenger and freight ferry.

For

MAIB
Ref:TTI -JN -574-2009-R

Date	Issue No	Description	Prepared by	Authorised by
05 May 2009	1	Final	JN	SB

Distribution:

Client: MAIB Attention:

Internal: TTI Ltd Attention:

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TABLE OF CONTENTS

1 Executive Summary

Three failed lashing samples were submitted to TTI Testing Ltd for investigation, along with a reference new lashing.

Two failures were from the same lashing, samples 1 and 3, whilst sample 2 was one half of a second failure

No evidence of excessive abrasion damage or cutting damage was found that might have contributed to the failures.

However, microscopic investigation did find evidence of tensile fatigue failure and crushing damage. The overall condition of the webbings, to the eye, was fair but did suggest they had been in service for some time. These observations do point to loss of strength due to fair wear and tear.

However, more detailed investigation did reveal constructional differences between the failed lashings themselves and between them and the reference lashing. Tensile testing found that the failed lashings had experienced significant loss of strength as shown below.

Lashing	**% Residual Strength**
Reference 100	
Samples 1 and 3	**57**
Sample 2	**35**

Therefore the extent of the loss of strength may not be entirely explained by ‘fair wear and tear’. Because the failed lashings are of different specifications from reference lashings, and also are different from each other, it may well be that the lashings as originally supplied did not have the same strength as the reference lashing supplied for this study.

2 Introduction

This investigation was conducted to determine the cause or causes of failures of vehicle lashings during an accident on a ferry. Three samples of failed lashings were sent to TTI Testing for investigation. A reference sample of new lashing was also submitted.

3 Visual Inspection and dissection

3.1 Investigation

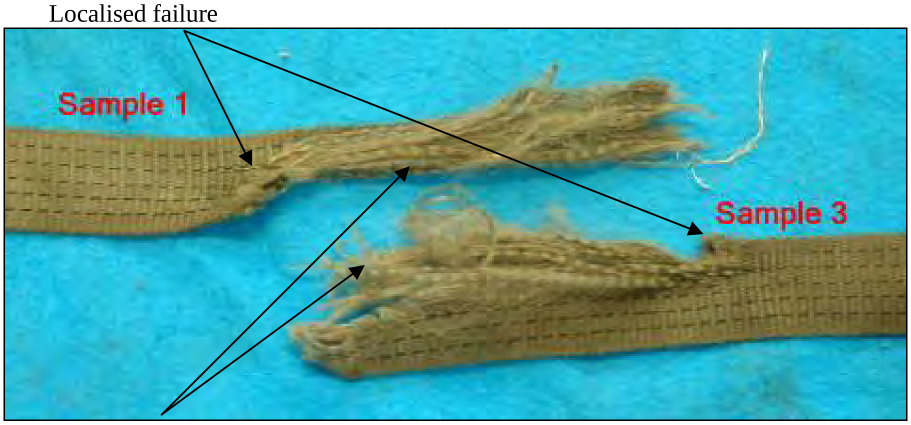
Photograph 1 is a general view of the three failures received by TTI Testing

Photograph 1 General view of failed lashings

The general appearance of failures 1 and 3 suggest they are the two halves of one failed lashing, as shown in photograph 2. The failure is characterised by a partial localised failure across the lashing width, the remainder appearing to be tensile failure.

Photograph 2

Localised failure



Tensile failure

Sample 2 is shown in photograph 3. This has the appearance of a tensile failure

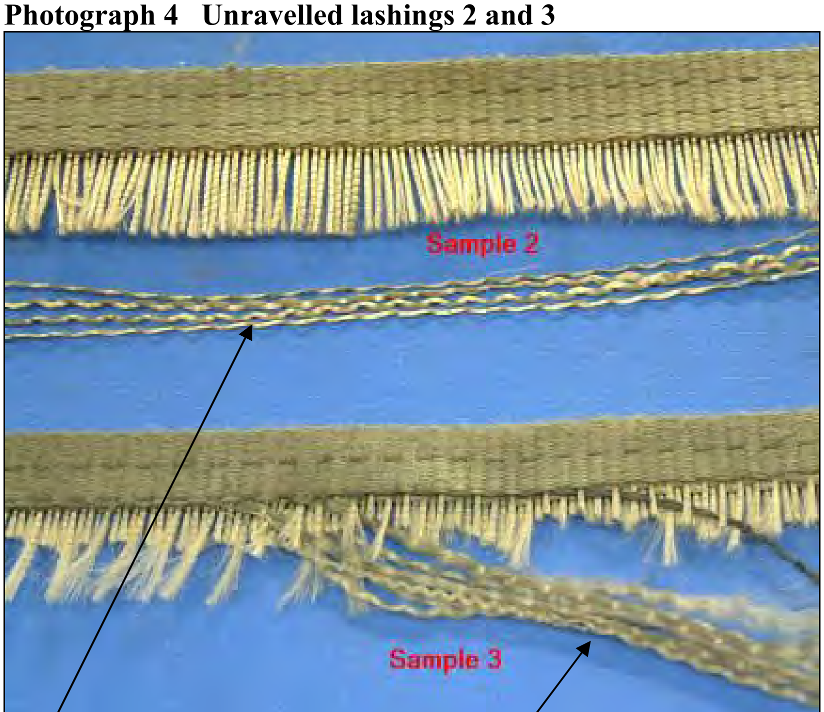
Photograph 3 Sample 2

All three samples showed little evidence of severe abrasion damage in their failure zones.

The lashings were first unravelled to determine their structure in terms of number of yarns used in the warp direction [along the lashing] and the linear density of them, tex.

Photograph 4 shows the unravelled lashings 2 and 3.

Photograph 4 Unravelled lashings 2 and 3



350 tex warp yarn from sample 2 260 tex warp yarn from sample 3

It was noticed that there was a difference in the appearance of the warp yarns of the two lashings. The warp yarns were analysed more closely and this difference was confirmed. The reference sample was also analysed in the same way.

Each of the lashings were found to contain a majority of heavier tex yarns, a small number of lighter tex yarns and a small number of black marker yarns. The focus of the investigation is on the heavier tex yarns, as they make the biggest contribution to the lashing strength.

Table 1 shows the analysis. The webbing was measured as being 48 mm wide

Table 1 Analysis of the warp yarns of lashing samples 2 and 3.

Lashing	Number of thick yarns/ 48 mm	Tex of thick yarn	Number of thin yarns/ 48 mm	Tex of thin yarn	Number of black yarns/ 48 mm	Tex of black yarn
Reference	192	460	24	102	6	100
Sample 2	182	350	24	106	6	100
Sample3 [and 1]	307	260	48	100	6	100

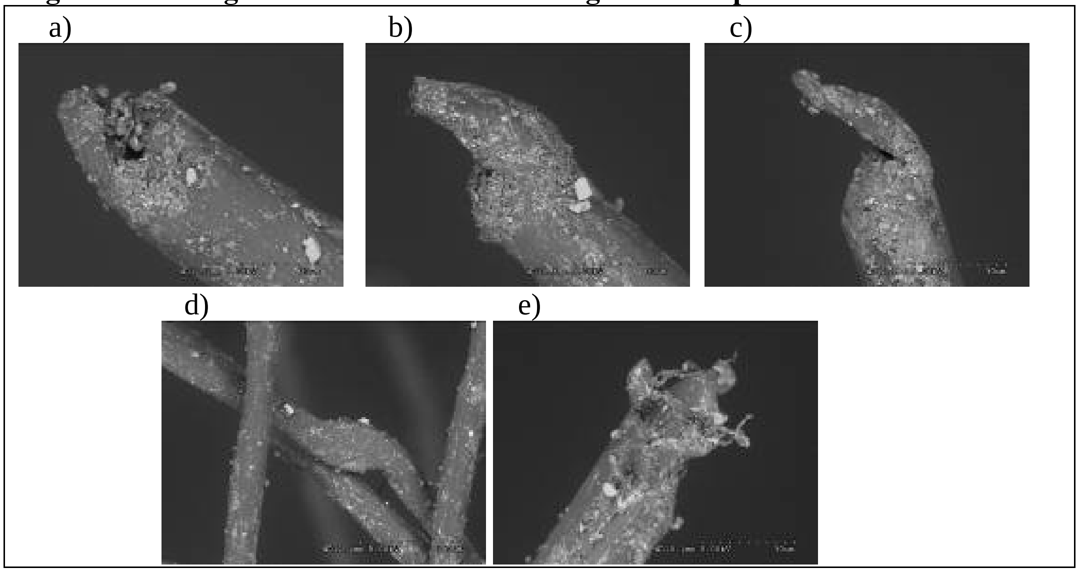
The unravelling of the samples 2 and 3 was not easy, as the yarns were both soiled and had suffered some damage**.** Thus the numbers quoted in the table could be subject to some error. The exact weaving specification can be easily confirmed by the manufacturer of the lashing.

Nevertheless, it can be seen that there is a variation in the warp yarn density and tex, particularly the ‘thick’ yarns, of the different lashings, and that lashings 2 and 3 appear to be of a different construction to the reference lashing. It is not likely that the differences in tex values can be explained by loss of yarn material due to abrasion damage.

3.2 Scanning electron microscopy

Sample 1 was sampled from both the region where yarns had failed in a suspected simple tensile manner and also from where the failure was localised for a short distance across the lashing width. Figure 1 is a selection of SEM images from the tensile failed region

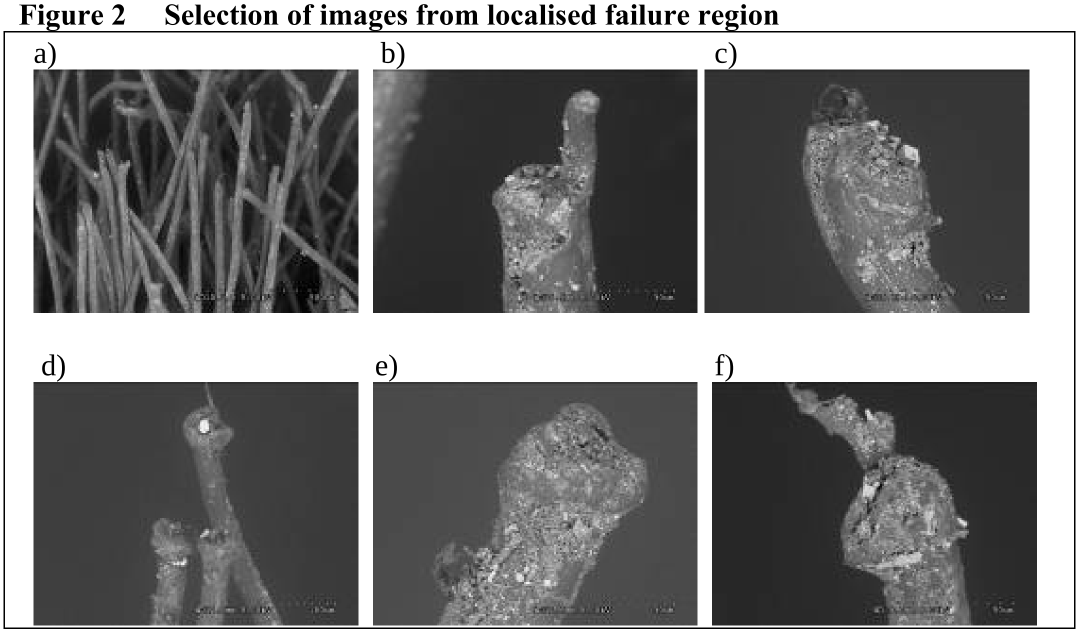
Figure 1 Images from the tensile failed region of sample 1



Images 1a to 1c are typical of failure caused by tensile fatigue, whilst 1d shows some flattening due to pressure. 1e shows evidence of both flattening and tensile fatigue. The degree of contamination across the failed diameter of some of the images suggests filament failure could have occurred some time before the final failure incident itself

Figure 2 shows a selection of images from the localised failure region.

Figure 2 Selection of images from localised failure region



2a is a general view where some filament crushing can be seen. Tensile fatigue is seen in 2b and 2f, whilst the bulbous ends to filaments in 2d suggest a higher energy fail where the filament has recoiled upon itself. Interestingly, salt crystals can be seen embedded in the failed filament ends of 2c and 2d, suggesting that the filament material has recoiled and enveloped the salt crystals during the failure.

The above images of figures 1 and 2 do not show any evidence of cut or abrasion damage, but evidence of crushing and tensile fatigue is seen.

3.3 Conclusions

The general conclusion from the visual inspection is that the webbing construction differs between the two failed lashings and that both are different from the reference lashing.

Samples 1 and 3 appear to be from the same lashing and the failure is a combination of localised failure across part of the width of the lashing with the remainder of the failure exhibiting characteristics suggesting tensile failure. Lashing sample 2 has the appearance of a tensile failure.

Visually there was little evidence of severe abrasion that might explain the failure, but during unravelling, damaged warp yarns were certainly found. An investigation by scanning electron microscope did not find any evidence that cutting or severe abrasion damage had contributed to the failure. Evidence of tensile fatigue and crushing was seen.

The overall conclusion for both of the failed lashings is that they probably have been in service for some time and that their strengths would be expected to have been reduced by general wear and tear mechanisms, such as tensile fatigue and possible crushing.

4 Tensile Testing

This section compares the tensile performance of the two lashings with the reference lashing, though it must be remembered that the visual investigation found that the lashings were of different specifications.

Only the breaking loads of the 'thick' warp yarns have been considered, as these yarns dominate the lashing constructions.

Table 2 gives the breaking loads of the yarns.

Table 2 Results of the tensile tests on thick yarns

Lashing Thi	ck yarn Br load N	tex Te	nacity N/tex
Reference 3	30	460	0.72
Sample 2	123	350	0.35
Sample 3 [and 1]	110 26	0	0.42

Because differences in the linear density [tex] were found, the only way to reasonably compare yarns is to use the parameter Tenacity, it being the breaking load divided by the tex. Units are N/tex. It can be seen that the tenacity values for both samples are substantially lower than that of the reference sample.

An idea of the relative strengths of the lashings can be obtained by calculating an aggregated thick yarn breaking load for the entire width of lashing, using the reference lashing aggregated breaking load as 100%

Table 3 gives this comparison.

Table 3 Aggregated breaking load for thick warp yarns

Lashing Thi	**ck yarn Br load N**	**Number of thick yarns in lashing**	**Aggregated breaking load kN**	**Residual strength %**
Reference 3	**30**	**192**	**63.4**	**100**
Sample 2	**123**	**182**	**22.4**	**35**
Sample 3 [and 1]	**110 3**	**07**	**36.2**	**57**

The thin yarn and the black marker yarn content would add about 5% to the aggregated load, bringing them up to 66.5 kN, 23.5 kN and 38.0 kN respectively.

MAIB confirmed the specified strength of the reference lashing as 5000 kgf, 50 kN. This suggests a new lashing realisation factor [lashing strength/aggregated yarn strength] of 0.75. On the assumption that this factor is the same for used lashing, then the estimated breaking strength of the lashings samples 1 and 2 are 17.6 kN and 28.5 kN respectively. The % residual strength value remains the same.

The used lashings appear to be substantially weaker than the reference lashing. Whilst some of this strength loss could be explained by the fact that the lashings have lost strength due to wear and tear, it also can not be ignored that the lashings are different specifications from the reference lashing and it is possible that the ‘as new’ lashings were not initially the same strength as the reference lashing.

5 Discussion and Conclusions

Three samples of failed lashings were submitted to TTI for investigation, along with a reference new lashing. Failure samples 1 and 3 appeared to be both halves of one failed lashing and sample 2 was a second failed lashing.

Visual examination did not find any evidence of excessive abrasion damage that might have explained the failures. The general visible condition of these lashings was reasonable, though they had the appearance of having been in service for some time.

Microscopic investigation did not reveal damage at the filament level to suggest that either abrasion or cutting damage was involved in the failures. However, evidence of tensile fatigue and crushing damage was seen. This supports the idea that the lashings had been in service for a long period of time.

Differences in the constructions of the lashings were found, both between the failed lashings and also between those and the reference lashing.

Tensile testing of the major warp yarn component of the failed lashings and the reference lashing found significant differences between them. Using the data from the tensile testing and the construction, it was possible to estimate the strengths of the lashings and compare them with the reference new sample. It was found that the failed lashings were significantly weaker than the reference lashing.

This difference may be due to loss of tensile performance caused by ‘fair wear and tear’ and the appearance of the lashings did suggest that they had been in service for some time. However, it is also possible, because of the constructional differences and the extent of the loss of strength when compared to the reference lashing, that the failed lashings, when new, where not to the same strength as the reference lashing.

An additional possibility for the failure could be that a small cut at the region of localised failures, as shown in photograph 2, could have precipitated the failure. Previous webbing failure investigations by TTI have found this to be a cause of failure. However, close examination under the optical microscope, as well as the evidence from the SEM investigation does not reveal any clear evidence of this having been a contributory factor the failure in this case.

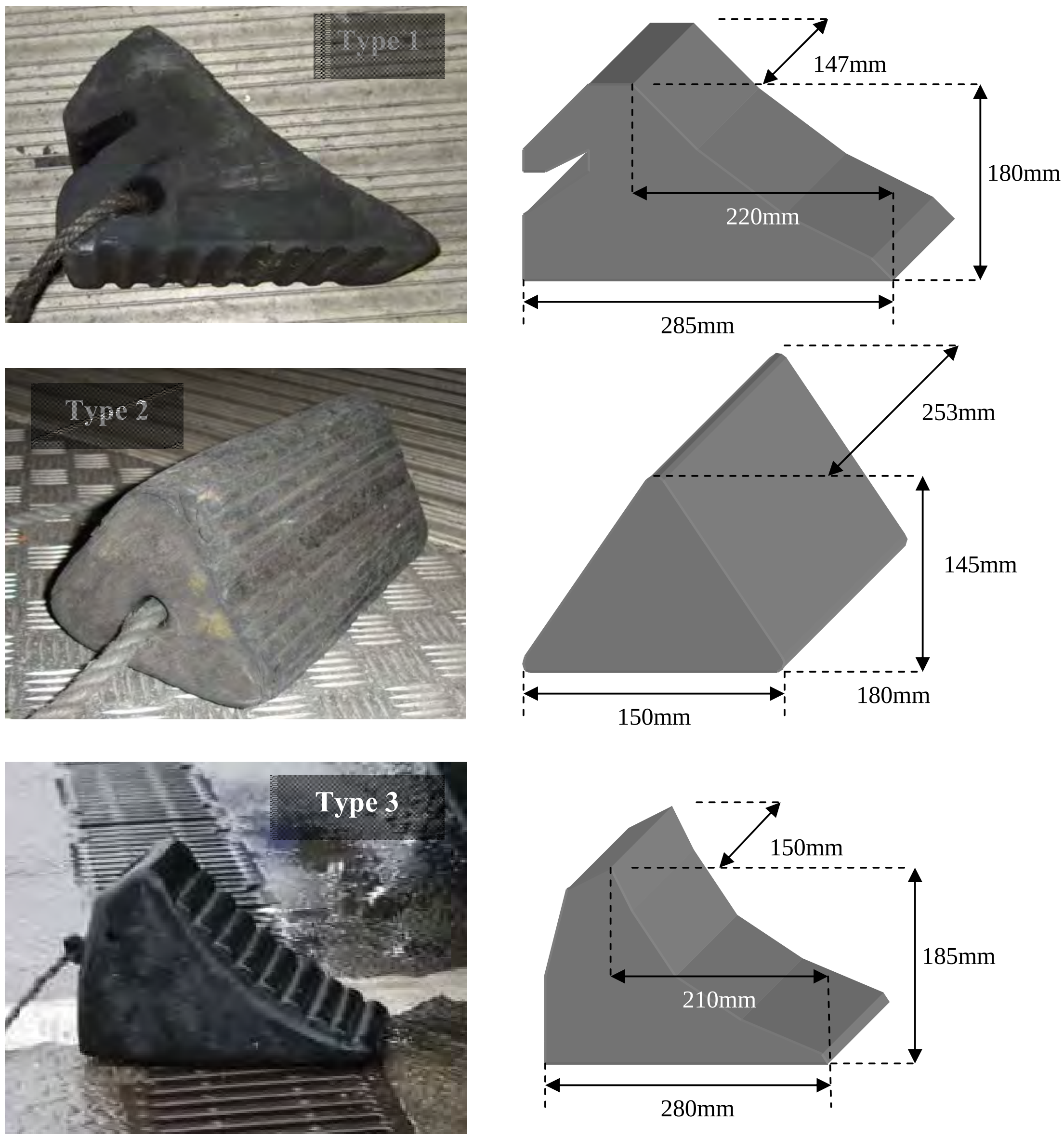
MAIB wheel chock test results

Shift of cargo on board HSS *Stena Voyager*

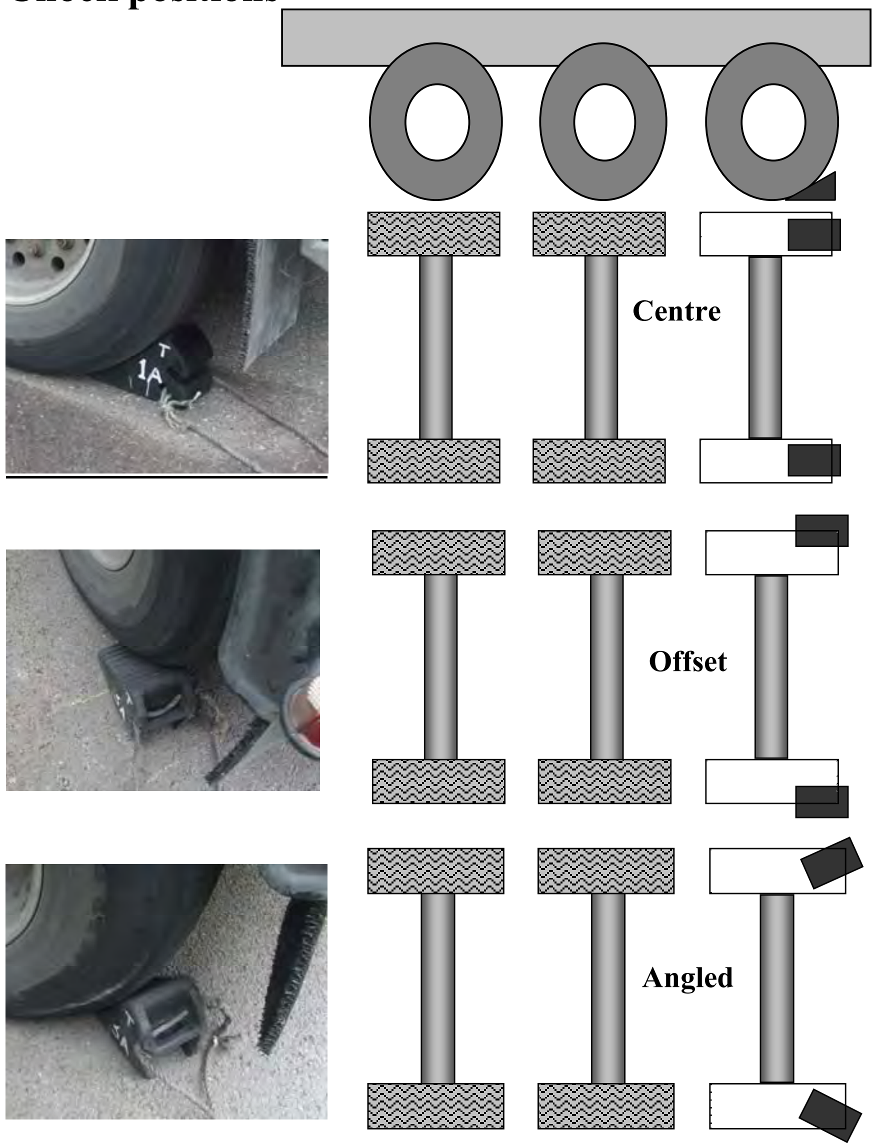
<u>Freight vehicle rubber wheel chock test results: 13 May 2009.</u>

Chocks provided by Stena Line

Type of chocks

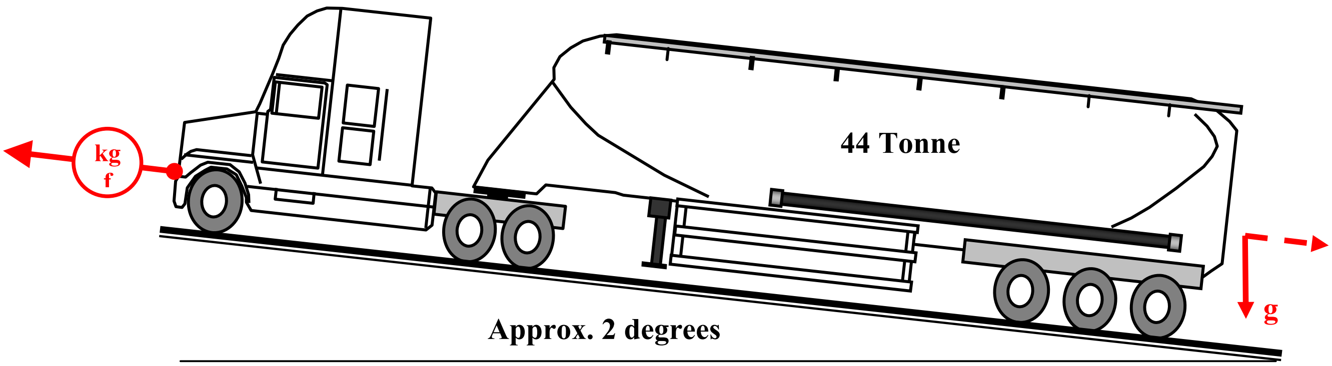


Chock positions



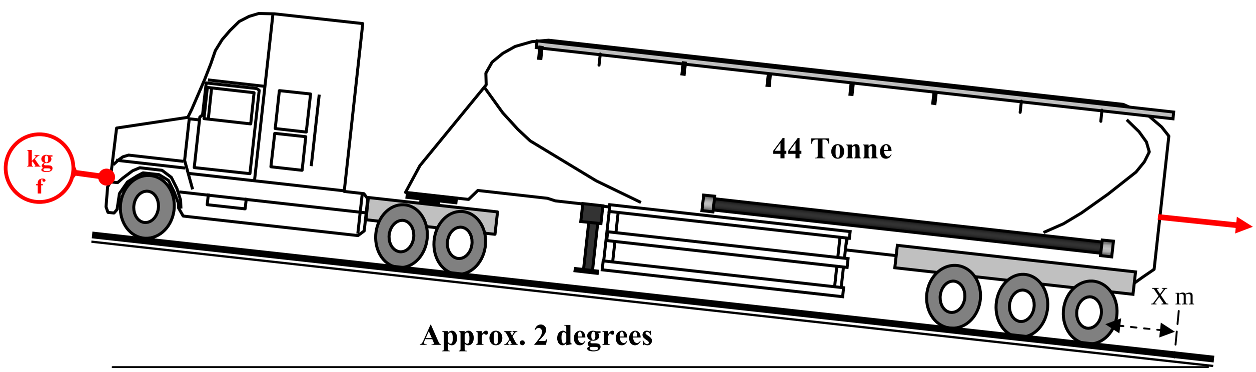
Results

Test One – Force generated by vehicle with brakes off & out of gear.



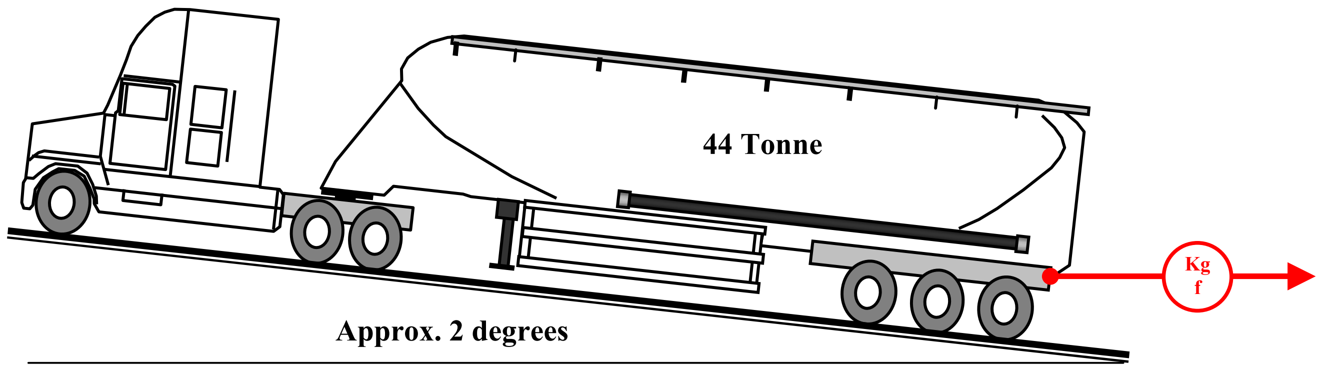
Test No.	Vehicle initial motion	Force (kg)	Comments
1	Static Hold	360	
2	Force required to tow	600	

Test two – Shock load on tow wire from free rolling vehicle.



Test No.	Rolling distance X (m)	Force (kg)	Comments
1	0.2	2500	
2	0.4	3860	
3	0.6	4680	
4	0.8	5370	
5	1.0	5590	
6	1.0	5750	Second reading taken at 1 metre

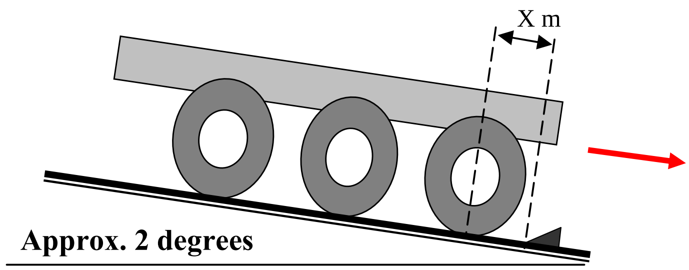
Test three – Vehicle on 2 degree slope



Test No.	Chock Type	No. off Chocks	Chock Position	Force (T)			Comments
				1st	2nd	3rd	
1	1	2	Centre	3710	3480		
2	1	2	Centre Upside down	3380	3380		
3	1	1	Centre	1670	1500		
4	1	1	Centre upside down	1620	1720		
5	2	2	Centre	3850	3860		Chock slippage and rotation (See video)
6	2	1	Centre	2030	1930		
7	3	2	Centre	3360	3280		
8	3	1	Centre	1690	1880	1580	Pull 2 affected by jolt in winch gear

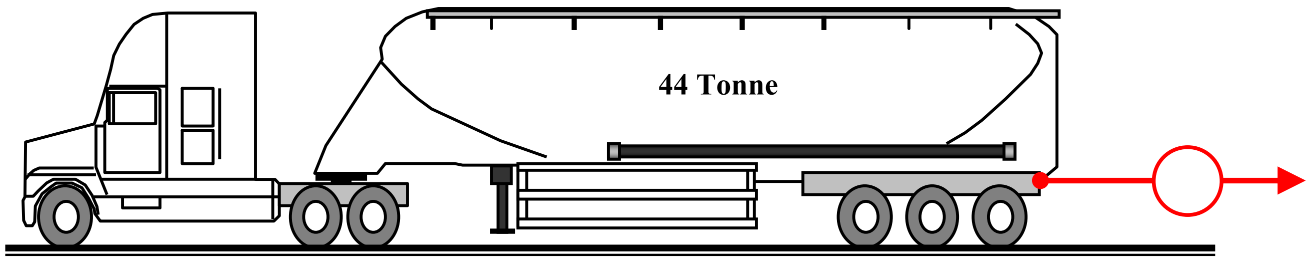
Test four – Rolling vehicle tests.

Distance X increased in increments until vehicle rolls over the chock(s)



Test No.	Chock Type	No. off Chocks	Chock Position	Chock arresting distance X (m)	Motion Arrested By chocks Y/N	Comments
1	1	2	Centre	0.1	Y	
2	1	2	Centre	0.2	Y	
3	1	2	Centre	0.3	Y	
4	1	2	Centre	0.5	Y	
5	1	2	Centre	1.0	Y	
6	1	2	Centre	5.2	N	All 3 trailer wheels rolled over both chocks
7	1	2	Centre	4.1	N	Trailer rear wheel rolled over chocks; motion arrested on second set of wheels
8	2	2	Centre	1.0	Y	
9	2	2	Centre	3.0	Y	
10	2	2	Centre	5.2	N	Trailer rear wheel rolled over chocks; motion arrested on second set of wheels
11	2	2	Centre	4.1	Y	
12	3	2	Centre	3.1	Y	
13	3	2	Centre	4.1	N	Trailer rear wheel rolled over chocks; motion arrested on second set of wheels
14	3	2	Centre	5.2	N	All 3 trailer wheels rolled over both chocks
15	1	1	Centre	3.3	N	All 3 trailer wheels rolled over both chocks
16	1	1	Centre	2.2	N	All 3 trailer wheels rolled over both chocks
17	1	1	Centre	1.2	Y	

Test five – Vehicle on flat road

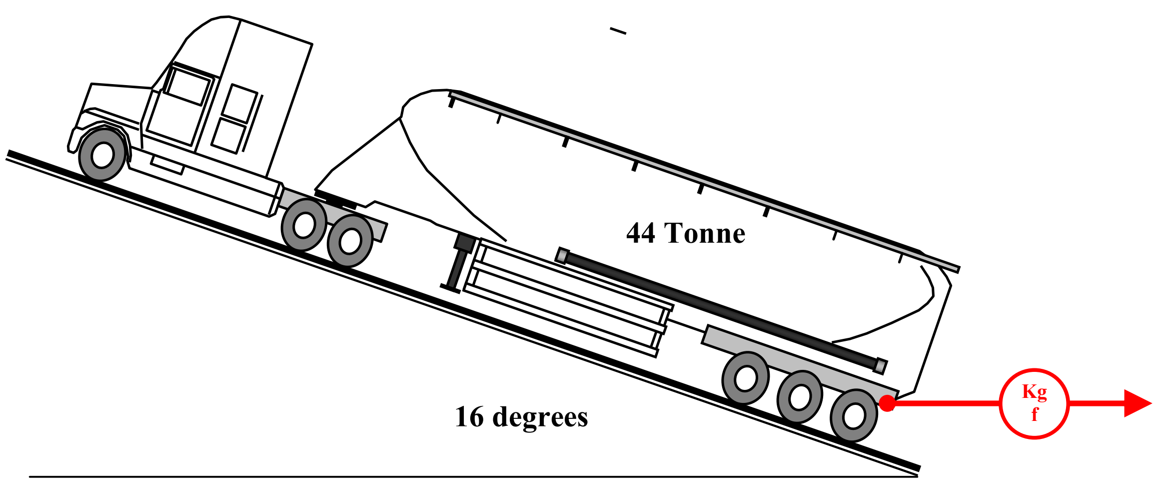


Test No.	Chock Type	No. off Chocks	Chock Position	Force (T)			Comments
				1st	2nd	3rd	
1	1	2	Centre	3670	3580		
2	1	2	Centre Upside down	3670	3660		
3	1	1	Centre	1610	1880	2090	
4	2	2	Centre	4380	4180		
5	2	1	Centre	2120	2280		
6	3	2	Centre	3570	3420		
7	3	1	Centre	1780	1770		

Test six – Vehicle on flat road, chocks angled and offset

Test No.	Chock Type	No. off Chocks	Chock Position	Force (T)			Comments
				1st	2nd	3rd	
1	3	2	Angled	3280	3480		
2	3	2	Offset	2630	2800		

Test 6 – Vehicle on 16 degree slope.



Test No.	Chock Type	No. off Chocks	Chock Position	Force (T)			Comments
				1st	2nd	3rd	
5	2	2	Centre				No.2 chocks failed to hold the weight of the vehicle on the slope, therefore this test was not progressed any further.

Turners articulated road tanker tachograph analysis report

MICROSCOPIC TACHOGRAPH CHART EVALUATION.

REPORT PREPARED FOR

MARINE ACCIDENT INVESTIGATION BRANCH.

Report Prepared By: **Keith Lloyd**
c/o Continental Automotive Trading UK Limited
(formerly Siemens VDO Trading Limited)
36 Gravelly Industrial Park
Birmingham B24 8TA

Our Ref: **VK2913/KL**

Date: 30th April 2009

INTRODUCTION

1. The following item was received for evaluation from the Marine Accident Investigation Branch of the Department for Transport:

   Item 002/2009 - a tachograph chart that I understand had been removed from a goods vehicle that had been involved in an incident on a ferry.

2. An enlarged copy of the face of the tachograph chart is shown at Figure 1.

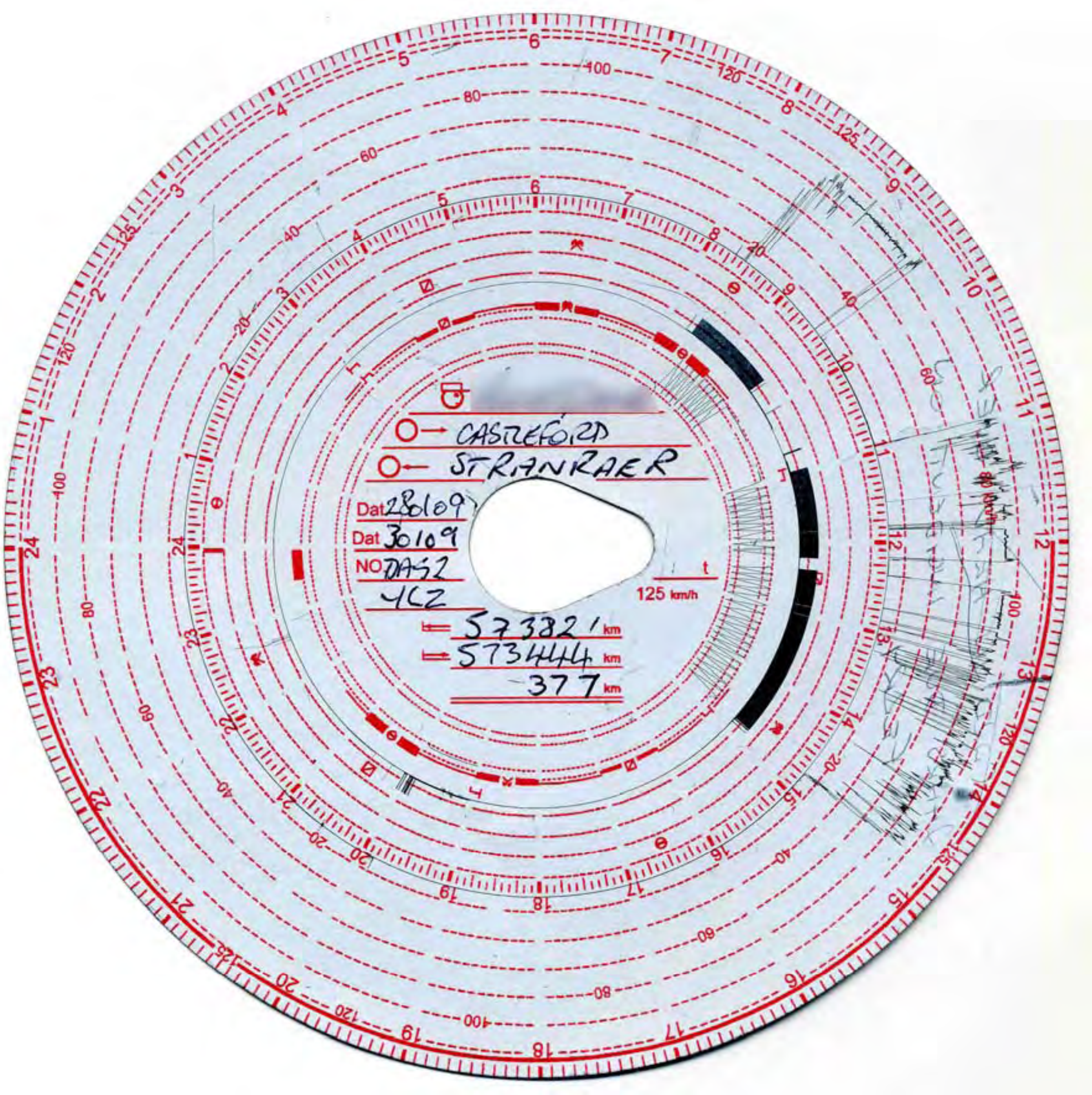


Figure 1

3. I was informed that:

- The vehicle from which the tachograph chart had been removed had boarded a ferry at about 19:50 hours. It was initially asked to reverse off the ferry before being re-boarded.
- By about 20:00 hours, all vehicles had been loaded onto the ferry.
- At about 20:12/20:13 hours the ferry departed.
- At about 20:34 hours a ‘doors open at sea’ alarm was recorded on the ferry.
- It was subsequently discovered that the vehicle had crashed into/through the ferry doors.
- The vehicle was fitted with a Siemens VDO 1324 tachograph.

A TACHOGRAPH (ANALOGUE TYPE)

4. A tachograph is a precision instrument which acts as a speedometer and at the same time records on a circular chart the speed of the vehicle, the distance travelled, and driving and stationary time. Its mechanism incorporates a clock movement and a set of recording styli. Whilst the speed of the vehicle and distance travelled are automatically recorded on the chart with respect to time, the clock on the instrument and the type of work done can be set by the driver and, therefore, may not necessarily be correct. All times quoted subsequently in this report have been read directly from the chart.

PURPOSE OF ANALYSIS

5. I have been requested to analyse the tachograph chart to ascertain any information about the movements of the vehicle that may be relevant to this

incident.

TACHOGRAPH CHART DETAILS

6. As can be seen from Figure 1, the tachograph chart had the following details handwritten on its centre field:

[redacted]	[Driver's name – some characters not clearly written]
CASTLEFORD	[Location at start of duty]
STRANRAER	[Location at end of duty]
28 01 09	[Date at start of duty]
30 1 09	[Date at end of duty]
[redacted]	[Registered number of vehicle – 6th character not clear but either L or C]
573821	[Odometer reading at end of duty in kilometres (kms)
573444	[Odometer reading at start of duty in kilometres (kms)]
377	[Calculated difference in the odometer readings]

7. A breakdown of the recorded vehicle activity is as follows:

CHART TIME	RECORDED ACTIVITY
08:19	Probable start of recordings.
08:19 – 08:20	Short, low speed movement(s) of vehicle.
08:20 – 08:25	Stationary.
08:25 – 09:36	Driving. Vehicle travelled approximately 96 kms (~60 miles).
09:36 – 09:39	Stationary.
09:39	Short, low speed movement(s) of vehicle.
09:39 – 10:01	Stationary.
10:01	Short, low speed movement(s) of vehicle.
10:01 – 10:39	Stationary.
10:39 – 10:40	Short, low speed movement(s) of vehicle.
10:40 – 10:56	Stationary.

10:56 – 12:11	Driving. Vehicle travelled approximately 100 kms (~62 miles).
12:11 – 12:21	Stationary.
12:21 – 14:45	Driving. Vehicle travelled approximately 181 kms (~112 miles).
14:45 – 14:46	Stationary.
14:46 – 14:47	Short, low speed movement(s) of vehicle.
14:47 – 14:49	Stationary.
14:49 – 14:50	Short, low speed movement(s) of vehicle.
14:50 – 19:49	Stationary.
19:49 – 19:50	Short, low speed movement(s) of vehicle.
19:50 – 19:51	Stationary.
19:51 – 19:56	Series of short, low speed movements of vehicle. These movements covered a total distance of at least 180 metres, possibly around 350 metres. Speed during these movements did not exceed about 16kph (10mph).
19:56 – 19:58	Stationary. The vehicle's ignition was OFF throughout this period.
19:58 – 19:59	Short, low speed movement(s) of vehicle. Speed no higher than about 6-7kph (~4mph). The vehicle probably travelled no more than a few metres, possibly 'tens of metres' but not 'hundreds of metres'.
19:59 – 20:00	Stationary.
20:00 – 20:01	Short, low speed movement(s) of vehicle. Speed no higher than about 6-7kph (~4mph). The vehicle probably travelled no more than a few metres, possibly 'tens of metres' but not 'hundreds of metres'.
20:01 – 20:13	Stationary. The vehicle's ignition was OFF throughout this period.
20:13	Short, low speed movement. Speed no higher than about 6-7kph (~4mph). It is not possible to determine the distance travelled but it was probably no more than a few metres. This movement may well have occurred while the vehicle's ignition was OFF. It is likely that this movement was on the same day as the movements leading up to 20:01 hours but I can not be totally certain of this.
20:13 – 20:31	Stationary. The vehicle's ignition was OFF throughout this period.
20:31	Short, low speed movement. Speed no higher than about 8kph

	(~5mph). It is not possible to determine the distance travelled but it was probably no more than a few metres. This movement may well have occurred while the vehicle's ignition was OFF. During this movement there was a disturbance to the recording consistent with the vehicle suffering an impact or substantial 'jolt'. It is likely that this movement was on the same day as the movements leading up to 20:01 hours but I can not be totally certain of this.
20:31 – 22:35	Stationary. The vehicle's ignition was OFF throughout this period. This period may have been in excess of 24 hours.
22:35 – 22:40	Series of short, low speed movements. Speed no higher than about 6-7kph (~4mph). It is not possible to determine the distance travelled but it was probably no more than a few metres. These movements may well have occurred while the vehicle's ignition was OFF.
22:40 – 11:30	Stationary. The vehicle's ignition was probably OFF throughout this period. This period may have been in excess of 24 hours.
11:30 – 11:34	Vehicle stationary but probably with its ignition ON. The tachograph chart was ejected from the tachograph at about 11:34 hours.

Please note that:

- Times are quoted to the nearest whole minute.

- Tachographs have a threshold below which they do not register vehicle movement. Without testing the whole tachograph installation in the vehicle I am unable to state, with absolute certainty, what the threshold for this tachograph/vehicle would be. However, with this type of tachograph, it is likely that movements of only a few metres (possibly as little as about 3 metres) will be registered by the tachograph. Low speed movements (below about 6-7kph) may not be registered on the speed recording but are often recorded on the driver's activity (mode) recording, the tachograph recording a very brief period of DRIVING activity.

- It is not possible to determine if any of the movements were in reverse, as the tachograph does not differentiate between forward and reverse movements.

- Where reference is made to vehicle movement in the above table, this indicates that one or more wheels on the driven axle of the vehicle was rotating. If the vehicle was sliding with the wheels on its driven axle 'locked' ie. not rotating, the tachograph would record the vehicle as being stationary.

DISCUSSION

8. In my opinion, the recorded journeys/periods of driving are consistent with the vehicle travelling from Castleford to Stranraer, as indicated on the centre field of the chart. The route taken was predominantly along the A1(M), A1, A66, M6 and A75 roads. The major 'stops' at 09:36-10:56 and 12:11-12:21 hours chart time were, in my opinion, at a location on or adjacent to the A66 road approximately 8 kms (~5 miles) west of Scotch Corner and at a location a short distance from junction 42 of the M6 motorway (there is a truck stop near this junction) respectively.

9. There are no recorded breaches of Driver's Hours Regulations shown on the tachograph chart. However, as I have only received one tachograph chart, I can not determine if the driver had taken sufficient Daily/Weekly Rest prior to commencing duty on the date in question.

10. I have no information that would allow me to definitively correlate the tachograph chart times with the various event timings provided ie. the time that the ferry departed or the 'doors open at sea' alarm. However, the chart recordings appear to give relatively close correlation with some of the times provided. Based on this, it is likely that:

    - The short, low speed movements recorded on the tachograph chart between 19:49 and 20:01 hours were when the vehicle was boarding the ferry.

- The short movement recorded at about 20:13 hours chart time would have been around the time that the ferry departed from the port.

- The movement and 'impact' recorded at about 20:31 hours chart time would have been when the vehicle crashed into/through the ferry doors.

11. An enlargement of the tachograph chart recording around 19:00-21:00 hours is shown at Figure 2.

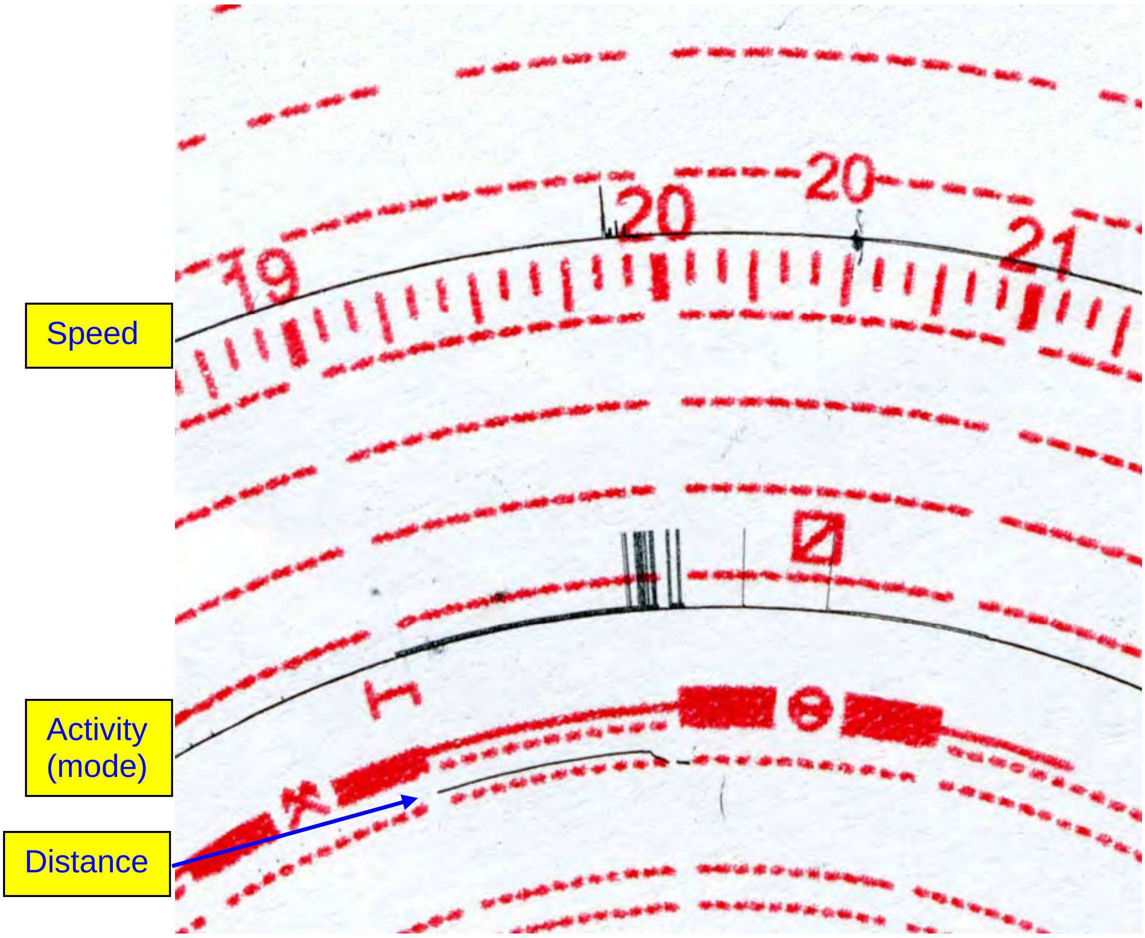


Figure 2

ON BEHALF OF CONTINENTAL AUTOMOTIVE TRADING UK LIMITED

Keith Lloyd

IMO resolution A.581 (14)

RESOLUTION A.581(14)

Adopted on 20 November 1985
Agenda item 10(b)

GUIDELINES FOR SECURING ARRANGEMENTS FOR THE TRANSPORT OF ROAD VEHICLES ON RO-RO SHIPS

THE ASSEMBLY,

RECALLING Article I5(j) of the Convention on the International Maritime Organization concerning the functions of the Assembly in relation to regulations and guidelines concerning maritime safety,

RECALLING ALSO resolution A.489(XII) on safe stowage and securing of cargo units and other entities in ships other than cellular containerships and MSC/Circ.385 of 8 January I985 containing the provisions to be included in a cargo securing manual to be carried on board ships,

BEARING IN MIND resolution A.533(I3) on elements to be taken into account when considering the safe stowage and securing of cargo units and vehicles in ships,

TAKING ACCOUNT of the revised IMO/ILO Guidelines for the Packing of Cargo in Freight Containers and Vehicles,

RECOGNIZING that the marine transport of road vehicles on ro-ro ships is increasing,

RECOGNIZING ALSO that a number of serious accidents have occurred because of inadequate securing arrangements on ships and road vehicles,

RECOGNIZING FURTHER the need for the Organization to establish guidelines for securing arrangements on board ro-ro ships and on road vehicles,

REALIZING that given adequately designed ships and properly equipped road vehicles, lashings of sufficient strength will be capable of withstanding the forces imposed on them during the voyage,

REALIZING FURTHER that certain requirements for side guards, particularly those positioned very low on road vehicles, will obstruct the proper securing of the road vehicles on board ro-ro ships and that appropriate measures will have to be taken to satisfy both safety aspects,

BELIEVING that application of the guidelines will enhance safety in the transport of road vehicles on ro-ro ships and that this can be achieved on an international basis,

HAVING CONSIDERED the recommendation made by the Maritime Safety Committee at its fifty-first session,

1. ADOPTS the Guidelines for Securing Arrangements for the Transport of Road Vehicles on Ro-ro Ships set out in the Annex to the present resolution;

2. URGES Member Governments to implement these Guidelines at the earliest possible opportunity in respect of new ro-ro ships and new vehicles and, as far as practicable, in respect of existing vehicles which may be transported on ro-ro ships;

3. REQUESTS the Secretary-General to bring these Guidelines to the attention of Member Governments and relevant international organizations responsible for safety in design and construction of ships and road vehicles for action as appropriate.

ANNEX

GUIDELINES FOR SECURING ARRANGEMENTS FOR THE TRANSPORT OF ROAD VEHICLES ON RO-RO SHIPS

PREAMBLE

In view of experience in the transport of road vehicles on ro-ro ships, it is recommended that these Guidelines for securing road vehicles on board such ships should be followed. Shipowners and shipyards, when designing and building ro-ro ships to which these Guidelines apply, should take sections 4 and 6 particularly into account. Manufacturers, owners and operators of road vehicles which may be transported on ro-ro ships should take sections 5 and 7 particularly into account.

1 SCOPE

1.1 These Guidelines for securing and lashing road vehicles on board ro-ro ships outline in particular the securing arrangements on the ship and on the vehicles, and the securing methods to be used.

2 APPLICATION

2.1 These Guidelines apply to ro-ro ships which regularly carry road vehicles on either long or short international voyages in unsheltered waters. They concern:

.1 road vehicles as defined in 3.2.l, 3.2.2, 3.2.3 and 3.2.5 with an authorized maximum total mass of vehicles and cargo of between 3.5 and 40 tonnes; and

.2 articulated road trains as defined in 3.2.4 with a maximum total mass of not more than 45 tonnes, which can be carried on ro-ro ships.

2.2 These Guidelines do not apply to buses.

2.3 For road vehicles having characteristics outside the general parameters for road vehicles (particularly where the normal height of the centre of gravity is exceeded), the location and the number of securing points should be specially considered.

3 DEFINITIONS

3.1 *"**Ro-ro ship**"* means a ship which has one or more decks either closed or open, not normally subdivided in any way and generally running the entire length of the ship, in which goods (packaged or in bulk, in or on road vehicles (including road tank-vehicles), trailers, containers, pallets, demountable or portable tanks or in or on similar cargo transport units or other receptacles) can be loaded or unloaded normally in a horizontal direction.

3.2 In these Guidelines the term road vehicle[1] includes:

.1 ***Commercial vehicle*** which means a motor vehicle which, on account of its design and appointments, is used mainly for conveying goods. It may also be towing a trailer.

.2 ***Semi-trailer*** which means a trailer which is designed to be coupled to a semi-trailer towing vehicle and to impose a substantial part of its total mass on the towing vehicle.

.3 ***Road train*** which means the combination of a motor vehicle with one or more independent trailers connected by a draw-bar. (For the purpose of section 5 each element of a road train is considered a separate vehicle.)

.4 ***Articulated road train*** which means the combination of a semi-trailer towing vehicle with a semi-trailer.

.5 ***Combination of vehicles*** which means a motor vehicle coupled with one or more towed vehicles. (For the purpose of section 5 each element of a combination of vehicles is considered a separate vehicle.)

4 SECURING POINTS ON SHIPS' DECKS

4.1 The ship should carry a Cargo Securing Manual in accordance with resolution A.489(XII) containing the information listed and recommended in paragraph I0 of the Annex to that resolution.

4.2 The decks of a ship intended for road vehicles as defined in 3.2 should be provided with securing points. The arrangement of securing points should be left to the discretion of the shipowner provided that for each road vehicle or element of a combination of road vehicles, there is the following minimum arrangement of securing points:

.1 The distance between securing points in the longitudinal direction should in general not exceed 2.5 m. However, there may be a need for the securing points in the forward and after parts of the ship to be more closely spaced than they are amidships.

.2 The thwartships spacing of securing points should not be less than 2.8 m nor more than 3 m. However, there may be a need for the securing points in the forward and after parts of the ship to be more closely spaced than they are amidships.

.3 The minimum strength without permanent deformation of each securing point should be I20 kN. If the securing point is designed to accommodate more than one lashing (y lashings) the corresponding strength should be not less than y x I20 kN.

4.3 In ro-ro ships which only occasionally carry road vehicles, the spacing and strength of securing points should be such that the special considerations which may be necessary to stow and secure road vehicles safely are taken into account.

5 SECURING POINTS ON ROAD VEHICLES

5.1 Securing points on road vehicles should be designed for securing the road vehicles to the ship and should have an aperture capable of accepting only one lashing. The securing

[1] Reference is made to ISO Standard No. 3833 (under revision).

point and aperture should permit varying directions of the lashing to the ship's deck[1].

5.2 The same number of not less than two or more than six securing points should be provided on each side of the road vehicle in accordance with the provisions of 5.3.

5.3 Subject to the provisions of notes I, 2 and 3 hereunder, the minimum number and minimum strength of securing points should be in accordance with the following table:

Gross vehicle mass (GVM) tonnes	Minimum number of securing points on each side of the road vehicle	Minimum strength without permanent deformation of each securing point as fitted (kN)
$3.5\ t \leqslant GVM \leqslant 20\ t$	2	$\dfrac{GVM \times 10 \times 1.2}{n^{*}}$
$20\ t < GVM \leqslant 30\ t$	3	
$30\ t < GVM \leqslant 40\ t$	4	

* Where n is the total number of securing points on each side of the road vehicle.

Note 1: For road trains, the table applies to each component, i.e. to the motor vehicle and each trailer, respectively.

Note 2: Semi-trailer towing vehicles are excluded from the table above. They should be provided with two securing points at the front of the vehicle, the strength of which should be sufficient to prevent lateral movement of the front of the vehicle. A towing coupling at the front may replace the two securing points.

Note 3: If the towing coupling is used for securing vehicles other than semi-trailer towing vehicles, this should not replace or be substituted for the above-mentioned minimum number and strength of securing points on each side of the vehicle.

5.4 Each securing point on the vehicle should be marked in a clearly visible colour.

5.5 Securing points on vehicles should be so located as to ensure effective restraint of the vehicle by the lashings.

5.6 Securing points should be capable of transferring the forces from the lashings to the chassis of the road vehicle and should never be fitted to bumpers or axles unless these are specially constructed and the forces are transmitted directly to the chassis.

5.7 Securing points should be so located that lashings can be readily and safely attached, particularly where side-guards are fitted to the vehicle.

5.8 The internal free passage of each securing point's aperture should be not less than 80 mm but the aperture need not be circular in shape.

5.9 Equivalent or superior securing arrangements may be considered for vehicles for which the provisions of table 5.3 are unsuitable.

[1] If more than one aperture is provided at a securing point, each aperture should have the strength for the securing point in the table in 5.3.

6 LASHINGS

6.1 Lashings should consist of chain or any other device and be made of material having strength and elongation characteristics at least equivalent to those of steel chain. The strength of the lashings, without permanent deformation, should be not less than 120 kN.

6.2 Lashings should be so designed and attached that, provided there is safe access, it is possible to tighten them if they become slack. Where practicable and necessary, the lashings should be examined at regular intervals during the voyage and tightened as necessary.

6.3 Lashings should be attached to the securing points with hooks or other devices so designed that they cannot disengage from the aperture of the securing point if the lashing slackens during the voyage.

6.4 Only one lashing should be attached to any one aperture of the securing point on the vehicle.

6.5 Lashings should only be attached to the securing points provided for that purpose.

6.6 Lashings should be attached to the securing points on the vehicle in such a way that the angle between the lashing and the horizontal and vertical planes lies preferably between 30° and 60°.

6.7 Bearing in mind the characteristics of the ship and the weather conditions expected on the intended voyage, the master should decide on the number of securing points and lashings to be used for each voyage.

6.8 Where there is doubt that a road vehicle complies with the provisions of table 5.3, the master may, at his discretion, load the vehicle on board, taking into account the apparent condition of the vehicle, the weather and sea conditions expected on the intended voyage and all other circumstances.

7 STOWAGE

7.1 Depending on the area of operation, the predominant weather conditions and the characteristics of the ship, road vehicles should be stowed so that the chassis are kept as static as possible by not allowing free play in the suspension of the vehicles. This can be done, for example, by compressing the springs by tightly securing the vehicle to the deck, by jacking up the chassis prior to securing the vehicle or by releasing the air pressure on compressed air suspension systems.

7.2 Taking into account the conditions referred to in 7.1 and the fact that compressed air suspension systems may loose air, the air pressure should be released on every vehicle fitted with such a system if the voyage is of more than 24 hours duration. If practicable, the air pressure should be released also on voyages of a shorter duration. If the air pressure is not released, the vehicle should be jacked up to prevent any slackening of the lashings resulting from any air leakage from the system during the voyage.

7.3 Where jacks are used on a vehicle, the chassis should be strengthened in way of the jacking-up points and the position of the jacking-up points should be clearly marked.

7.4 Special consideration should be given to the securing of road vehicles stowed in positions where they may be exposed to additional forces. Where vehicles are stowed athwartship, special consideration should be given to the forces which may arise from such stowage.

7.5 Wheels should be chocked to provide additional security in adverse conditions.

7.6 Vehicles with diesel engines should not be left in gear during the voyage.

7.7 Vehicles designed to transport loads likely to have an adverse effect on their stability, such as hanging meat, should have integrated in their design a means of neutralizing the suspension system.

7.8 Stowage should be arranged in accordance with the following:

.1 The parking brakes of each vehicle or of each element of a combination of vehicles should be applied and locked.

.2 Semi-trailers, by the nature of their design, should not be supported on their landing legs during sea transport unless the landing legs are specially designed for that purpose and so marked. An uncoupled semi-trailer should be supported by a trestle or similar device placed in the immediate area of the drawplate so that the connection of the fifth-wheel to the kingpin is not restricted. Semi-trailer designers should consider the space and the reinforcements required and the selected areas should be clearly marked.

Annex G

Summary of key ISO 9367 requirements

Summary of key ISO9367 requirements:

ISO 9367-1: Lashing and securing arrangements on road vehicles for sea transportation on Ro/Ro ships – General requirements – Part 1: Commercial vehicles and combination vehicles, semi-trailers excluded.

ISO 9367-2: Lashing and securing arrangements on road vehicles for sea transportation on Ro/Ro ships – General requirements – Part 2: Semi-trailers.

<u>Securing points on road vehicles:</u>

- Securing points shall be designed to enable the road vehicle to be secured to the ship.
- Each securing point shall have at least one lashing point…
- The securing point and lashing point shall allow different angles of lashing to the ships deck.
- The same number of securing points shall be provided on each side of the road vehicle. The number and minimum strength of securing points shall be in accordance with table 1.
- Securing points shall be capable of transferring the forces from the lashings to the chassis of the road vehicle.

Table 1 – Number and strength of securing points

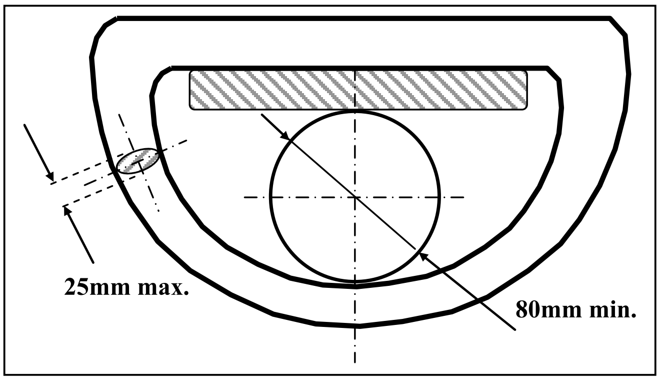
<table>
<tr><th rowspan="2">Maximum design total mass
ISO-MO7
(according to-ISO 1176)</th><th colspan="2">Number of securing points on each side of vehicle</th><th rowspan="2">Value of load to be used for calculation or test of each securing point
F, kN</th></tr>
<tr><th>min.</th><th>max.</th></tr>
<tr><td>3.5t ≤ ISO-MO7 ≤ 20t</td><td>2</td><td>6</td><td rowspan="3">$F = \frac{1{,}2(\text{ISO-MO7 x } g)}{n}$
Where
g is the acceleration due to gravity, i.e. 9.80665 m/s²

n is the total number of securing points on either side of the vehicle. (in exceptional cases, due to design, more than the maximum number of securing points is permitted)</td></tr>
<tr><td>20t < ISO-MO7 ≤ 30t</td><td>3</td><td>6</td></tr>
<tr><td>30t < ISO-MO7 ≤ 40t</td><td>4</td><td>6</td></tr>
<tr><td colspan="4">Notes:
1: For road trains, table 1 applies to each component, i.e. to the motor vehicle and each trailer respectively.
2: Semi-trailer towing vehicles are excluded from the table above. They should be provided with two securing points at the front of the vehicle, the strength of which should be sufficient to prevent lateral movement of the front of the vehicle. A towing coupling at the front may replace the two securing points.
3: If the towing coupling is used for securing vehicles other than semi-trailer towing vehicles, this shall not replace the number and minimum strength of securing points on each side of the vehicle given in table 1.</td></tr>
</table>

Lashing points:

Each lashing point, when assembled at the securing point, shall allow the inside free passage of a circle of at least 80mm diameter, but the aperture need not be circular. The thickness of the lashing point material shall allow engagement of a hook of at least 25mm opening (see figure 1).

Figure 1 – Free passage and lashing point material thickness



Location on vehicle:

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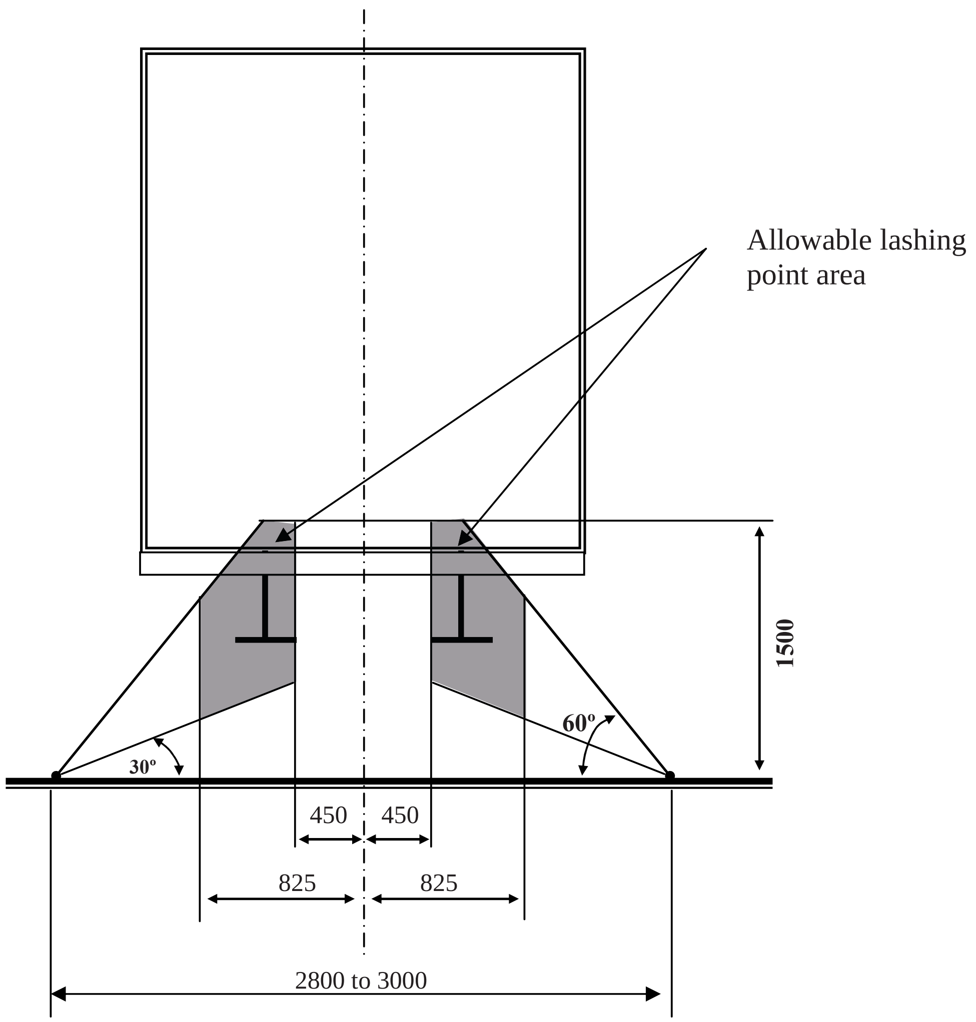
- The securing points on vehicles shall be so located as to ensure effective restraint of the vehicle by the lashings and allow lashings to be readily and safely attached.

- Securing points should be positioned in such a way that the angle between the lashing and the horizontal and transverse planes lies preferably between 30º and 60º.

- Lashing points should preferably be set two by two on the vehicle symmetrical to its longitudinal axis.

- Lashing points shall be located within defined areas on the semi-trailer.

Figure 2 – Allowable vertical and transverse lashing point areas on laden semi-trailers



Marking:

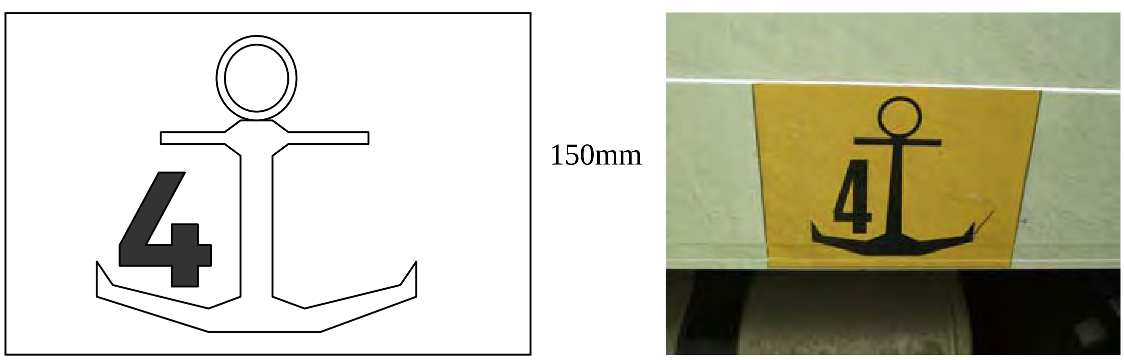
So as to ensure easy recognition of the securing arrangements on a vehicle or trailer intended for sea transportation of goods, the markings below are required:

- Each point on the vehicle chassis shall be painted in a contrasting colour. If the body type permits the marking shall be repeated on the vehicle structure outside surface:

- A plate measuring 200mm x 150mm shall be affixed permanently on both sides of the vehicle at or within 1.6m from the front end. If due to operational conditions further plates are necessary, they may be fitted.

- Markings on the plate shall comprise a number indicating the number of lashing points per side and a sketch of an anchor:

Figure 3 – Information plate example



200mm

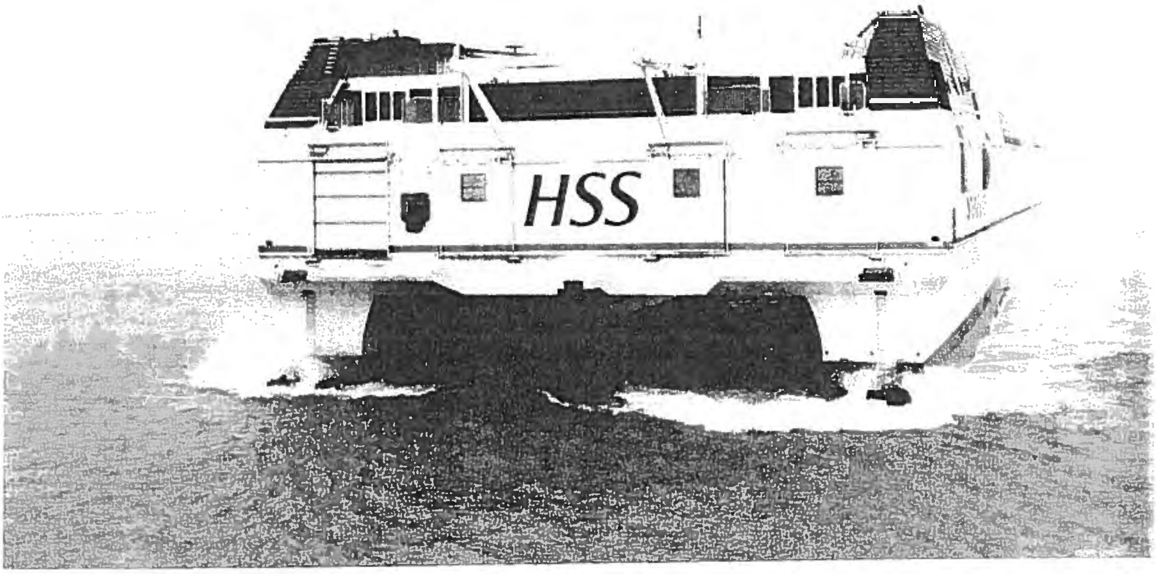
2001 *Stena Discovery* trials

POLITIE
• ROTTERDAM-RIJNMOND
• Regionale Operationele Ondersteunende Diensten

Afschrift

EENHEID	:	**VERKEERSPOLITIE**
AFDELING	:	**TECHNISCHE- EN ONGEVALLENDIENST**
TOD Nr .	:	0192/2001
RAPP. TOD	:	[redacted]
BETREFT	:	Onderzoek scheepvaart ongeval
DAG	:	donderdag
DATUM	:	15 maart 2001
TIJD	:	16:20 uur
LOKATIE	:	Veerboot "Stena Discovery"
PLAATS	:	Noordzee, Hoek van Holland
DISTRICT	:	12
BUREAU	:	Rivierpolitie basiseenheid Stad
O.V.V.	:	[redacted]
BIJZ.	:	Alleen zware materiele schade, start onderzoek woensdag 21 maart 2001.

VOA



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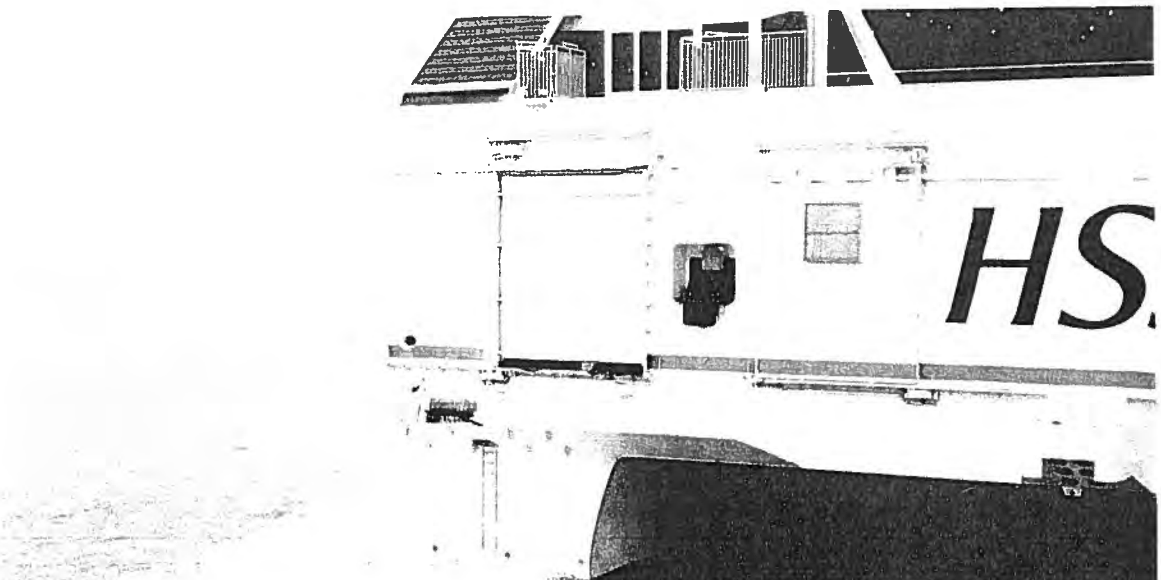

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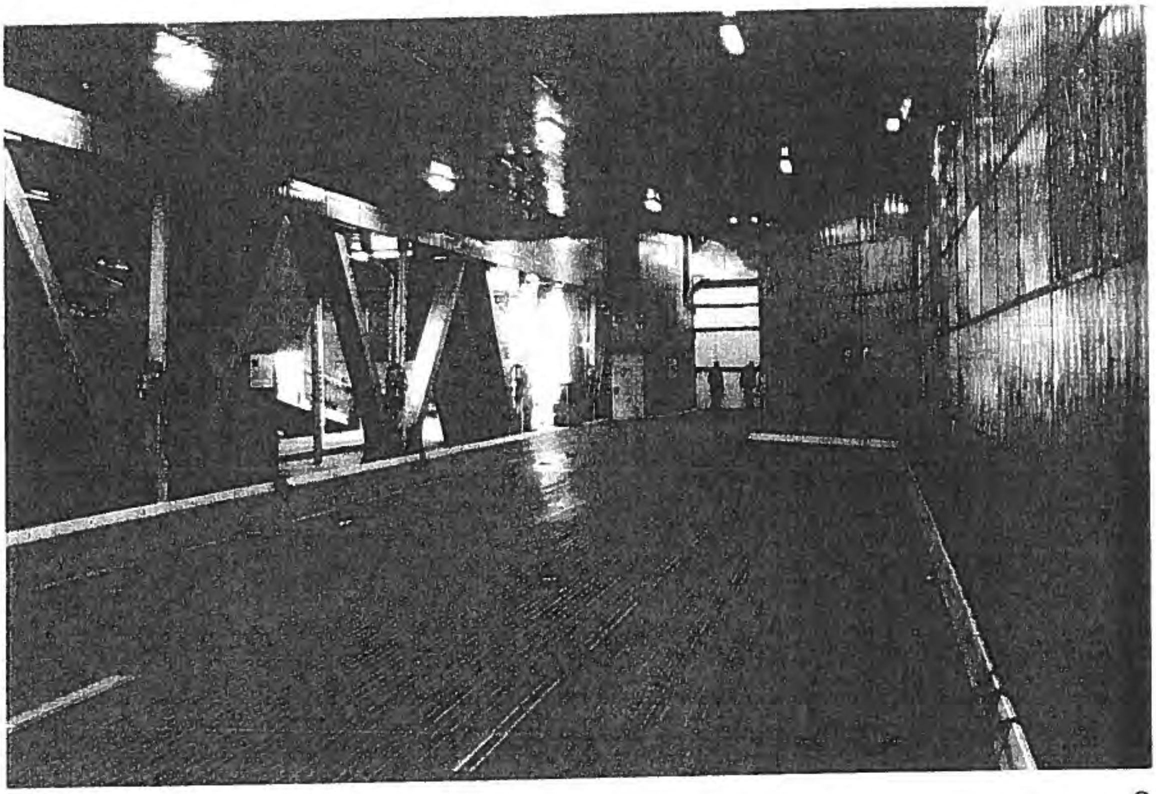

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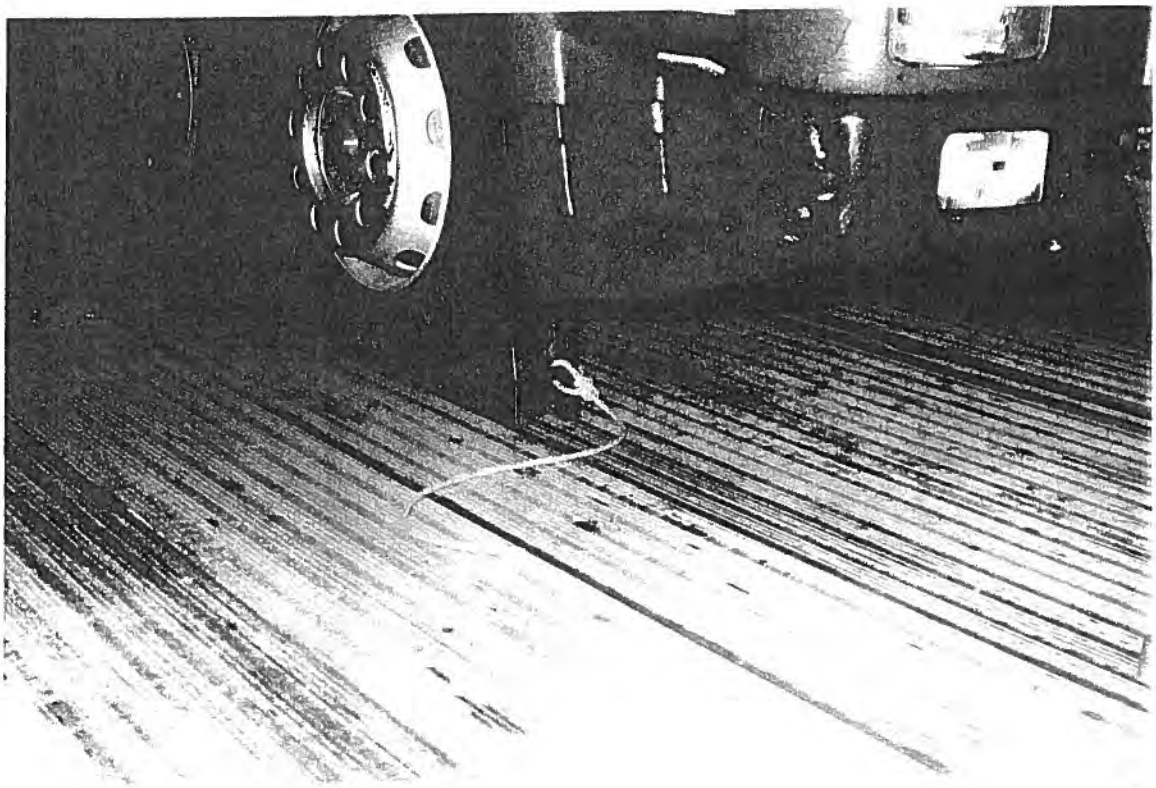
No Smoking
Park in Gear with Handbrake On
Beware - Moving Vehicles
Do Not Start Engine Until Instructed
No Access to Car Deck at Sea
Stena Line

4



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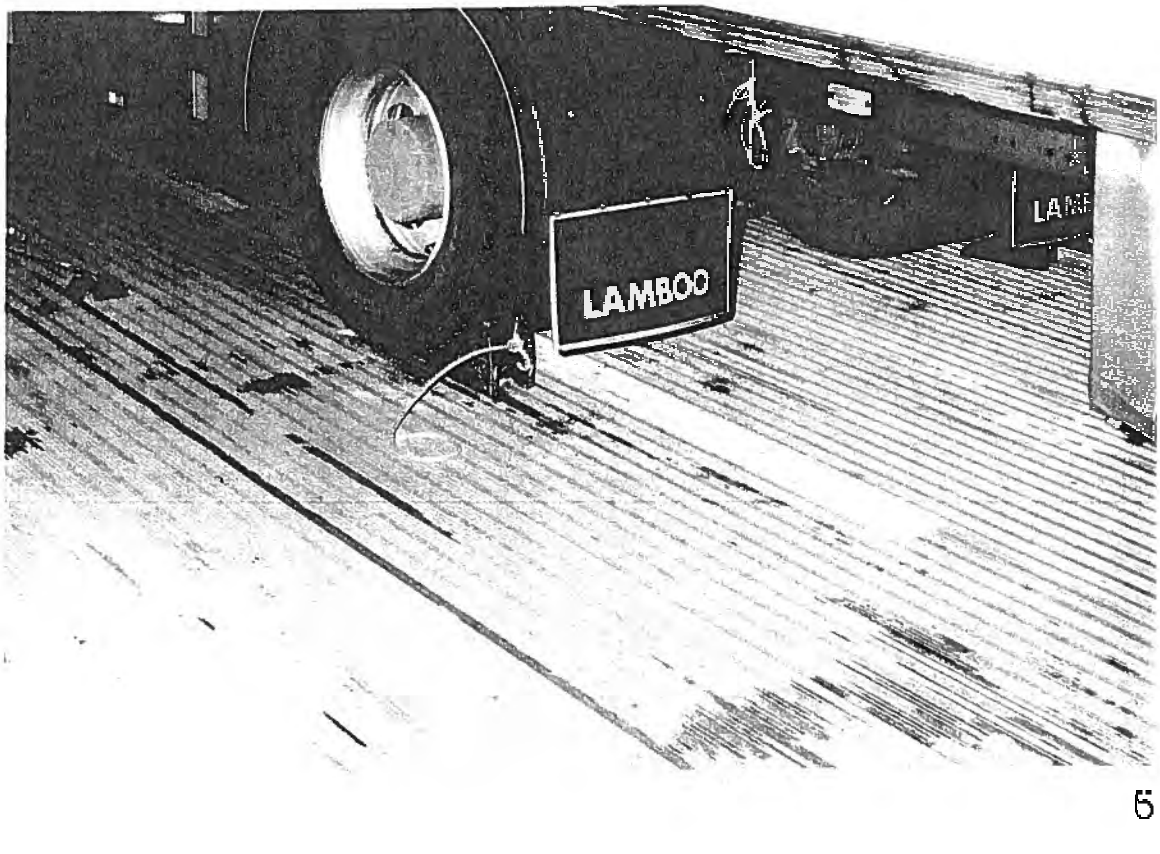

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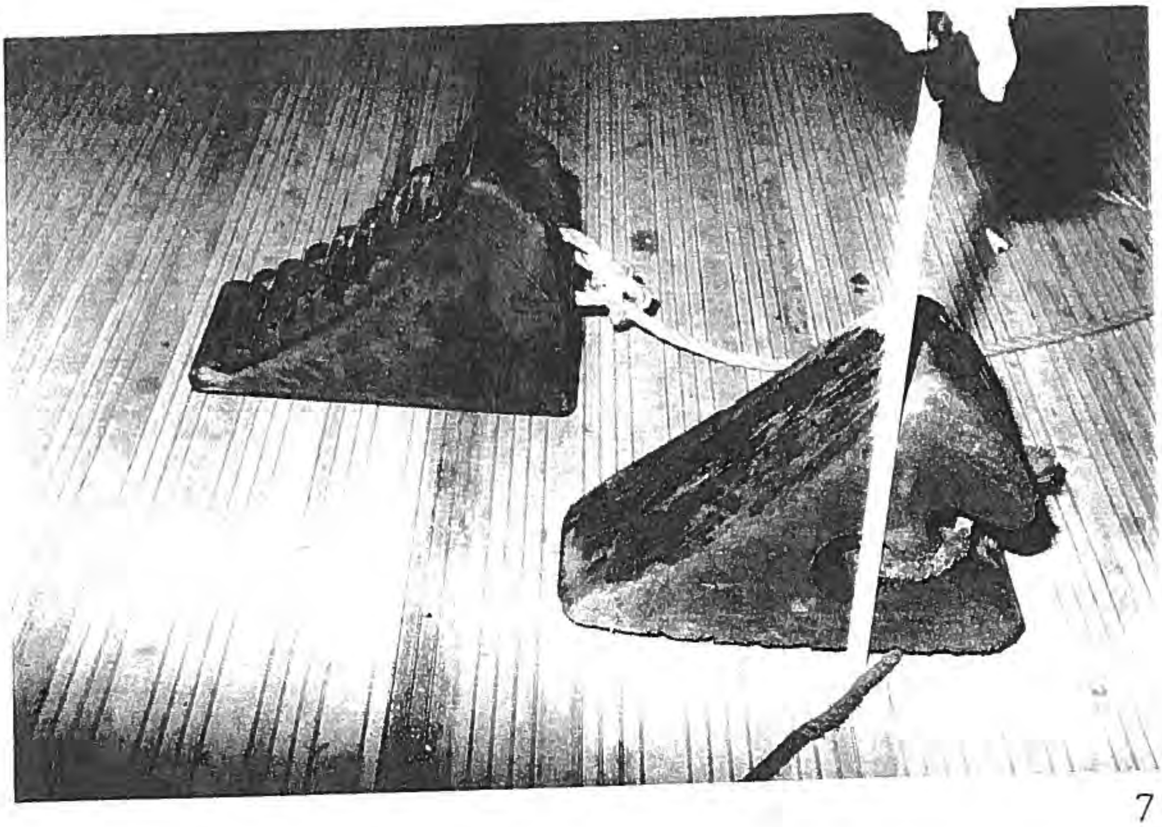

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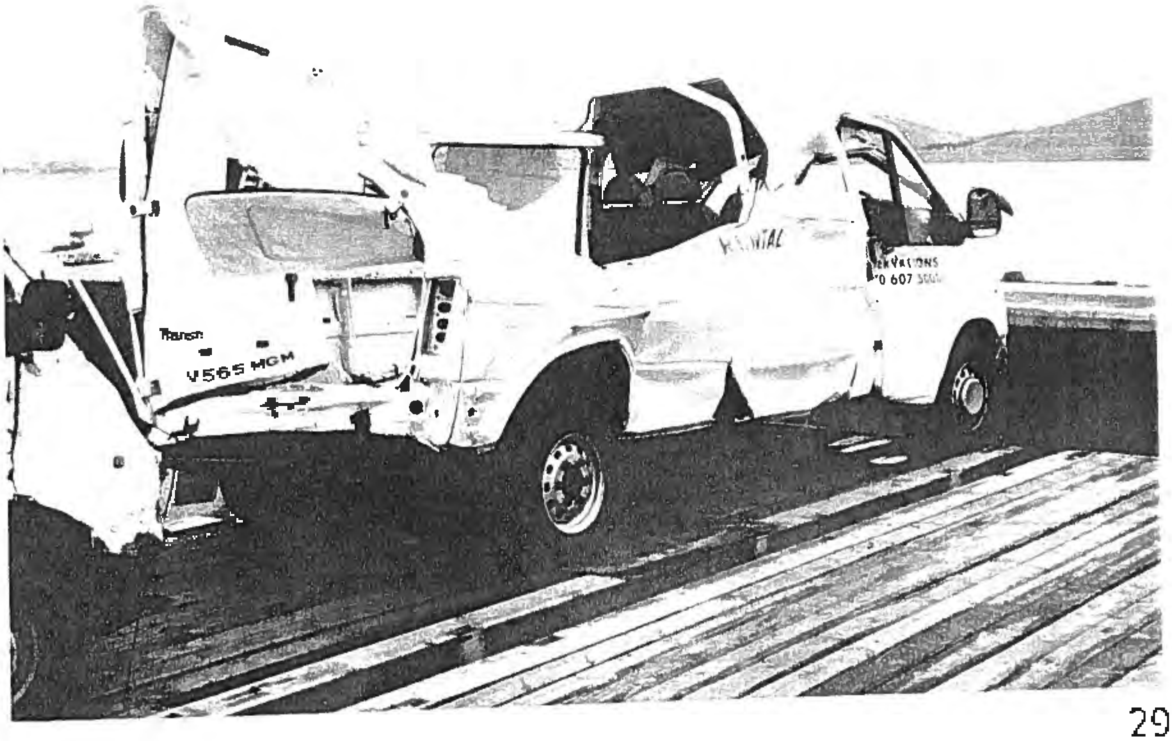

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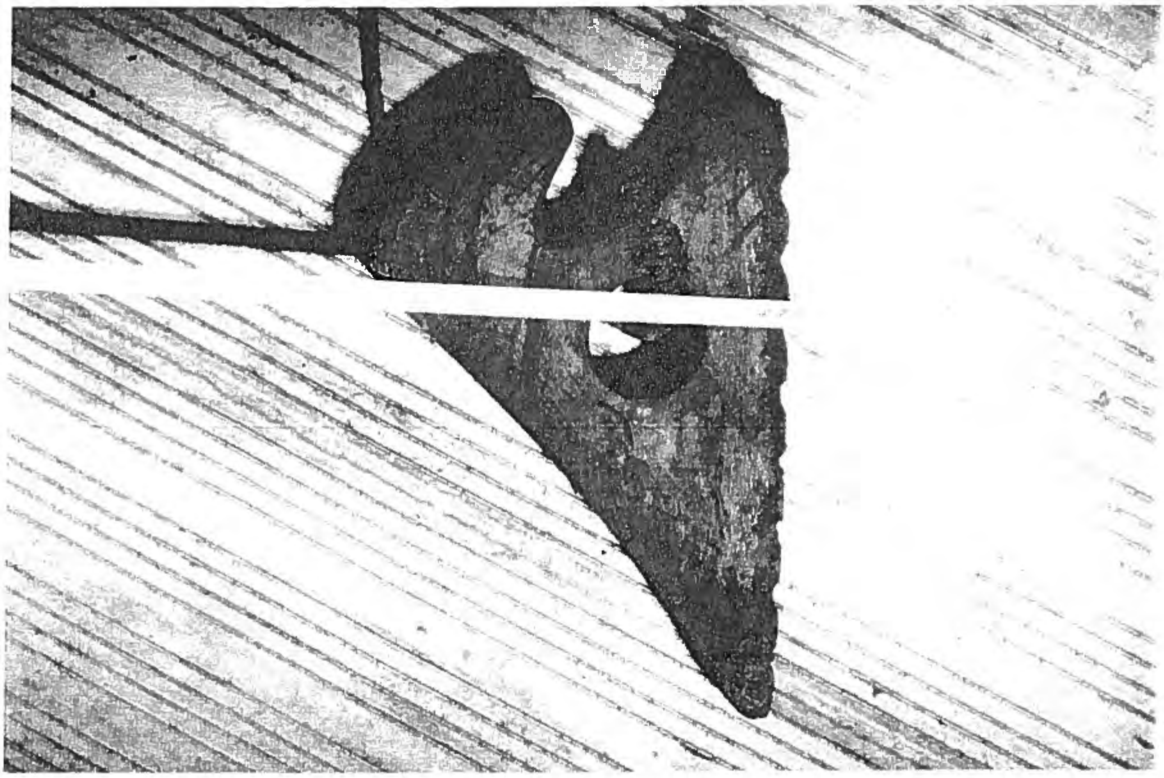

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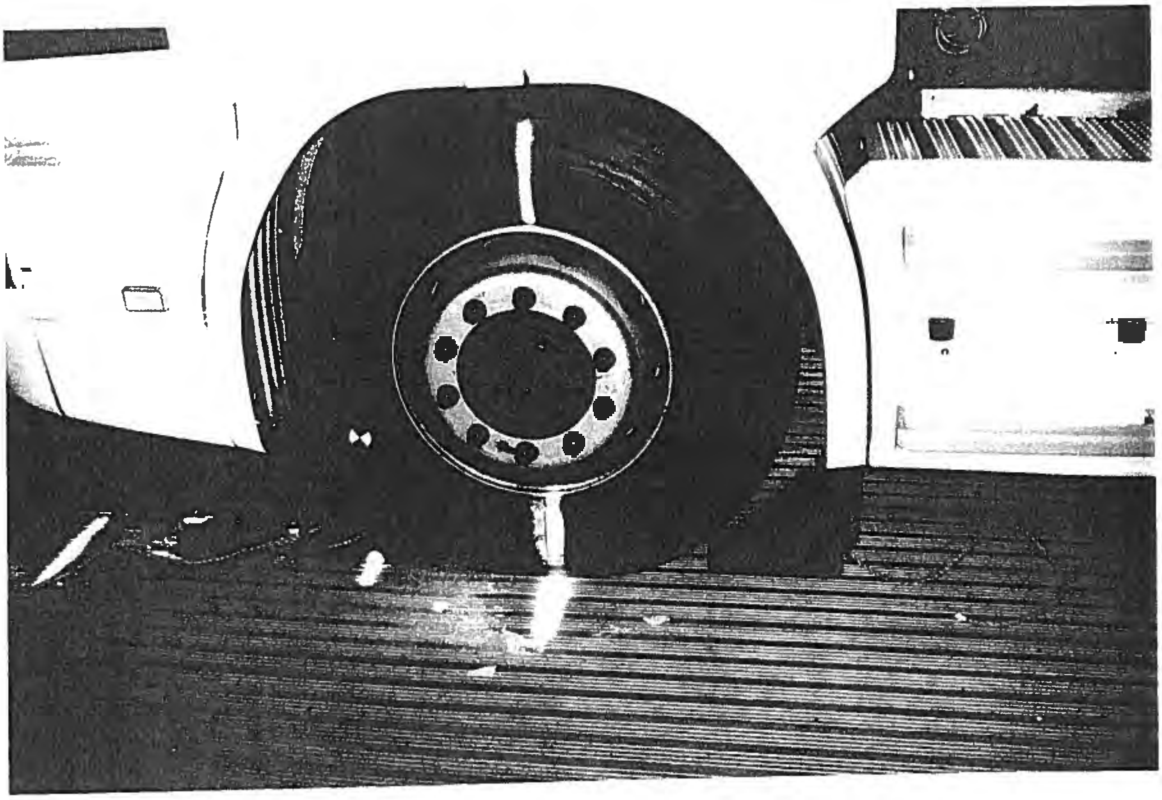

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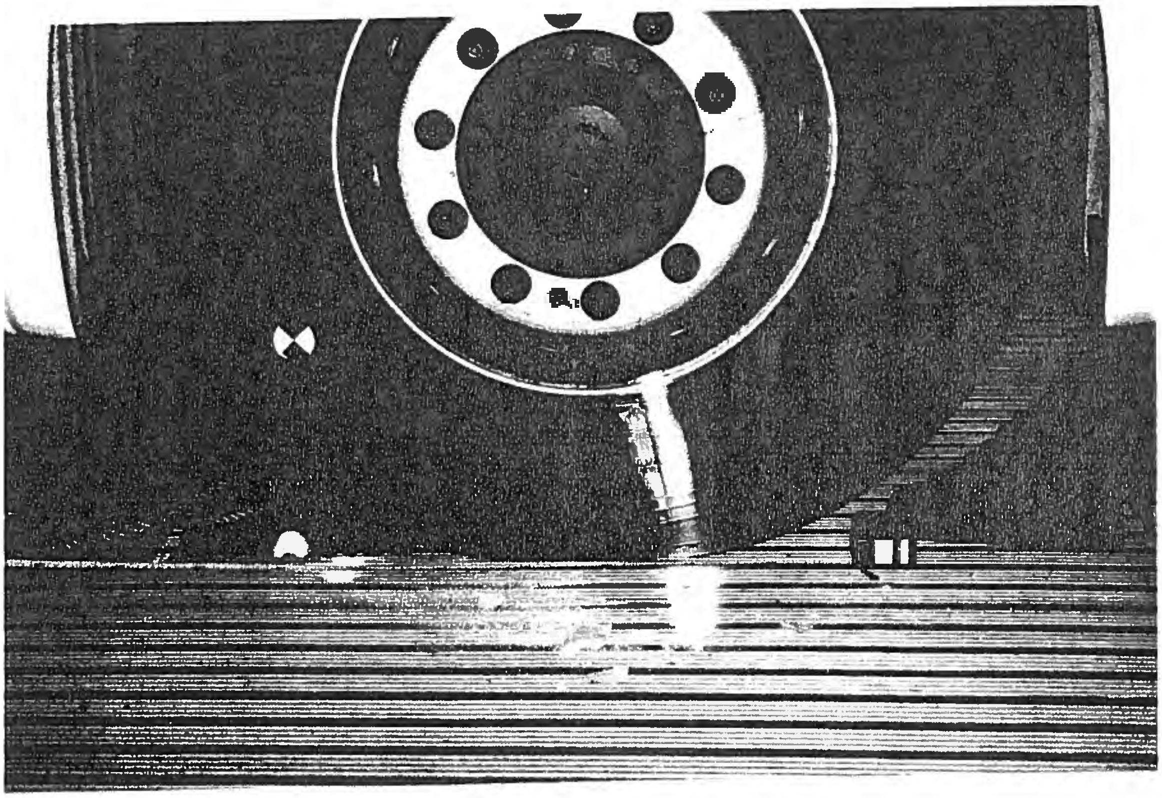

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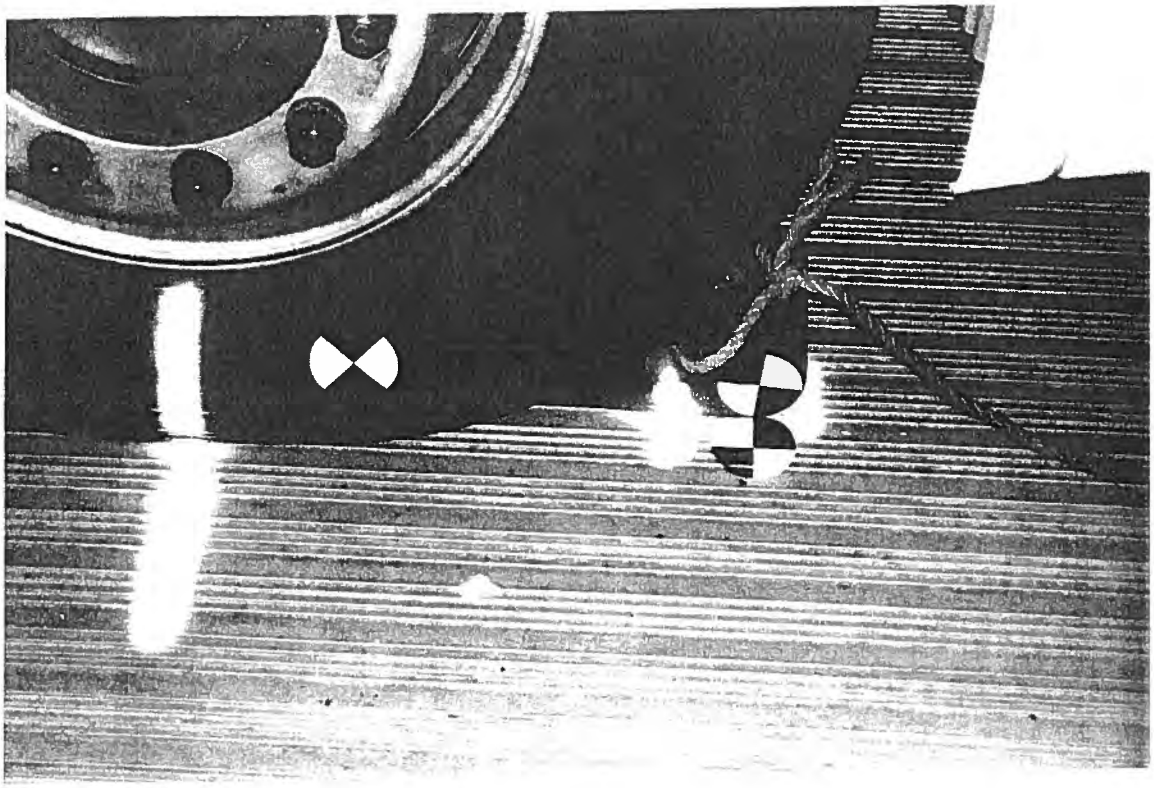

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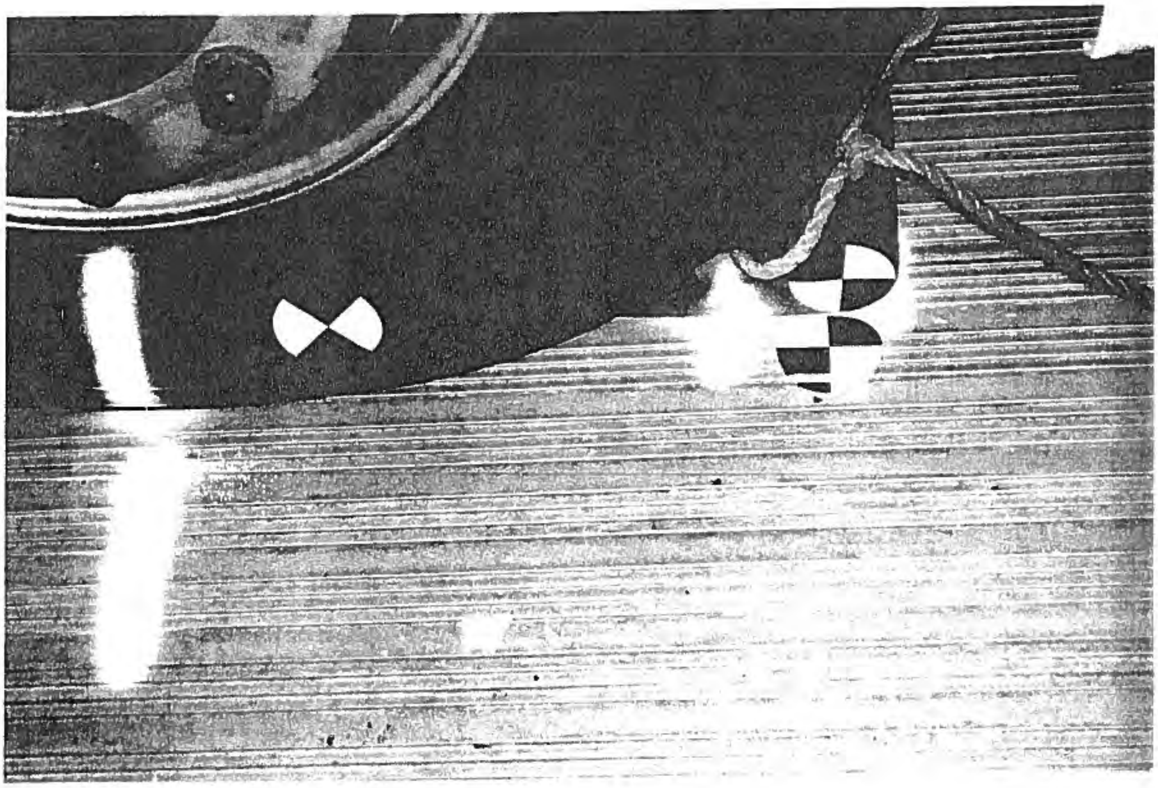

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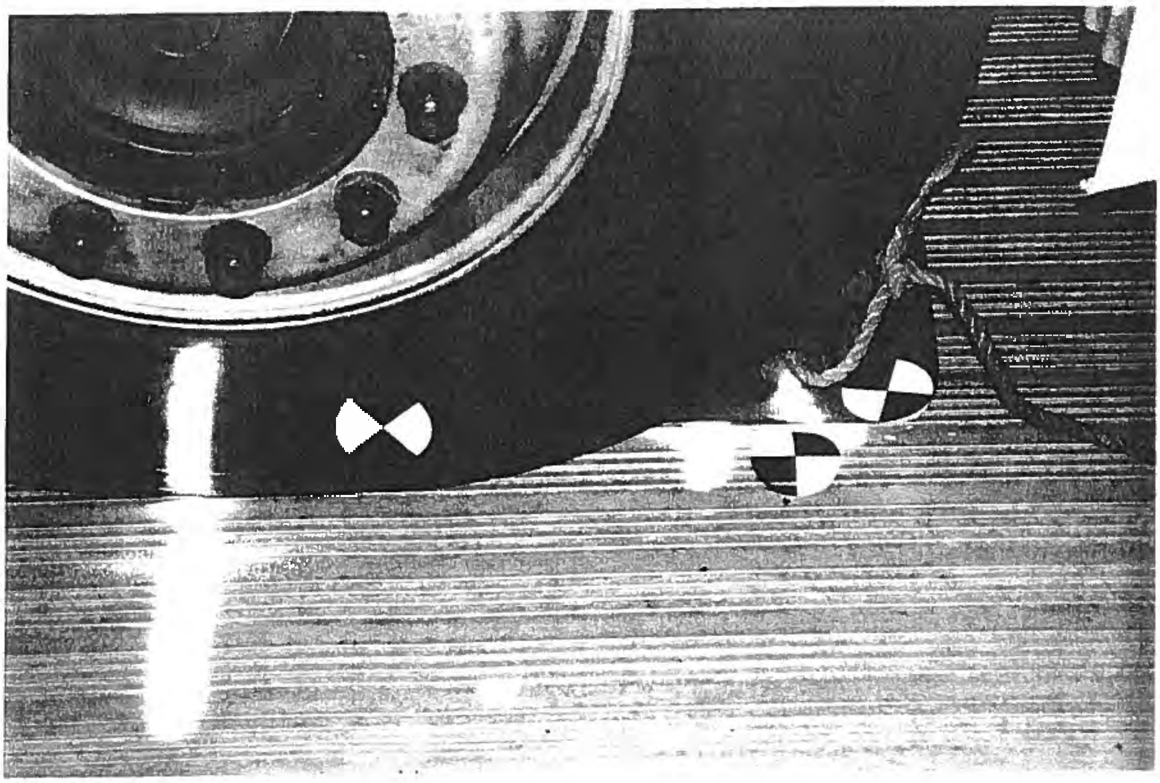

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