



**ELLEBOGEN 75 & 100**

# FATIGUE TEST REPORT

 ELLEBOGEN

# Introduction

- The aim of this document is to summarize the results of the fatigue test that has been carried out with a Ellebogen 75 (Ref. 128270-08341) and Ellebogen 100 (Ref. 128377-08351) marine engine mounts.
- The parameters of the fatigue test have been defined based on measurements carried out in the Bay of Biscay on a rough sea day in a boat powered by a Yanmar 3YM30. The sea conditions were the following:
  - Douglas Swell Scale: 4
  - Beaufort Wind Scale: 5
- Vertical displacements of  $\pm 3\text{mm}$  and longitudinal displacements of  $\pm 2\text{mm}$  were measured in the marine engine mounts with position transducers.
- The goal of the fatigue test is to replicate 10 years of these sailing conditions. Around 60 vertical displacements per hour and 20 longitudinal displacements per hour of the mentioned magnitude were measured. The number of vertical displacements of these magnitude in a period of 10 years would be of 5,256 million. To increase the safety margin, a total of 10 million vertical cycles and 3,33 million longitudinal cycles were applied.
- The static load applied to each marine engine mount corresponds to the load distribution of a Yanmar 3YM30.
- The dynamic stiffness and damping properties are continuously measured during the test.
- The drawings of the Ellebogen 75 and Ellebogen 100 marine engine mounts are shown in the next page.



# Drawings

FIXED STUDBOLT  
NUT  
NORD-LOCK WASHER  
FLAT WASHER  
NUT  
LOCKNUT  
GROWER WASHER  
MODEL NUMBER

75

**LOAD-DEFLECTION CURVE**

**NATURAL FREQUENCY CURVE**

**RECOMMENDED TIGHTENING TORQUE:**

190 ~ 240 Nm  
19 ~ 24 kgf·m  
137 ~ 174 ft·lbs

	PROJECTION	DESCRIPTION	DRAWN	DATE	SCALE	SHEET SIZE																																	
		ELLEBOGEN 75 MARINE ENGINE MOUNT	R.E.	15/12/2022	1:2	A3																																	
	REF. NO.	ESTIMATED WEIGHT	REV.	APPROVED	THIS DOCUMENT IS TO BE TREATED AS STRICTLY PRIVATE AND CONFIDENTIAL.																																		
	128270-08341	1,695kg	04	I.J.	IT SHALL NOT BE DISCLOSED TO THIRD PARTIES WITHOUT PRIOR WRITTEN CONSENT.																																		
					GENERAL TOLERANCES AND FITS TO ISO 2768																																		
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**NATURAL FREQUENCY CURVE**

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# Test specs

## The main parameters of the test are described below:

- **Date period of the test:** 07/09/2020 - 24/11/2020
- **Place of the test:** Ellebogen, Spain
- **Marine engine mount types:**
  - Ellebogen 75 (Ref. 128270-08341)
  - Ellebogen 100 (Ref. 128377-08351)
- **Testing equipment:** Instron® Biaxial Servo-Hydraulic Dynamic Test Bench
- **Static load of Ellebogen 75:** 29,4kg
- **Static load of Ellebogen 100:** 49,1kg
- **Excitation signal shape:** Sinus
- **Vertical amplitude:**  $\pm 3$ mm
- **Vertical test frequency:** 3Hz
- **Number of vertical cycles:** 10.000.000
- **Longitudinal static load:** 0kg
- **Longitudinal amplitude:**  $\pm 2$ mm
- **Horizontal test frequency:** 1Hz
- **Number of longitudinal cycles:** 3.333.333

## The sensors used during the tests are the following:

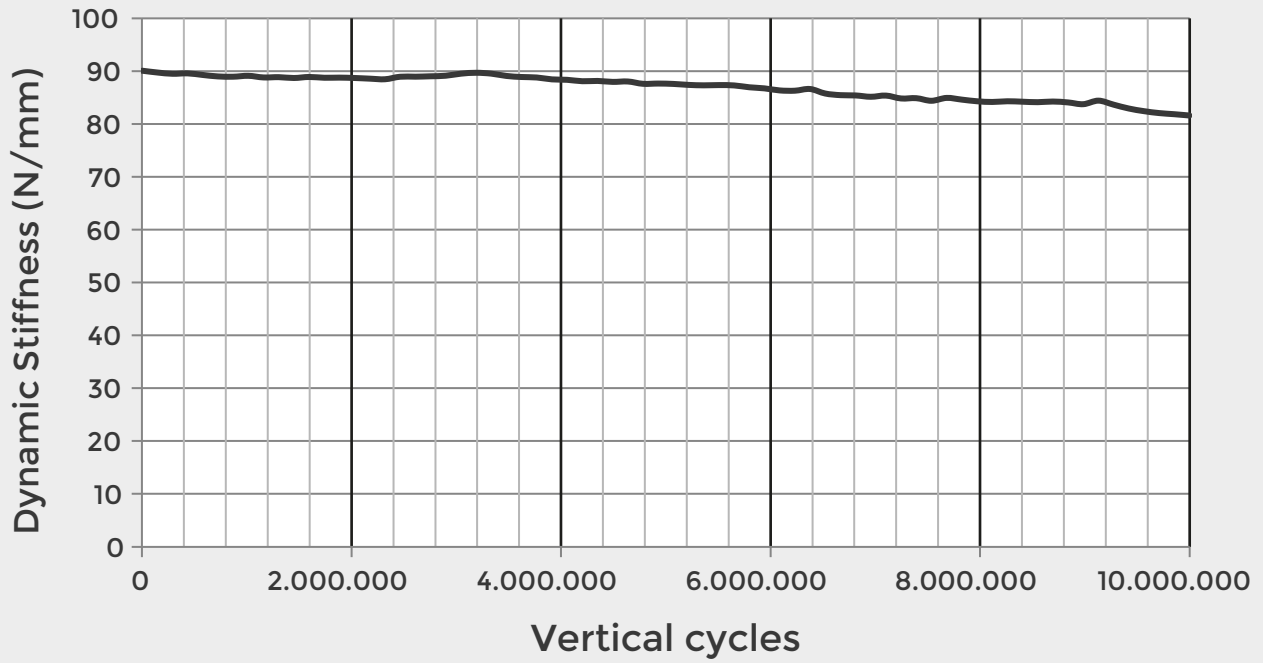
- **Vertical load cell:** Instron® IST 2526-807
- **Horizontal load cell:** Instron® IST 2526-804
- **Vertical position transducer:** Messotron® WLC 250
- **Horizontal position transducer:** Messotron® WLC 250

## Video of the test:

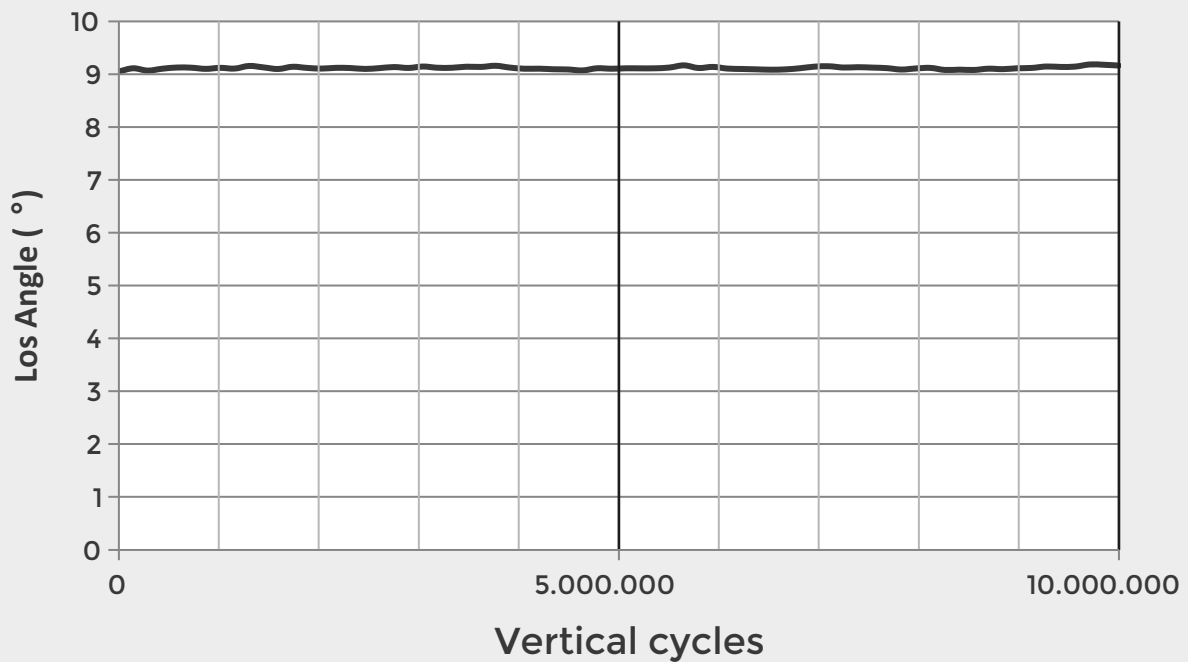


# Test results

## Ellebogen 75 dynamic stiffness evolution:



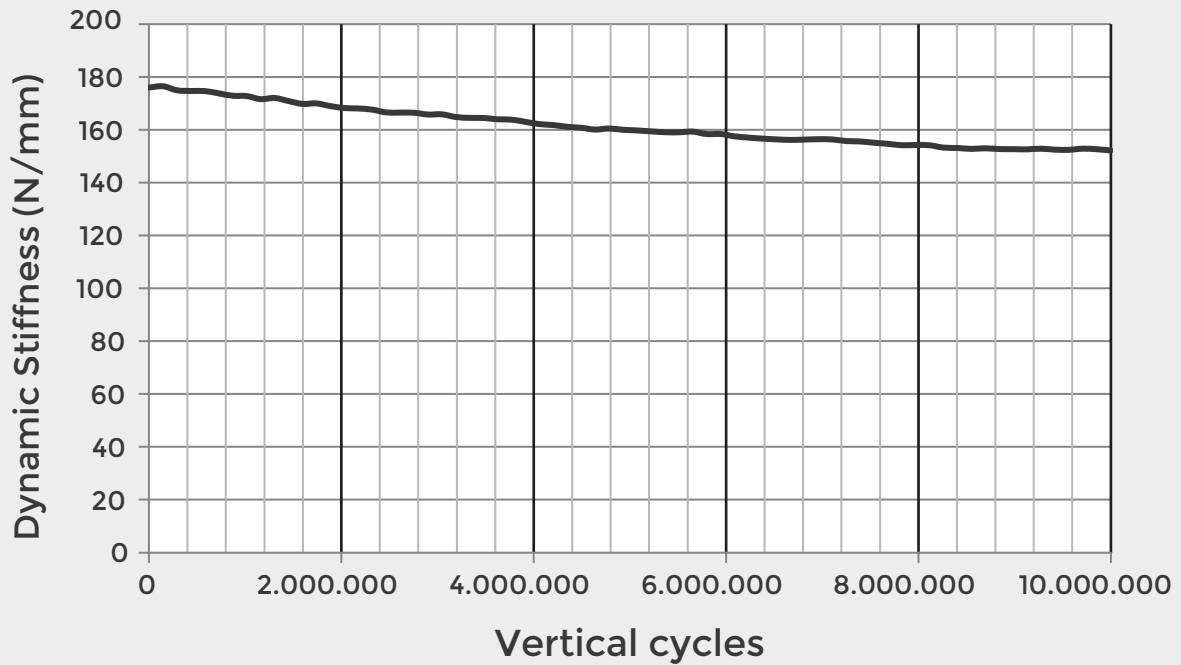
## Ellebogen 75 loss angle evolution:



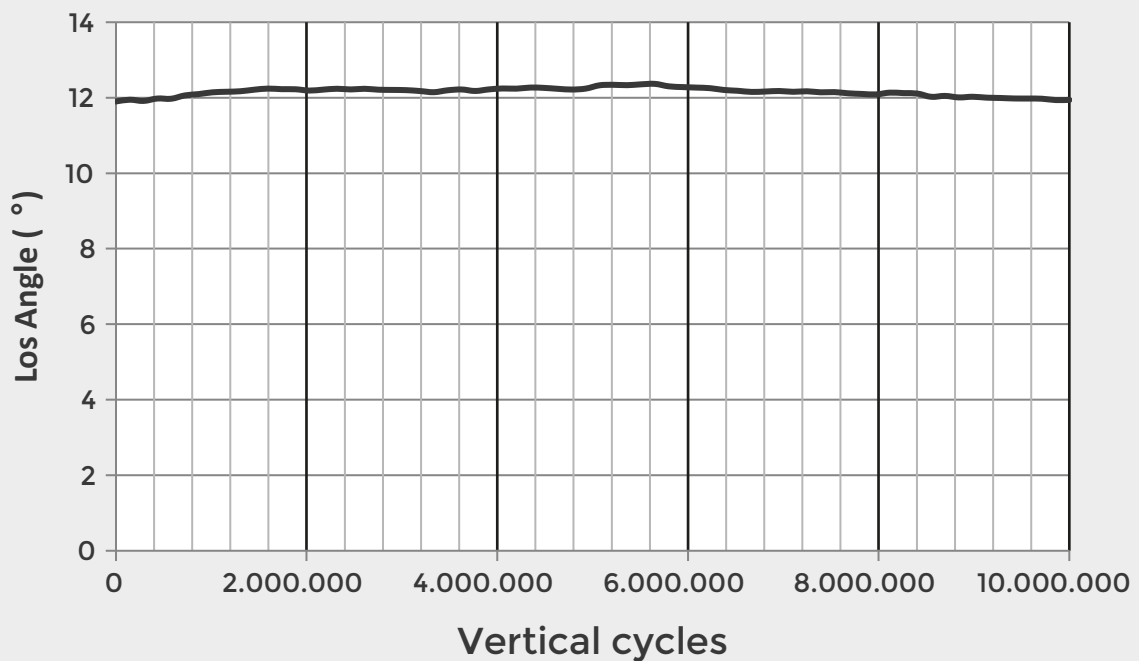


# Test results

## Ellebogen 100 dynamic stiffness evolution:



## Ellebogen 100 loss angle evolution:

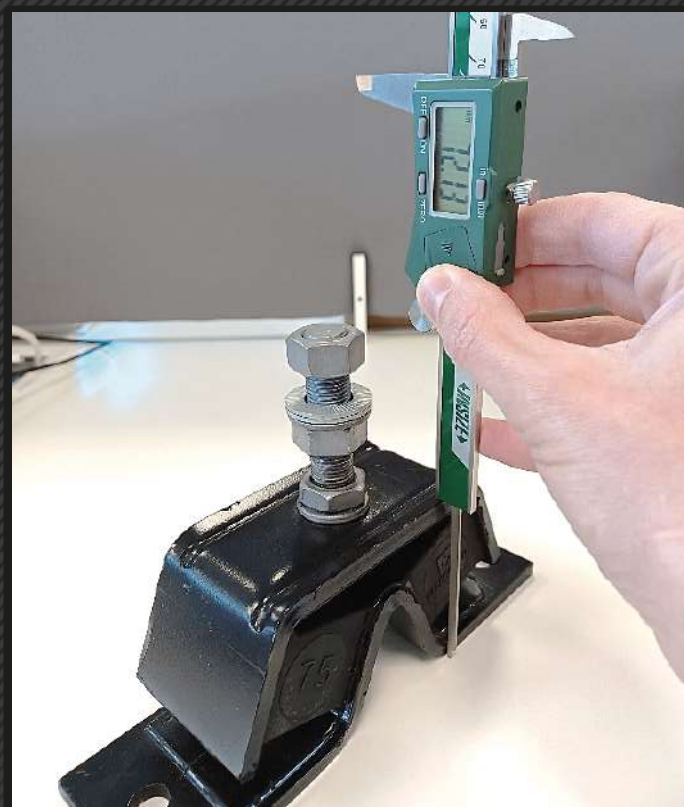


# Visual inspection

Pictures of the **Ellebogen 75** mount after the fatigue test:



The Ellebogen 75 mount shows a height of about 72mm, which corresponds to a permanent set of about 4mm:



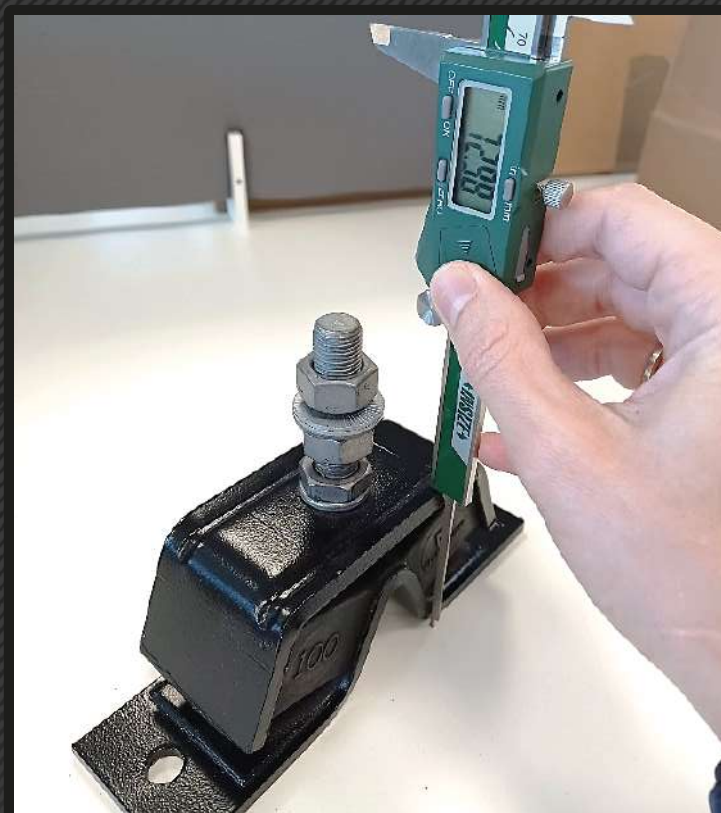


# Visual inspection

Pictures of the **Ellebogen 100** mount after the fatigue test:



The Ellebogen 75 mount shows a height of about 72mm, which corresponds to a permanent set of about 4mm:





# Visual inspection

## Summary of the checked points and their evaluation of the **Ellebogen 75** mount:

Checking points		Evaluation of the top mount
Metal parts	Plastic deformation	No signs of plastic deformation.
	Corrosion	No signs of corrosion.
Rubber	Cracks	No signs of cracks.
	Bonding failure	No signs of bonding failure.
	Rubber wear	Some rubber wear can be seen in the mount.
	Permanent set	The mount shows a permanent set of 4mm (5%).
	Other damage	No signs of other damages.

## Summary of the checked points and their evaluation of the **Ellebogen 100** mount:

Checking points		Evaluation of the top mount
Metal parts	Plastic deformation	No signs of plastic deformation.
	Corrosion	No signs of corrosion.
Rubber	Cracks	No signs of cracks.
	Bonding failure	No signs of bonding failure.
	Rubber wear	Some rubber wear can be seen in the mount.
	Permanent set	The mount shows a permanent set of 3mm (4%).
	Other damage	No signs of other damages.

# Conclusions

- The structural integrity of the mounts is intact.
- The dynamic stiffness remains similar during the whole fatigue test for both mounts, decreasing less than 10% during the test.
- The loss angle (damping) remains similar during the whole fatigue test.
- Both mounts show some rubber wear in some areas, which is something usual in mounts that have been in operation during long time. This phenomenon is not usually something of concern.
- The mounts have undergone some permanent set, which is also unavoidable in elastomers that are subjected to load. The measured permanent sets are not critical for the intended use of these marine engine mounts.
- In general, the damages observed in the marine engine mounts after the fatigue tests are not critical from the point of view of Ellebogen.