

ACCELERATION TESTING OF ROLLER COASTER
SUPERMAN
PARQUE TEMATICO DE MADRID

Test No. 201/AA

01 February 2002

Client: xxxxxxxxxxxxxxxx

Prepared by: **ing. Settimo Martinello**



Superman Attraction

REF.: 7p-G-sup

Bolzano, 18 February 2002

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1. INTRODUCTION

General

4 EMME Service Spa has been requested by xxxxxxxxxxxxxx to carry out dynamic measurements on a fairground attraction called *Superman* at the *Parque Tematico de Madrid*.

The purpose of the test is to find the dynamic spatial components produced by the attraction users.

Measurement date

The measurements were made on **01 February 2002**.

Persons attending

The following persons attended the testing:

| | |
|----------------------------|-------|
| ing. Alessandro Pinizzotto | B & M |
| ing. Todd Twigg | B & M |
| mr. Fabrice Dupertuis | B & M |
| ing. Fernando Cid Sampalo | SGS |

the following attended on behalf of 4 EMME Service Spa. :

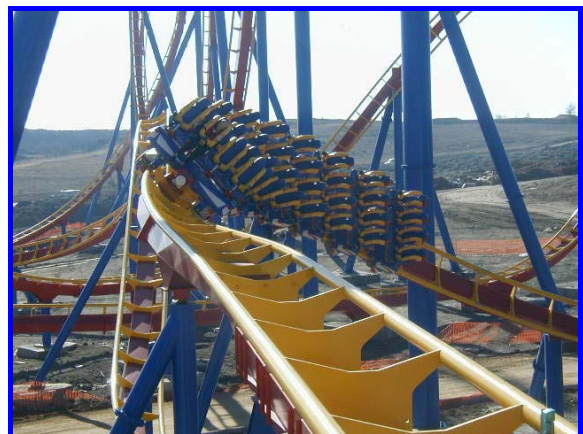
| |
|-------------------------|
| ing. Settimo Martinello |
| ing. Roberto Bruson |

Roller coaster characteristics

The roller coaster is 1054 m long. The coaster cars are 32-seat cars, composed of 8 rows of 4 seats each.



Superman



8 x 4 seat car

2. DESCRIPTION OF EQUIPMENT

Testing equipment

The following equipment was used for the measurements:

- 1 instrumented dummy weighing 150 N;
- 3 141A SETRA capacitive accelerometers;
- 1 MCDR-M-128 analog-digital conversion unit;
- 1 Toshiba Satellite 1800 computer;
- MCDR 128 data acquisition software;
- WorkBench for Windows processing software.

The characteristics of the sensors are as follows:

- sensitivity 65 mV/g;
- measure range ± 8 g;
- resolution 0,0001 g;
- frequency response 0 to 650 Hz;
- transverse sensitivity 2 %;
- linearity 1% full range.

The calibration certificates of the transducers employed on the system are issued by the Calibration Laboratory of 4 Emme Service Spa, ISO 9002 certified by CISQ/RINA n. 6441/01/S.

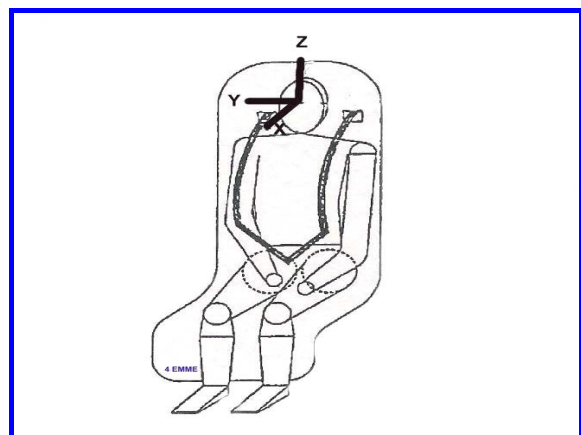
Measurement positions

For the purpose of surveying the effects on the human body, the transducer measurement axes are referred to a levorotatory Cartesian triad.

The dummy was equipped with the three accelerometric sensors (with direction and sense as shown in the figure) and was seated in the first row inner seat of the coaster car. The triad was fastened to the base of the neck and represents the stress of the head on the cervical vertebra.



Instrumented dummy



Position of instrumented dummy

3. DESCRIPTION OF TEST

Data acquisition procedure

After installing the instrumented dummy, we made a series of launches automatically memorizing the data for 500 seconds, by means of a $\pm 0,5$ g *trigger* on the Z direction sensor. The measurements were made according to 50 Hz scans and a Butterworth type 10 Hz low-pass filter was used.

| FILES | CONDITION | DESCRIPTION |
|------------|-----------------|--|
| Superman 1 | 50% load | Coaster car loaded with 15 weights of 750 N placed on the outer seats (except the first seat on the right) |
| Superman 3 | No load | Unloaded car |

The data thus acquired was stored by our computer No. 174 under the Directory “*Vibra - dati - giostre*” with “asc” extension.

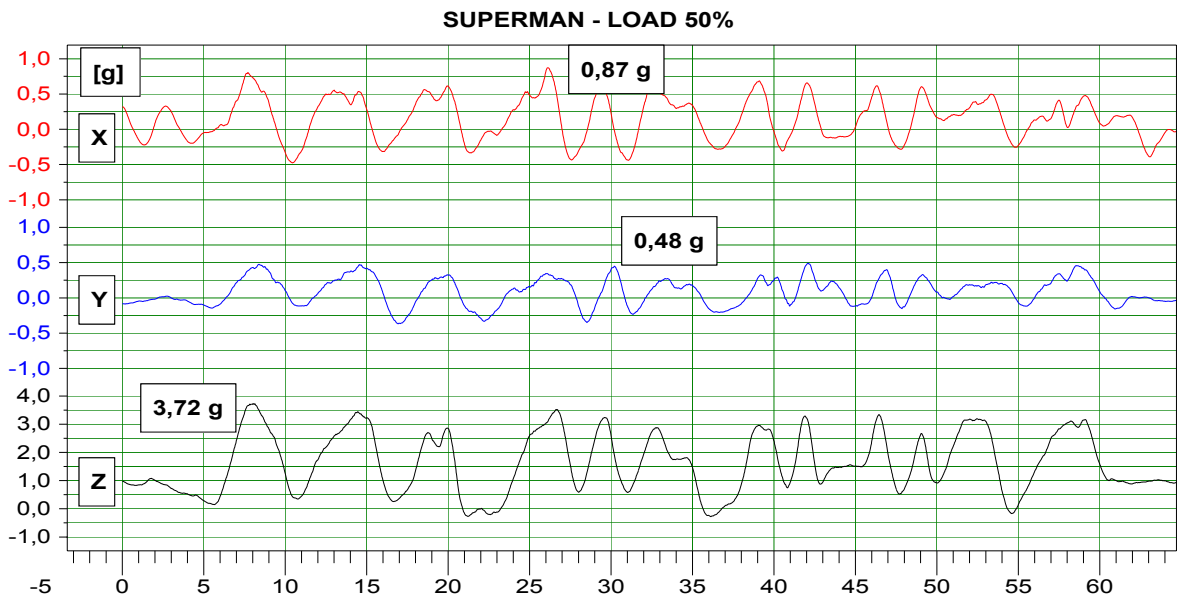


Running car

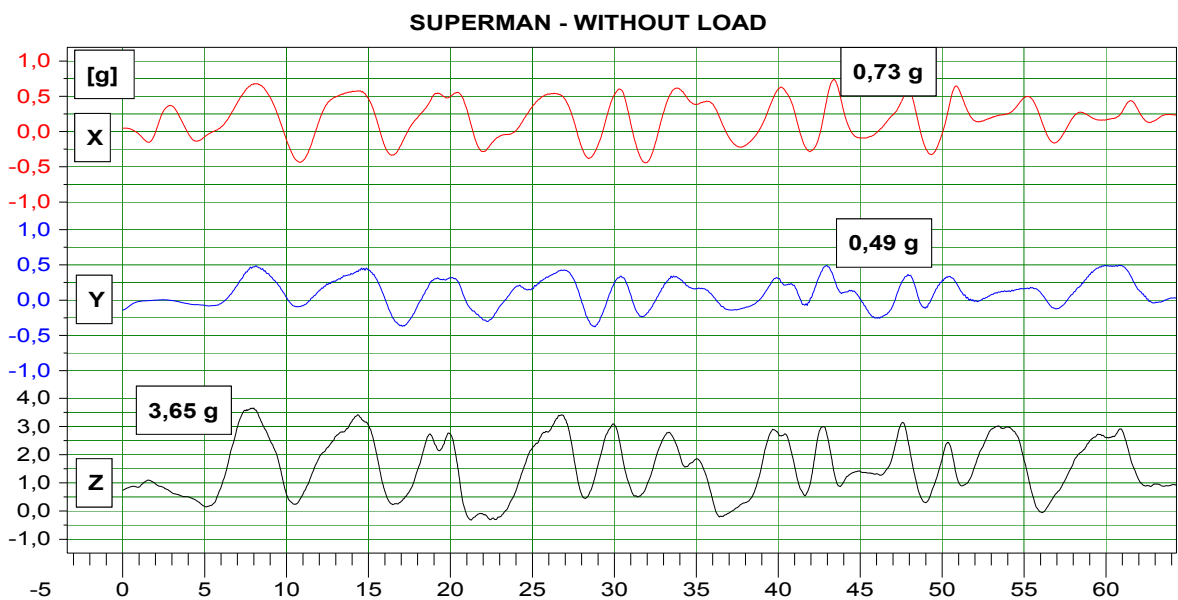
During the acquisitions the temperature was 14°C.

4. ANALYSIS OF EXPERIMENTAL VALUES

The graphs show the acceleration trends with 50% load and no load. On the x-axis are the times and on the y-axis the acceleration expressed in “g”. The acquired data was filtered with a Butterworth type 3 Hz low-pass filter. Time “zero” corresponds to the departure position at the top of the coaster.

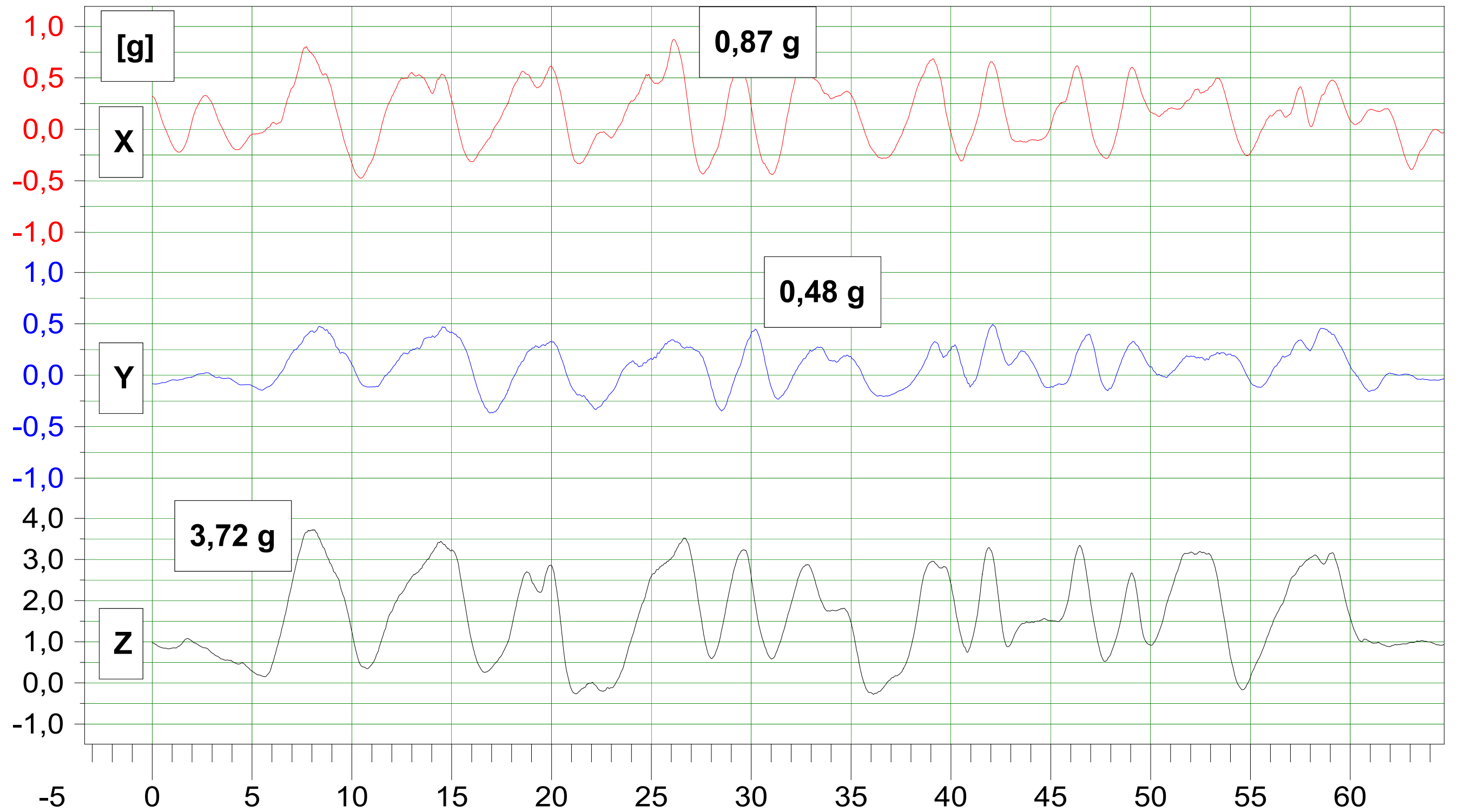


Graph 1: acceleration trend with a 50% load



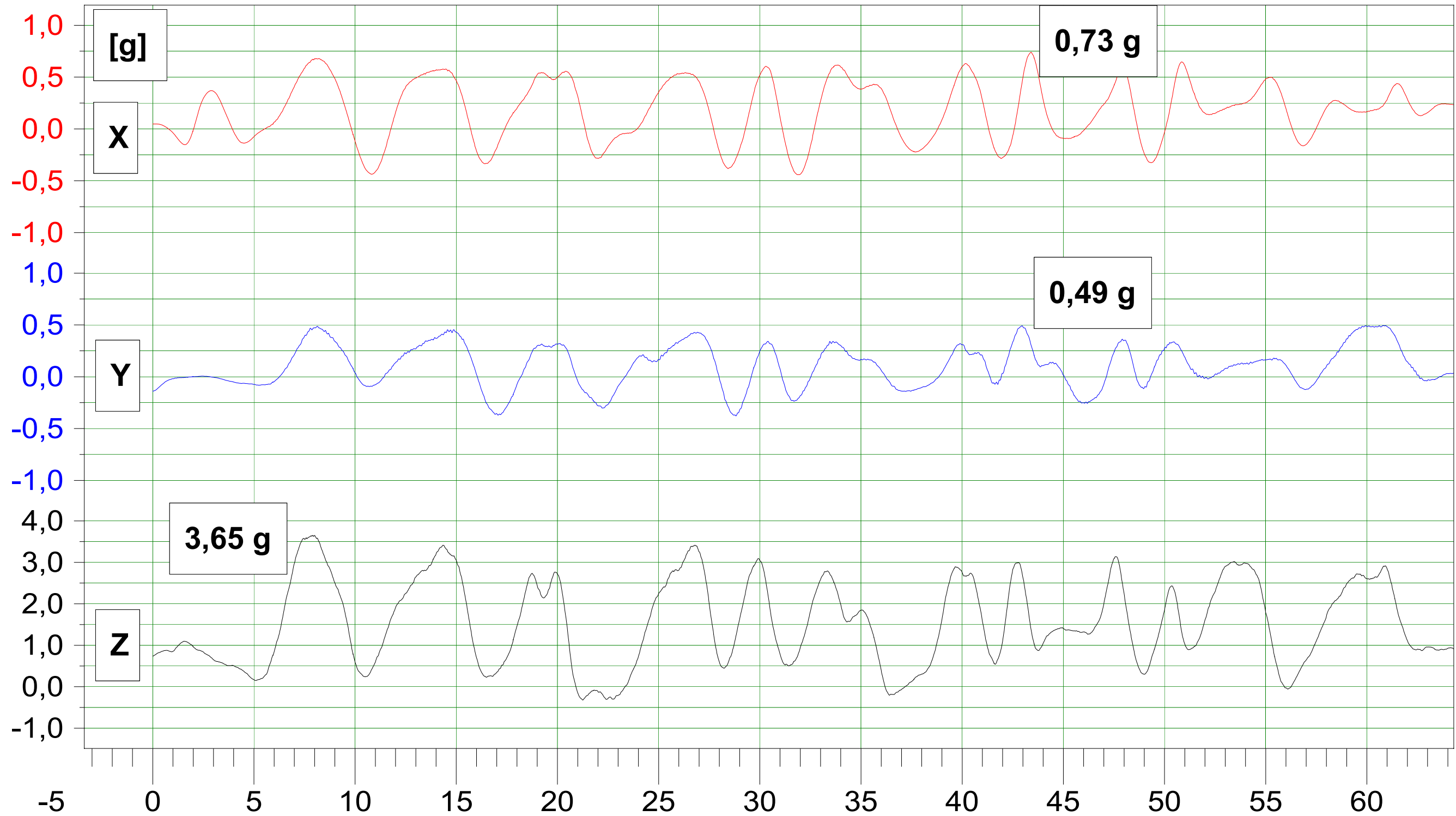
Graph 2: acceleration trend with no load

SUPERMAN - LOAD 50%



Graph 1: acceleration trend with a 50% load

SUPERMAN - WITHOUT LOAD

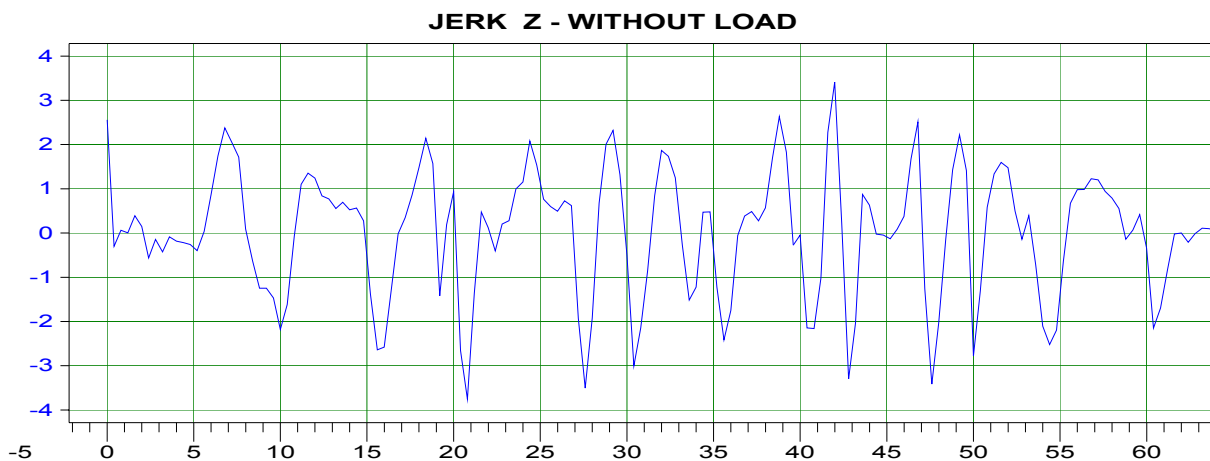
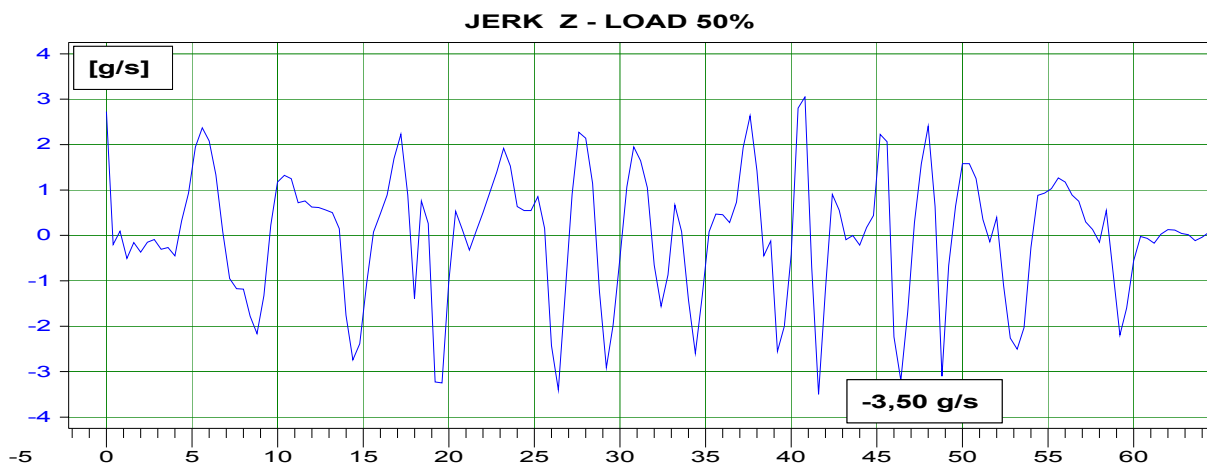


Graph 2: acceleration trend with no load

The two examined load conditions highlight similar peaks, but slightly different trends. Peak accelerations are given in the following table.

| CONDITION | G_x [g] | G_y [g] | G_z [g] |
|-----------|-----------|-----------|-----------|
| 50% load | +0.87 | +0.48 | +3.72 |
| No load | +0.73 | +0.49 | +3.65 |

The graphs show the acceleration **gradient** (*Jerk*), obtained from the signal derivative on the Z axis.



Bolzano, 18 February 2002

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