wheel®

MILANO

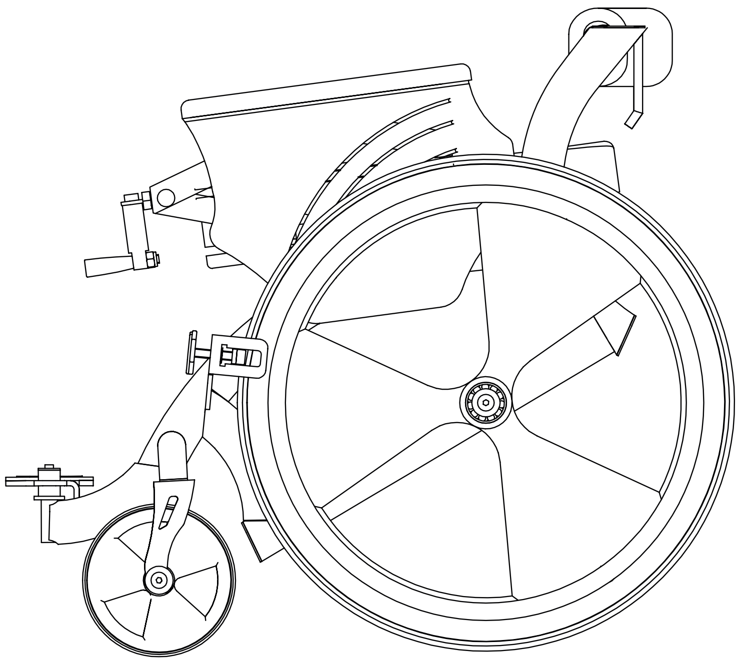
FOR BARRIER-FREE GYM WORKOUTS

DISPOSITIVO MEDICO
DI CLASSE 1

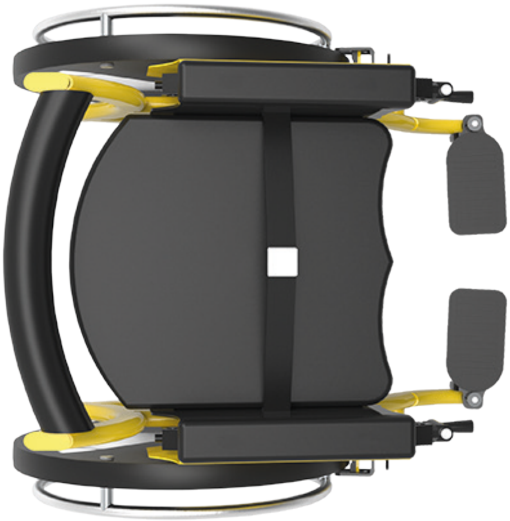
CE

DESIGN REGISTRATO PRESSO
EUIPO
EUROPEAN UNION
INTELLECTUAL PROPERTY OFFICE

Make your structure
inclusive with O wheel®,
a barrier-free training tool



O wheel® is a professional tool meant to be left available to the customer inside your gym



Barrier-free workouts

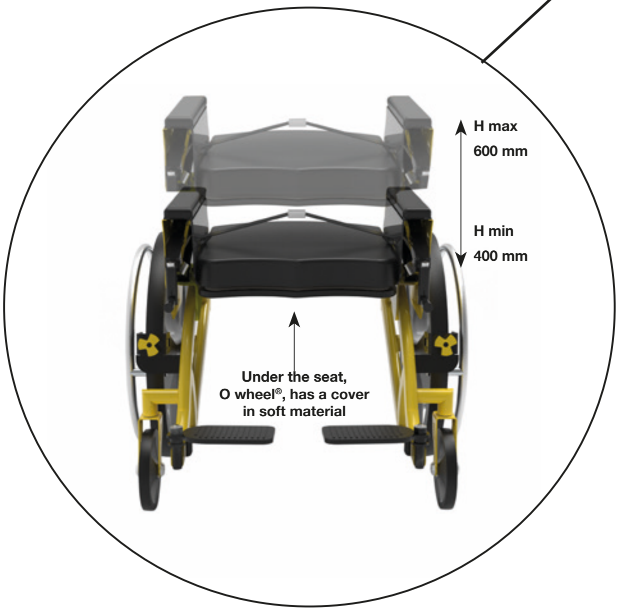
The special O wheel® wheelchair allows people with disabilities to train, using the common machines found in gyms, hotels and rehabilitation centers.

Innovative design

Thanks to its innovative design entirely made in Italy and registered with the European Union, O wheel® allows people with disabilities to be able to carry out a whole series of exercises that until now were forbidden to them, due to the structure of the equipment commonly present in the gym.

O wheel® can be used in synergy with many fitness machines existing in your gym club

No modifications to existing fitness equipment
O wheel® represents an opportunity for gyms, hotels and rehabilitation centers to expand their offer and access new customers, otherwise barred, without modifying their machinery or purchasing new ones.



Compatibility
O wheel® can be used in synergy with many fitness machines currently on the market: Lat Machine, Pec Deck, Pulley, Shoulder press, Pectoral Machine, Chest Press, Scott Bench, Low Row, Vertical Row, Arm Curl, Pullover, Rowing and more.
Under the seat, O wheel®, has a cover in soft material.

O wheel® is a design object, you can have it in multiple colors

Available in different colors

O wheel® is a design object, available in multiple colors (yellow, green, orange, bordeaux, black) or, on request, it is possible to customize the color. The materials have been carefully chosen considering the need for resistance and at the same time the convenience of use. With its weight of 70 kg it is a stable and safe tool for any type of exercise.

EXAMPLES OF USE

WWW.OWHEEL.NET

Scan the QR Code
to Watch the VIDEO

Professional tool
O wheel® is not a classic wheelchair for private use, but a professional tool designed to be left available to the customer within the center.

Data sheet
The O wheel® wheelchair has been designed to help all professionals who work with people with disabilities by providing their center (gym, hotel, rehabilitation centers, hospitals, etc.) with a useful tool, to allow customers to use different professionals gym machines.

Adjustable
Under the seat, O wheel® is completely free from obstacles. Thanks to special cranks placed on the front, it is possible to adjust the seat from a minimum height of 40 cm to a maximum of 60 cm.

Weight and Safety
With its 70 kg of weight, O wheel® is a stable and safe for all types of exercise.

Facilities not accessible
People with disabilities whether they are athletes or a simple enthusiastic, often need more than others to strengthen muscle. Unfortunately, not all clubs, hotels and places for physical activity are suitable for receiving this type of clientele.

New opportunities
The purpose of O wheel® is to help people with disabilities to use machinery which until today they had no access, but also to get gym owners, sports centers, hotels, hospitals, centers of rehabilitation an opportunity to increase their customers.

Handmade in Italy
O whee!® is handmade by skilled artisans in Friuli-Venezia Giulia: this makes each chair incredibly resistant and unique in its kind.

The numbers of disability in Italy
Estimates in the population indicate that this condition involves about 4,36 million people, of which 2,60 million are aged over 65 and live in the southern regions (source ISTAT). O wheel® wants to be a first step in breaking down the barriers in the world of training for people with disabilities.

WARNING

1) Each person with a disability who intends to use O wheel® must have a certification signed by a doctor that identifies the opportunity for safe use of the O wheel® and also the type of appropriate training (exercises, level of loads, and training machines)

2) The use by a person with disabilities must, in any case, be carried out under the supervision of a person expert in adapted physical therapy and who has undergone specific training on the O-Wheel device. This person must be present in the centre during use.

3) A lack of trunk control and skin lesions in the interface areas are clinical reasons for excluding the device's use.

4) The use of the device, coupled with a decubitus pillow with a preventive scope, can be provided, given an appropriate fastening system that prevents the additional pillow from slipping during exercises. Such a pillow is not included in the current prototype.

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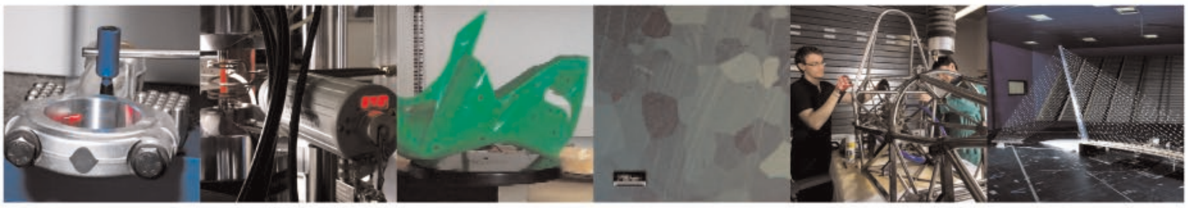

Testing of a wheelchair O wheel® for specific use in the gym

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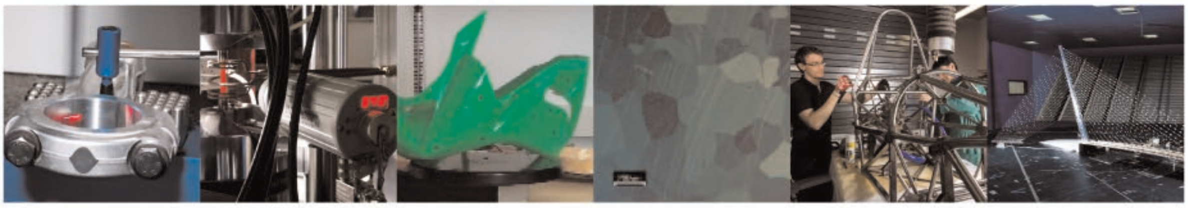

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Summary

1 Introduction

In order to be able to carry out the certification of the wheelchair O wheel®, two tests have been carried out on:

- a load test to assess the integrity of the wheelchair O wheel®;
- a capsizing test to assess the capsizing risk of the wheelchair O wheel®.

The wheelchair O wheel® under test has been provided by the customer and is considered to be in nominal conditions (no further indications have been provided by the customer).

2 Load test

The load test has been carried out by positioning the wheelchair O wheel® below an MTS 248 hydraulic actuator that is equipped with an internal stroke displacement sensor. The applied load is directly measured through an MTS U15 load cell (serial number 015567S).

To better distribute the load on the seat of the wheelchair O wheel®, a metal plate having thickness of 20 mm and having size almost equal to the one of the seat has been used. To avoid ruining the cushion of the seat, hard rubber lamina of a total thickness of 5 mm have been interposed between the metal plate and the cushion.

During the load test, the wheelchair O wheel® was braked. Moreover, being the test done in force control, to prevent the wheelchair O wheel® to slip away, additional mechanical stops were used on each wheel.

The sampling frequency has been set equal to 5Hz and the load rate has been set equal to 12 N/s, i.e., a quasi-static test has been carried out. Both loading and unloading have been considered.

Figure 1 shows the output of the load test carried out.

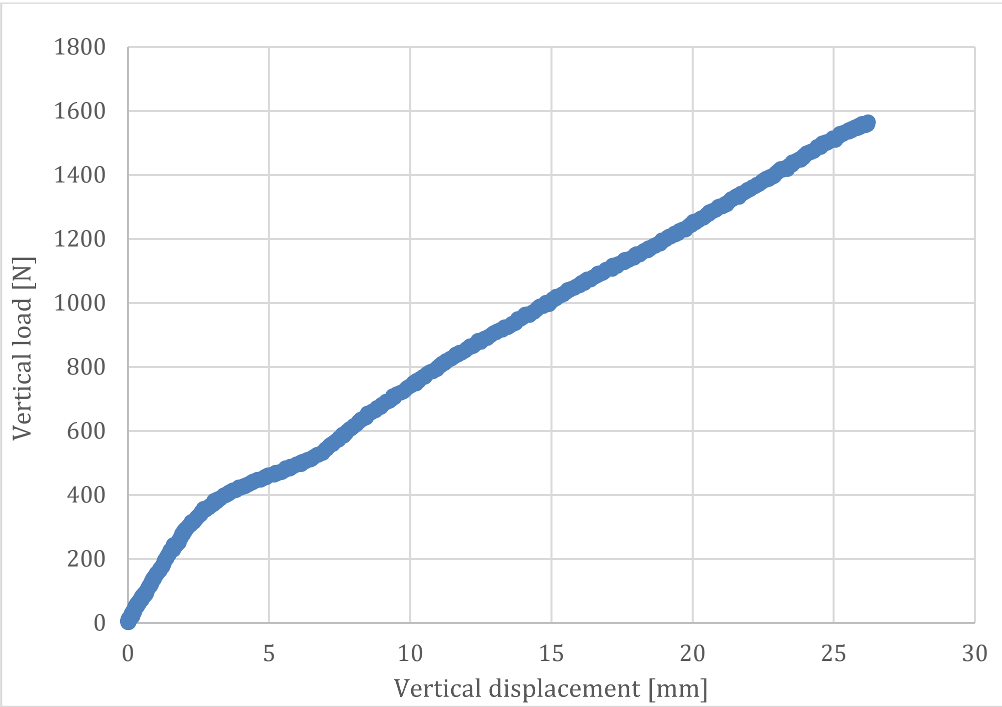

Figure 1 – load test of the wheelchair O wheel® (loading branch)

It can be clearly seen that the loading curve is almost perfectly linear after an initial settling zone. Moreover, no changing (decrease) in slope is observed at the reaching of the maximum loading value. This highlights the fact that no structural damages were observed up to this highest load (almost 1600N, i.e., 160kg of weight).

Another result that can be observed from Figure 1 is that the measured (linear) stiffness is equal to almost 50 N/mm. This relatively low stiffness is associated to the fact that the load wasn't applied directly to the metal structure of the wheelchair O wheel® but on its soft cushion.

3 Capsizing test

The capsizing test has been carried out by measuring the height of the centre of mass of the wheelchair O wheel®. This has been done positioning the braked wheelchair O wheel® on an inclined plane and by measuring the static load under the four wheels. In fact, as shown in figure 2, through simple static equilibria it is possible to determine both the height and the in-plane position of the centre of mass of the wheelchair O wheel®.

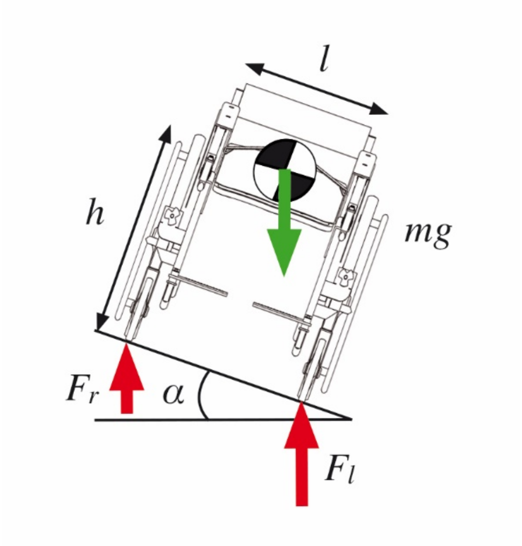

Figure 2 – front view: scheme of the wheelchair O wheel® highlighting the static forces and the most relevant dimensions

Assuming symmetry in the lateral direction and knowing the inclination angle α of the inclined plane as well as the track l of the wheelchair O wheel®, one can determine the height of the centre of mass through the rotational equilibrium, i.e. through the following equation

$$h = \frac{mg\frac{l}{2}cos\alpha - F_r l cos\alpha}{mg sin\alpha}$$

where m is the mass of the wheelchair O wheel®, g is the gravitational acceleration, and the product mg is equal to $F_r + F_l$ (obtained from the vertical equilibrium). Thus, once F_r and F_l have been measured (F_r is the sum of the two loads under the right wheels while F_l is the sum of the two loads under the left wheels), the height of the centre of mass of the wheelchair O wheel® can be determined. In our case, the height is equal to 449.3 mm from the ground (in unloaded conditions). The same value has been determined by considering two different inclination angles, i.e., $\alpha = 5°$ and $\alpha = 10°$.

To assess the capsizing risk, also the longitudinal position of the centre of mass has to be determined. Knowing the wheelbase b, one can easily determine the longitudinal position of the centre of mass by placing the wheelchair O wheel® on a flat ground and by measuring the load F_f under the front wheels and the load F_b under the rear wheels (figure 3).

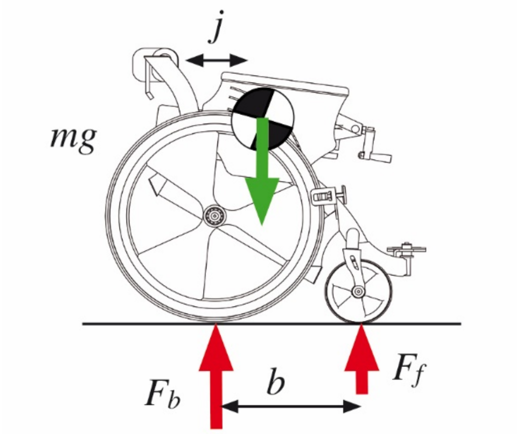

Figure 3 – side view: scheme of the wheelchair O wheel® highlighting the static forces and the most relevant dimensions

In fact, through a rotational equilibrium one can obtain the forward displacement j of the centre of mass with respect to the centre plane of the rear wheels:

$$j = \frac{(mg - F_b)b}{mg}$$

For the wheelchair O wheel® under investigation j turned out to be equal to 92.8 mm.

Now, assuming that the height n of the centre of mass of user is 300 mm above the cushion (conservative assumption) and 50 mm in front of the backrest (k), we can carry out the capsizing analysis.

Let's fist consider the capsizing in lateral direction. Figure 4 sums up all the relevant quantities for the capsizing analysis.

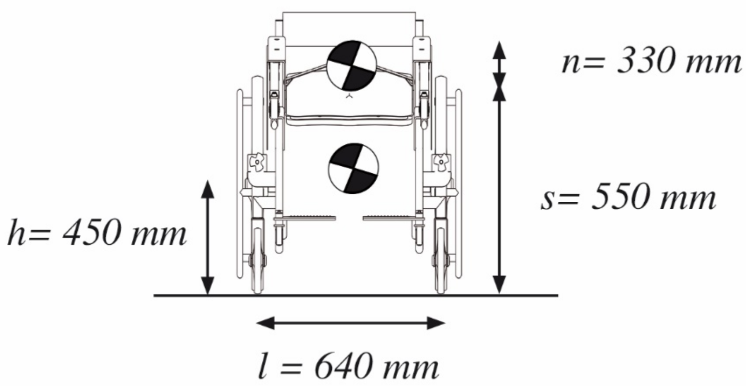

Figure 5 – side view: relevant dimensions for the capsizing analysis

The limit condition for capsizing occurs when the load on either of the wheels reduces to zero. Through simple calculations we obtain that the lateral inertia force that allows to reach the capsizing limit condition is equal to:

$$Ma_{lateral} = \frac{(M+m)g\frac{l}{2}}{s+n}$$

where M is the mass of the user and s is the height of the cushion. Table 1 sums up the maximum allowable lateral accelerations for different masses of users.

User's mass [kg]	Maximum allowable lateral acceleration [m/s^2]
70 kg	7.67
80 kg	7.17
90 kg	6.79
100 kg	6.48
110 kg	6.22
120 kg	6.01

Table 1 – maximum allowable lateral accelerations

Let's now consider the capsizing in longitudinal direction. Figure 5 sums up all the relevant quantities for the capsizing analysis.

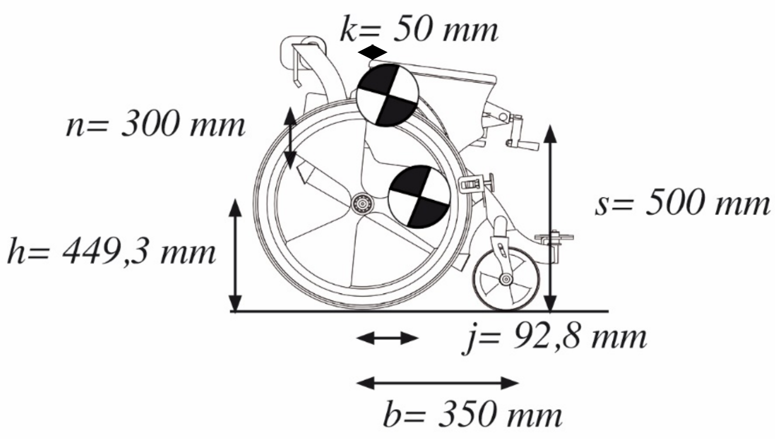

Figure 5 – side view: relevant dimensions for the capsizing analysis

The limit condition for capsizing occurs when the load on either of the wheels reduces to zero. Through simple calculations we obtain that the forward inertia force that allows to reach the capsizing limit condition is equal to:

$$Ma_{forward} = \frac{Mg(b-k)+mg(b-j)}{s+n}$$

while the backward inertia force that allows to reach the capsizing limit condition is equal to:

$$Ma_{backward} = \frac{Mgk+mgj}{s+n}$$

Table 2 sums up the maximum allowable forward and backward longitudinal accelerations for different masses of users.

User's mass [kg]	Maximum allowable forward longitudinal acceleration [m/s^2]	Maximum allowable backward longitudinal acceleration [m/s^2]
70 kg	6.66	1.73
80 kg	6.26	1.59
90 kg	5.95	1.47
100 kg	5.70	1.38
110 kg	5.50	1.31
120 kg	5.33	1.25

Table 2 – maximum allowable forward and backward longitudinal accelerations

Since it is unlikely that the maximum longitudinal and lateral accelerations that the user will apply on the wheelchair O wheel® are going to be measured, a restrain system that prevents capsizing should be considered.

4 Usability considerations

Concerning usability and safety, the O-Wheel prototype was analyzed by Prof. Alessandra L. G. Pedrocchi of the DEIB and Eng. Eleonora Guanziroli of the Villa Beretta Neurorehabilitation Center of the Valduce Hospital on August 26, 2021, at the Villa Beretta Rehabilitation Center in the presence of Mr. Salgaro.

Following the checks carried out, the following indications are outlined for the safe use of the O-Wheel system by a person with disabilities performing physical training.

1) Each person with a disability who intends to use O-Wheel must have a certification signed by a doctor that identifies the opportunity for safe use of the O-Wheel and also the type of appropriate training (exercises, level of loads, and training machines)

2) The use by a person with disabilities must, in any case, be carried out under the supervision of a person expert in adapted physical therapy and who has undergone specific training on the O-Wheel device. This person must be present in the centre during use.

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4) The use of the device, coupled with a decubitus pillow with a preventive scope, can be provided, given an appropriate fastening system that prevents the additional pillow from slipping during exercises. Such a pillow is not included in the current prototype.

Bibliography

[1] Nicolò Bachschmid, Stefano Bruni, Andrea Collina, Bruno Pizzigoni, Ferruccio Resta, Alberto Zasso – FONDAMENTI DI MECCANICA TEORICA E APPLICATA, McGraw-Hill Education, 2015

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