

# **Performance diagnostics in sport climbing**

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## **Test manual**

Claudia Augste, Marvin Winkler & Stefan Künzell

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## Foreword

The following manual was created as part of the research project "Development of a scientifically based performance diagnostics in sport climbing"<sup>1</sup>. All the tests described here proved to be empirically and statistically relevant to performance in at least one of the competition disciplines of sport climbing - bouldering, lead, speed and combined in the women's and/or men's competitions.

General notes on the tests:

- The tests should only be carried out if the athlete is in good health. If pain occurs, the tests should be stopped immediately.
- Before the start of the tests, the athlete should have completed a climbing-specific warm-up program of at least 15 minutes.
- When ordering the tests, care should be taken to ensure that the execution of individual tests is not restricted by the exhaustion from previous tests. If possible, tests with different muscle groups and different motor requirements should be alternated. The strength endurance tests should rather be run towards the end of the test battery.
- If the athlete does not conduct the test exactly as described in the manual, the results cannot be used for inter-individual comparison.
- The tests can be completed in normal sports climbing clothing. For some tests normal sports shoes are required, for others climbing shoes. Chalking of the hands is allowed and is recommended for some tests.
- In addition to the test battery described here, anthropometric characteristics should also be recorded. These are partly necessary for the adjustment of the test devices (knee, hip and shoulder height) or necessary for the calculation of relative values (height, weight, arm span). In some cases, they themselves represent factors relevant to performance (ape index (arm span width/body height), body fat percentage).

The test battery is designed for competition climbers and is suitable for individual performance diagnostics as well as for interindividual performance comparisons.

Have fun and success with the implementation!

PD Dr. Claudia Augste (project manager) and M.A. Marvin Winkler (project collaborator), Prof. Dr. Stefan Künzler (project consultant and head of the department of movement and training science), University of Augsburg

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# 1 One-handed rung pulling

## Characteristic to be tested

- Static maximum strength of the finger flexion muscles

## Starting position

- Standing on a force plate
- Upright body position, straight arm
- Variants
  1. Rung-depth 23 mm, radius 12 mm
    - a. Half-crim grip
    - b. Open hand grip
  2. Rung-depth 8 mm (micros from Beast-maker)
    - a. Half-crim grip
    - b. Open hand grip



## Test execution

- Test procedure
  - Adding additional weights (e.g. to the climbing harness) if the athlete is expected to be able to hang with more than his/her own body weight
  - Gripping the rung centrally over the force plate
  - Slow lowering of the body's centre of gravity by bending the knees and lifting the heels
  - Maximally loading the rung for 3 seconds
- Instruction after starting the measurement: "Stand still - hand on the rung - straight arm - 21 - 22 - 23".
- Number of attempts: 1 attempt per side, finger position and rung size, pause between attempts on one side: 2 minutes

## Test evaluation

- Calculation of the maximum average value of the loaded weight for a 3-second period
- Division of the calculated average value by the athlete's body weight

## Measured value

- Average weight that can be loaded for 3 seconds, in relation to body weight
- Unit: %

## 2 Bent arm lock off

### Characteristic to be tested

- Static maximum strength of the upper arm flexor muscles

### Starting position

- Standing on a force plate, frontally to the bar
- Pull-up hand position
- Bent elbow (90 degrees)

### Test execution

- Test procedure
  - Adding additional weights (e.g. to the climbing harness) if the athlete is expected to be able to hang with more than his/her own body weight
  - Grabbing the bar
  - slow force build-up over approx. 1 second
  - Maximally loading the bar over 3 seconds
- Instruction after starting the measurement: "Stand still - put your hand on the bar - build up force - 21 - 22 - 23".
- Number of attempts: 1 attempt per side



### Test evaluation

- Calculation of the maximum average value of the loaded weight for a 3-second period
- Division of the calculated average value by the athlete's body weight

### Measured value

- Average weight that can be loaded for 3 seconds, in relation to body weight
- Unit: %

### 3 Momentum absorption

#### Characteristic to be tested

- Maximum strength of the trunk musculature

#### Starting position

- Attachment of a digital angle measurement system with recording function between the athlete's shoulder blades (e.g. smartphone with corresponding app)
- Holding on to the bar with arms stretched out
- Standing on the footholds (symmetrical holds of Hardwoodholds) with both feet (hip width)
- distance bar to footholds = distance floor to shoulder
- Wall inclination: -60 degrees



#### Test execution

- Test procedure
  - Simultaneous release of both feet
  - as little back swing as possible
- Number of attempts: 1 attempt

#### Test evaluation

- Measurement of the maximum angle during the first back swing

#### Measured value

- Angle at first back swing
- Unit: degrees

## 4 Powerslap

### Characteristic to be tested

- Speed strength of the arm, shoulder and back musculature

### Starting position

- Hanging from the rung (depth: 45 mm, radius: 12 mm) of the Powerslap board (inclination: -20 degrees)
- Shoulder width distance between the hands
- Finger grip position of choice
- Avoid swinging and hang with straight arms and torso



### Test execution

- Test procedure:
  - Explosive initiation of a pull up followed by the release of one hand hitting the board at the highest possible point
  - Initiation of movement from the shoulder girdle without using the body as a swinging element
- Number of attempts: 2 attempts per side

### Test evaluation

- Measurement of the vertical difference between the upper edge of the rung and the highest point of the visible imprint of the hand
- Determination of the best test per side

### Measured value

- Version 1
  - Measured vertical difference
  - Unit: cm
- Version 2
  - Measured vertical difference in relation to arm span
  - Unit: %

## 5 Jump from high step

### Characteristic to be tested

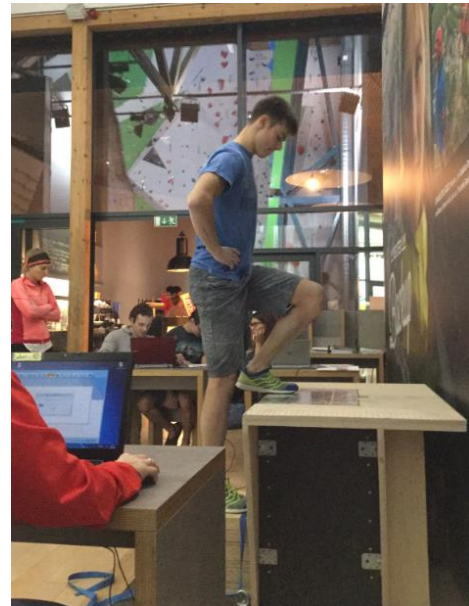
- High jumping power from high step

### Test preparation

- Adjust the vault table to individual height:
  - Lower leg with the tip of the foot on the edge of the vault table
  - Upper foot flat on the force plate, heel ends with rear edge
  - Knee angle: 90 degrees

### Starting position

- Lower leg with the tip of the foot on the edge of the vault table
- Upper foot with the ball of the foot on the edge of the force plate



### Test execution

- Test procedure
  - Put one's hands on one's hips
  - Straight lower leg
  - Jump up as explosively as possible without using a countermovement of the lower leg
  - Landing with both feet on the force plate
- Number of attempts: 1 attempt per side

### Test evaluation

- Calculation of the vertical jump height of the centre of gravity

### Measured value

- Jump height
- Unit: cm



## 6 Countermovement Jump (CMJ)

### Characteristic to be tested

- Jumping power with countermovement

### Starting position

- Put one's hands on one's hips
- Upright body position
- Version 1:
  - With both legs
- Variant 2:
  - Single legged

### Test execution

- Test procedure
  - Jump up as explosive as possible with using a countermovement
  - Landing with both feet on the force plate
- Number of attempts: 1 attempt with both legs, 1 attempt single legged



### Test evaluation

- Calculation of the vertical jumping height of the centre of gravity of the body

### Measured value

- Jump height
- Unit: cm

## 7 Squat Jump (SJ)

### Characteristic to be tested

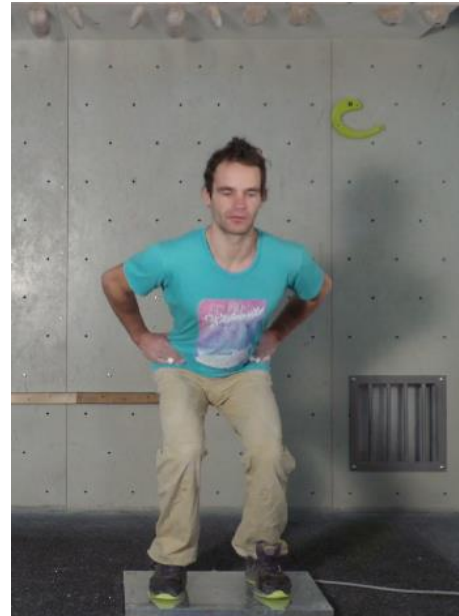
- Jumping power without countermovement

### Starting position

- Put one's hands on one's hips
- Standing on both legs with bent knees

### Test execution

- Test procedure
  - Jump up as explosively as possible without using a countermovement
  - Landing with both feet on the force plate
- Number of attempts: 1 attempt



### Test evaluation

- Calculation of the vertical jump height of the centre of gravity of the body

### Measured value

- Jump height
- Unit: cm

## 8 Intermittent rung hanging

### Characteristic to be tested

- Finger strength endurance with intermittent loads

### Starting position

- Standing frontal to the fingerboard (Beast-maker 2000)
- Upright body position

### Test execution

- Test procedure
  - Intensive chalking of the hands allowed before the test
  - Hanging on the holds (small outer crimps) in an intermittend way:
    - 7 seconds hanging (finger position as desired, but without using the thumb, hanging with straight arms and shoulders)
    - 2 seconds pause (while standing on the floor), short shaking of the hands is allowed
    - repeated execution until contact with the hold is lost before the end of the load interval (= test abort criterion)
- Frequency generation of the load/pause intervals (e.g. by a smartphone app)
- Instruction at each interval: "3 - 2 - 1 - pause - 1 and hang"
- Number of attempts: 1 attempt



### Test evaluation

- Count the complete number of repetitions until the test is aborted due to the abort criterion

### Measured value

- Number of completely performed load intervals
- Unit: Number

## 9 30-second rung pulling

### Characteristic to be tested

- Static strength endurance of the finger flexor muscles

### Starting position

- Standing on a force plate
- Upright body position, straight arm
- Gripping the rung with one hand centrally over the force plate (finger position as desired, but without using the thumb)
- Depth of the rung: 23 mm, radius 12 mm

### Test execution

- Test procedure
  - Adding additional weights (e.g. to the climbing harness) if the athlete is expected to be able to hang with more than his/her own body weight
  - Grapping the rung
  - Slow lowering of the body's centre of gravity by bending the knees and lifting the heels
  - Maximally loading the rung for 30 seconds
- Instruction after starting the measurement: "Stand still - hand on the rung - straight arm - ... 20 seconds more - ... 10 more - ... 5 - 4 - 3 - 2 - 1".
- Number of attempts: 1 attempt per side



### Test evaluation

- Calculation of the maximum average value of the loaded weight for a 30-second period
- Division of the calculated average value by the athlete's body weight

### Measured value

- Average weight that can be loaded for 30 seconds, in relation to body weight
- Unit: %

## 10 Footholds fishing

### Characteristic to be tested

- Strength endurance of the trunk musculature for maintaining body tension

### Starting position

- Hold on to the bar using the pullup hand position with straight arms
- Standing on the footholds (symmetrical holds of Hardwoodholds) with both feet (hip width distance)
- Distance bar to footholds = distance knee to head height
- Wall inclination: -60 degrees



### Test execution

- Test procedure
  - Alternating "fishing" of the footholds (right foot to left kick, left foot to right kick)
  - Starting position for each repetition is vertical (touching the footplate with both feet for 1 second)
  - Swing fetch is not allowed
  - repeated execution until the kick has not been loaded in 3 consecutive attempts (= test abort criterion)
- Number of attempts: 1 attempt

### Test evaluation

- Counting of the completely executed single repetitions until the test is aborted due to the abort criterion

### Measured value

- Number of repetitions completed
- Unit: Number

## 11 Lateral-frontal leg lifting

### Characteristic to be tested

- Hip mobility during lateral-frontal leg lifting

### Device Specification

- Board: width: 110 cm, height: 250 cm
- Footholds: horizontal distance: 40 cm, width: 50 mm, depth: 30 mm, radius 12 mm
- Rung: height adjustable at 5 cm intervals, width: 100 mm, depth: 30 mm, radius 12 mm

### Starting position

- Standing on the footholds
- Height of the rung so that just about all 4 fingertips can touch the wall
- Hold on to the rung (central, shoulder width)



### Test execution

- Lifting the leg as far as possible
- Taking a lateral position to the wall is allowed
- Holding the highest possible foot position for 2 seconds
- Number of attempts: 1 attempt per side

### Test evaluation

- Measurement of the highest foot position that can be held for 2 seconds on the lateral measuring scale

### Measured value

- Version 1
  - Reach height
  - Unit: cm
- Version 2
  - Reach height in relation to body height
  - Unit: %

## 12 Lateral knee raising

### Characteristic to be tested

- Hip mobility during lateral knee raising

### Device Specification

- Board: width: 110 cm, height: 250 cm
- Footholds: horizontal distance: 40 cm, width: 50 mm, depth: 30 mm, radius: 12 mm
- Rung: height adjustable at 5 cm intervals, width: 100 mm, depth: 30 mm, radius: 12 mm

### Starting position

- Standing on the footholds
- Height of the rung so that just about all 4 finger-tips can touch the wall
- Hold on to the rung (central, shoulder width)



### Test execution

- Lifting the knee as high as possible
- Maintaining the frontal position to the wall (hip (opposite side), foot, heel and knee in contact with the wall)
- Holding the highest possible knee position for 2 seconds
- Number of attempts: 1 attempt per side

### Test evaluation

- Reading the highest knee position that can be held for 2 seconds (horizontal projection on measuring scale)
- Subtract the knee height of the athlete from the measured knee position (= starting height)

### Measured value

- Version 1
  - Measured knee position height minus the athletes knee height
  - Unit: cm
- Variant 2
  - Measured knee position height minus the athletes knee height
  - Unit: %

## 13 Wall jump

### Characteristic to be tested

- Coordination of several extremities under simultaneous and precision pressure

### Test preparation

- Measurement knee height (joint gap)
- Measurement hip height (spina iliaca)
- Attach holds (flat foot holds of hardwood holds, flat side up) and footholds (symmetrical holds of hardwood holds) into the vertical wall, adapted to physical characteristics
- Mark jump off area

### Starting position

- Laterally (right or left) in the marked jump-off area

### Test execution

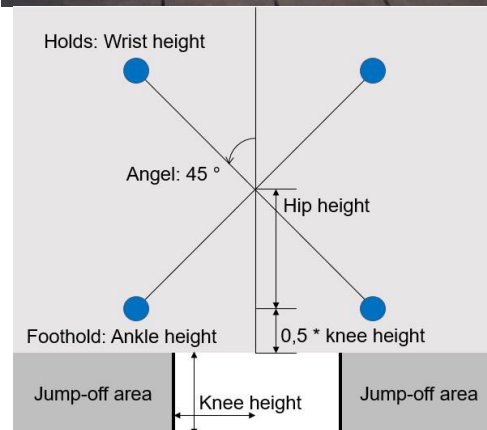
- Test procedure
  - Jump to the wall and hold the position
  - Alternately from right and left
  - Objective: to achieve the most precise possible simultaneous contact on the holds and footholds with all four extremities
- Number of attempts: 3 trial jumps per side, then 3 attempts per side
- Recording the jumps with a high-speed camera

### Test evaluation

- Determination of the time difference from the first contact of the first extremity to the last contact of the fourth extremity if the position can be held.
- Determination of the minimum time difference of 3 attempts per side

### Measured value

- Time difference from the first contact of the first extremity to the last contact of the fourth extremity
- Unit: s





## 14 Route planning

### Characteristic to be tested

- Visualisation of movements

### Test preparation

- Setting of 4 competition boulders (including marked start and top positions) in submaximal difficulty
- Clearly visible numbering of the holds and footholds



### Test execution

- Observation of the 4 boulders according to the competition rules (2 minutes each)
- Filling out a questionnaire for planning the motoric realisation of the boulder
  - For each move, the number of the climbing hold or the term "wall" is entered in one line in the visualized climbing order.
- Climbing of the 4 boulders in the final modus (max. 4 minutes per boulder) with video recording

	linker Fuß	rechter Fuß	linke Hand	rechte Hand	sonstiges	
Aktion 1	1	2	3	4		Griffnummer
Aktion 2				7		
Aktion 3		5				
Aktion 4			8	9		
Aktion 5	6					
Aktion 6						
Aktion 7						



### Test evaluation

- Determination of the number of matches between visualized and actually realised movement actions. After a mismatch, the rows are skipped until there is a match again.
- After failed ascents, the match is considered up to the fall and at the next attempt the match is considered from there on.
- Division of the matches by the number of climbed movement actions of the successful attempt

### Measured value

- Agreement between visualized and realised movement actions
- Unit: %