Stichting FietsParKeur

Standards for multilayer bicycle parking systems

Version 1.0

FIETSPARKEUR

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Introduction

1.1 Cause

In 1998 the first version of the FietsParkeur Standards for Bicycle Parking Systems was published. In 2004 this document has been revised. It later became apparent there was also a need for FietsParkeur Standards for multilayer Bicycle parking systems (also referred to as multi-tiered parking stands).

Multilayer bicycle parking has thrived in recent years, due to a number of reasons:

- the development of user-friendly bicycle-parking systems;
- increasing bicycle parking pressure, particularly near train stations;
- a desire to improve public spaces in heavily-used areas.

Increasingly bicycle sheds with multilayer parking systems have appeared, more recently the large-scale use of outdoor facilities with multilayer parking systems. The growing number of multilayer parking systems make users, policymakers and manufacturers feel the need to establish uniform requirements for these systems. Stichting FietsParKeur has therefore decided to formulate standards for multilayer bicycle parking systems.

The preamble to the first version describes the genesis of the Standards for Bicycle Parking.

1.2 Introduction to the first version (November 1998)

These standards for bicycle parking systems herald the first quality requirements regarding bicycle parking systems in the Netherlands. This document aims at major improvements in the bicycle parking systems used in the Netherlands. Time will tell whether this document is satisfactory in all respects. Chances are that new types of bicycle parking systems will be developed beyond the range of this document. Moreover, techniques improve over time. This document will therefore need to be updated regularly. These standards are meant to follow social trends and certainly not impede innovation. However, the standards also do not intend to raise the threshold to using a bicycle. The standards therefore assume that bicycle parking systems for public use should be available for free. For the future the use of electronic techniques is not excluded, provided these offer clear advantages.

More development is necessary, particularly in the field of theft prevention. The requirements stated in this document are deemed to be currently attainable within reason and signify a qualitative improvement of the bicycle parking systems currently on the market. In the years to come a study will be conducted in close consultation with the industry and the Stichting ART, in order to decrease the opportunities for bicycle theft in the combination bicycle, lock and bicycle parking system. At present the following areas of improvement have been identified in bicycle parking systems:

- the facility to fasten the frame and one wheel with a single lock;
- a design that prevents the lock from being too taut when fastened (a taut lock is easier to distort);
- the fastening features to be positioned in such a way that smaller locks will suffice;
- heavier requirements for attack resistance.

1.3 Summary

Chapters 2 and 3 contain the definitions and classification of the report, while chapter 4 describes the requirements for top and bottom layers in more detail. Chapter 5 contains the product information and chapter 6 discusses in depth the test methods. The report finishes with the terms and definitions used. In the appendices the test results as well as the dimensions of the standard bicycles have been listed.

A separate appendices report, not part of the standards document, contains the background to the standards document, for instance the test results. This appendices report is available from the website of Stichting FietsParKeur.

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Definition

These standards apply to multilayer bicycle parking systems.
Multilayer bicycle parking refers to systems where bicycles are parked in two or more horizontal tiers on top of each other. The cyclist remains standing at the original ground level. This also encompasses all systems where bicycles are parked opposite and/or partially on top and below each other within a multilayer bicycle parking system (BPS).

The standards are not intended for use in automated bicycle parking systems.

The standards are also aimed at testing and evaluating other multilayer bicycle parking systems, beside those currently available. Nevertheless it is conceivable that the tests are don’t quite suit these new systems, particularly when these operate in a completely different manner. In that case it may be necessary to supplement these standards, in line with the current requirements.

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Classification

In the requirements distinctions have been made by:

- ad a) the field of application of the system;
- ad b) the location within the system.

Ad a) Regarding the field of application a distinction has been made by:

- bicycle parking systems used in a guarded environment;
- bicycle parking systems used in an unguarded environment.

This distinction is expressed in the degree of theft prevention. Some requirements do not apply to systems in a guarded environment, which will be stated at the individual requirements.

In case of intermediate environments, for instance situations with surveillance or a limited public function, a situation-specific assessment can be made.

Ad b) Regarding the location within the system a distinction can be made by:

- the bottom layer;
- the layers above.

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Requirements for top and bottom layers

4.1 Parking bicycles

4.1.1 Principal requirement

The dimensions of the BPS should allow all bicycles described in appendix 1 to be positioned in or against it in a stable fashion. Test method: empirical trials.
The handlebars should not touch parts of adjoining bicycles when moving the bicycle into or out of the system.

Test method: empirical trials by a random combination of the standard bicycles from appendix I.

Qualification: The combination of a high-positioned standard bicycle C with a low-positioned standard bicycle A/B needs to be tested in the bottom layer only.

Qualification: When positioning a bicycle next to a bicycle with panniers, the bicycle is allowed to touch the pannier. The presence of panniers should however not prevent moving a bicycle into or out of the system. In manoeuvring a bicycle alongside a bicycle with panniers one hand may be used to move the bicycles sideways.

4.1.2 Dimensions in relation to the bicycle

As an additional requirement the bicycle parking system should allow positioning of a bicycle with a tyre width of 50 mm at most.

4.1.3 Dimensions in relation to bicycle parts

The dimensions of the BPS should prevent vulnerable parts like spokes, headlight and dynamo from being damaged by the BPS when positioning as intended. Nor should cables become ensnared and/or be caught.

Test method: empirical trials by the standard bicycles from appendix I.

4.1.4 Stability

The BPS should provide a sufficient degree of stability for the bicycles from appendix I to be clasped/held in such a way that these remain upright in or against the system and not be damaged when being moved into or out of the system.

In case the BPS is intended for two-sided use, bicycles on either side should not affect each other's stability.

Bicycles on stacked layers should not affect each other's stability.

4.1.5 'Heart to heart'- distance at high/low systems

The 'heart to heart'- distance between two bicycle spaces at high/low systems and a perpendicular or oblique arrangement of the BPS should be at least 40 cm for both top and bottom layers.

The requirements in paragraphs 4.1.1 to 4.1.4 prevail over the requirement stated in this article. Deviations are possible, provided the requirements stated are met.

4.1.6 'Heart to heart'-distance at same level

The 'heart to heart'- distance between two bicycle spaces in a clamp or hanging system at the same level and a perpendicular or oblique arrangement of the BPS should be at least 80 cm 'heart to heart'.

The requirements in paragraphs 4.1.1 to 4.1.4 prevail over the requirement stated in this article. Deviations are possible, provided the requirements stated are met.

4.1.7 'Heart to heart'- distance at oblique approach

In case the bicycle cannot approach the parking space in a straight line (for instance when a sideways movement has to be made to manoeuvre the bicycle along part of the BPS), the required 'heart to heart'- distance needs to be increased by the necessary swerve distance.

4.1.8 Height difference

In multilayer bicycle parking systems the difference in height between the wheels of adjoining bicycles should be such that the bicycles do not touch each other or the system.

4.1.9 Threshold and lift heights

In systems where the front wheel is to be positioned, the threshold height of the BPS should not exceed 42 cm, on the basis of a flat floor surface.

In other systems, where the front wheel does not have to be positioned in the system, the height required to lift the bicycle into the BPS should not exceed 30 cm, on the basis of a flat floor surface.

4.2 Technical requirements

4.2.1 Safety

In case the system contains moving components, the system's movements should always be controlled and gradual. Neither seizure, release or other movements, nor the correct or incorrect operation of the system should cause uncontrolled movements of these components, constituting danger to the user.

4.2.2 Finish

Protruding parts and sharp edges

The BPS should not contain sharp edges and/or protruding parts that might injure users, catch them and/or damage their bicycles.

- protruding parts at a height between 0.8 to 2 m should be blunted and have an (end) width of at least 3.6 cm (flat part of the extremity) with a projected surface of at least 4 cm^2 (flat surface + radius of curvature);
- protruding parts at heights below 0.8 m and/or over 2 m should be blunted and have an (end) surface of at least 0.8 cm^2 (corresponding to Ø 10 mm);
- corners and edges of protruding parts should be cut (at least 2x2 mm) or possess a radius of curvature of 2 mm or more;
- the remaining edges of the BPS should have a radius of curvature of 0.5 mm or more.

Surface roughness

The surfaces of the BPS should be smooth enough not to cause injury and damage to the bicycle (for instance no wire edges, welding spatters and/or zinc droplets). To be judged by the naked eye and by touch (smooth to the touch).

Entrapment

Holes in the BPS with an insertion depth exceeding 8 mm should have a diameter <8 mm or > 25 mm at accessible locations.

4.2.3 Theft prevention

This requirement holds exclusively for bicycle parking in an unguarded environment.

The BPS should be equipped with a feature to allow the bicycle to be fastened to the BPS with an integrated or external lock.

- A fastening feature for both frame and front wheel is preferable. In addition to good theft prevention this has the advantage that users will not try and find a way of fastening their frame and front wheel to the system.
- A minimum requirement is the possibility to fasten the back wheel's rim to the system.
- In case of an external lock the feature should accommodate the locks listed in appendix I.

- The aperture taking an external lock should have a diameter of at least 6 cm.
- It should not be feasible to remove the fastening feature from the BPS.
- In case the BPS is equipped with an integrated lock, improper use by third parties should not be possible.
- The anti-theft features should be available to anyone only in possession of a bicycle and a lock, including a key (should for instance not operate exclusively with the aid of money, a chip card or any other specific item).

4.3 User requirements

4.3.1 Comprehensibility to users

The procedure for positioning and/or fastening/bolting should be clear and comprehensible and/or be clearly indicated (for instance by means of drawings).

Test method: assessment by panel (for procedure and composition of the panel see paragraph 6.4).

4.3.2 Positioning manoeuvres

After positioning the bicycle both hands should be free to operate the system.

4.3.3 Positioning effort

No excessive effort should be required to position and/or remove a bicycle and/or to operate the system. A distinction is made between efforts to initiate a movement (peak load) and efforts during ongoing movements (load over a longer time). Both types of effort should be recorded separately. The requirement for initial efforts is *150%* of the values formulated for the ongoing movements.

The force needed to operate a full and empty bicycle parking system should meet the following requirements:

- maximum force of an ongoing movement executed at a height below 135 cm above ground level is 150 N with a peak load of 225 N[1];
- maximum force of an ongoing movement executed at a height exceeding 135 cm above ground level is 100 N with a peak load of 150 N[1];
- the maximum height of the point of application of forces is 170 cm above ground level.

[1] Peak loads are only available for movements in a horizontal plane in literature. For other (for instance vertical) movements, no unequivocal standards are available. Expectations are that these are easier to execute, justifying the use of this peak load for vertical movements as well.

Moving bicycles into and out of the bicycle parking system should be feasible by lifting a single wheel. Lifting the entire bicycle is unacceptable. In addition the bicycle's angle of inclination during positioning and removal should not exceed 42º with the horizontal.

These values have been based on NEN 1005. This standard specifies that for the labour force and young adults 90% of women and 99% of men is able to carry a weight of 15 kg up to and including a point of application of 135 cm.

Test method for these requirements according to paragraph 6.5.

4.3.4 Accessibility of anti-theft feature

In case an anti-theft feature is required, this should be easily accessible (to be ascertained at full occupancy of the BPS); in addition no complex manoeuvres should be required to operate the anti-theft feature and/or fastening the bicycle to the BPS.

- operating procedures for bolts or clasps should not coincide with positioning of the bicycle.

4.3.5 Effort of anti-theft feature

No excessive effort should be required to operate the anti-theft feature.
The force required to operate an anti-theft feature present on the BPS (bolts, clasps etc.) should not exceed 100 N.
Test method see paragraph 6.6.

4.3.6 Drainage

Wheel grooves and/or moving parts of the BPS should not retain objectionable amounts of water.

4.3.7 Temperature isolation

Contact surfaces of the BPS (for instance bolts etc.) that for correct operation must inevitably be touched by the user should not be composed of metal (synthetics or powder coating etc. are allowed).

4.3.8 Damage prevention

With correct use of the BPS no damage should occur to the bicycle, adjoining bicycles, the cyclist or third parties.

4.4 Strength and durability

4.4.1 Strength

Impact

The BPS should be vandalism-proof. In tests conforming to paragraph 6.7 no breaks and/or visible cracks should appear in the BPS and the BPS should continue to function properly.

Fatigue

In case of non-rigidity of the BPS or parts thereof (10 cm displacement at a force of 250 N or less) these should be able to withstand alternating stress.
In tests conforming to paragraph 6.8 no breaks and/or visible cracks should appear in the BPS and the BPS should continue to function properly.

Removability protective parts

Parts fitted onto the BPS and intended as (protective) contact surfaces between the BPS and the bicycle and/or hands of the user should withstand for at least 3 minutes attempts to remove these parts by:

- exerting a pushing or pulling force of 150 N on the part involved and/or
- manipulation, excluding cutting movements, with pointed leverage tools like screwdrivers, knives et cetera, with a maximum length of 20 cm, with the force exerted on the tool not to exceed 150 N.

Durability moving parts

In case the BPS contains parts that are to be moved for the adequate operation of the BPS (bolts etc.) these should last at least 20.000 movements. After tests conforming to paragraph 6.8 the moving part should still function properly, the effort needed should meet the requirements of paragraph 4.3.3 and no excessive slack should have occurred.

4.4.2 Crack resistance

Fastening feature and bolt system

In case of attack of the fastening feature and/or bolt system according to paragraph 6.6, these should resist at least 90 sec. against wrongful opening and resultant removal of the bicycle.

Integrated lock

In case the BPS is equipped with an anti-theft feature with a lock, this lock should resist for at least 3 minutes against wrongful opening and resultant removal of the bicycle, when attacked according to paragraph 6.9.

4.4.3 Paint bonding

- the paint bonding should be equal to or less than class 1;
- the paint bonding is determined in accordance with NEN-EN-ISO 2409.

In case the paint layer exceeds 250 μm the paint bonding may also be determined in accordance with ASTM 3359, test method A (X-cut). The paint bonding should in that case be equal to or less than class 4A (equivalent to class 1 according to NEN-EN-ISO 2409).

4.4.4 Resistance to weather influences

Corrosion resistance

The entire BPS (including mounting materials) should be free of rust after six months of outdoor exposal or 48 hours of exposal to 'salt-spray test' ISO 9227 (to be judged by the naked eye). In case the BPS is completely galvanized, the galvanization should comply with NEN-EN-1461.

Synthetic components

Synthetic materials used should be weather-resistant (temperature, humidity, UV, ozone) to such a degree that the mechanical properties still conform to at least 80% of the original value after 15 years of use in all weather conditions.
Test method: statement of the supplier of the synthetic components or research into mechanical properties of new and artificially aged material.

Glass transition synthetics

In case a glass transition occurs at low temperatures in the synthetic materials used (the temperature at which brittleness occurs) this transition should be at or below minus 25 ˚C.
Test method: statement of the supplier of the synthetic components or research into the mechanical properties of new and artificially aged materials.

5 Information for users

5.1 Information on the product

Preferably no information is necessary on the product.
In case information is provided, the following requirements should be met:

- all information on the product relevant for the end user should be durable and applied in such a way as to be clearly visible and legible in the operating situation of the product;
- in case symbols and/or letters are used, these should display marked contrasts (e.g. by the use of black and white or primary colours);
- the type size of the information on the BPS should be at least 4 mm.

5.2 Sales information

The sales information should include the following data:

- name, address and other relevant information about the supplier (for instance telephone, fax etc.);
- model name/type BPS;
- does the BPS meet the standards with or without anti-theft feature;
- group(s) for which use of the BPS is intended (bicycle types);
- number of bicycles to be parked in the BPS;
- 'heart to heart'-distance (HtH-distance) of the bicycle places in the BPS;
- installation distance between two individual bicycle parking places;
- overall dimensions of the BPS (after installation);
- assembly/positioning;
- overall dimensions of the BPS after installation and with bicycles (length bicycle, but also (extra) space due to the width of the handlebars of the outermost bicycles);
- overall dimensions of the BPS with the space required to position bicycles (room to manoeuvre);
- assembly dimensions;
- total weight;
- in case the BPS can be disassembled, the weight of the heaviest part;

- materials and surface treatments used;
- maintenance;
- in case guarantees are mentioned, conditions should be stated (which guarantees, on what and period);
- information concerning availability in colour;
- information on sales procedure (delivery times, prices etc.).

5.3 Installation instructions

The installation instructions should contain the following information:

- assembly/ positioning instructions;
- materials and/or tools required for assembly/positioning;
- maintenance and cleaning.

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Test methods

6.1 Safety

Test method
For all moving parts that are accessible to users, in occupied and unoccupied conditions with bicycle type B:

- release moving parts with the system at rest;
- release moving parts while executing a movement;
- put pressure on the system at rest with one hand.

Requirement
The movement is controlled when the tester is able to grab hold of the system and still slow down.

6.2 Stability full

Test method
For bicycles parked on the bottom layer:

- bicycle types: ABC (see appendix I);
- 10 kg in a pannier bag on the luggage carrier; centre of gravity over the rear axle, 20 +- 2 cm below the top of the luggage carrier and 5 +- 2 cm to the side of the luggage carrier;
- measure sideways tilt of bicycle in relation to the vertical axis.

For bicycles parked on the top layer:

- bicycle types: ABC (see appendix I);
- 5 kg in a pannier bag on the luggage carrier; centre of gravity over the rear axle, 20 +- 2 cm below the top of the luggage carrier and 5 +- 2 cm to the side of the luggage carrier;
- measure sideways tilt of bicycle in relation to the vertical axis.

Requirement
The BPS should provide stability on both sides for top- and bottom-layer parked bicycles without the use of fastening or bolt features. Discernible bending or damage to bicycle parts will result in rejection of the BPS. The bicycles should not tilt more than 15º in relation to the vertical axis. See also paragraph 4.1.4.

6.3 Stability empty

Test method
For bicycles parked in top and bottom layers:
- bicycle types: ABC (see appendix I);
- measure sideways tilt of the bicycle in relation to the vertical axis.

Requirement
The BPS should provide stability on both sides for top- and bottom-layer parked bicycles without the use of fastening or bolt features. Discernible bending or damage to bicycle parts will result in rejection of the BPS. The bicycles should not tilt more than 5º in relation to the vertical axis. See also paragraph 4.1.4.

6.4 Comprehensibility BPS to users

Test method
The council of experts has requested the comprehensibility of the BPS to users be demonstrated in the following manner. A user panel is to be composed of twelve people who cycle on a regular basis. The panel is to be randomly chosen and will consist of:
- four people (two male/two female) in the age category 12-20;
- four people (two male /two female) in the age category 20-55;
- four people (two male /two female) in the age category 55-70.

Requirement bottom-layer parking
Within three attempts each member of the user panel is to be convinced that the use of the BPS for bottom-layer parking of bicycles as well as the anti-theft feature (if present) are clear and comprehensible. An attempt is made each time a bicycle touches the BPS.

Requirement top-layer parking
Within five attempts the members of the user panel from the 20-55 age category are to be convinced that the use of the BPS for top-layer parking of bicycles as well as the anti-theft feature (if present) are clear and comprehensible. An attempt is made each time the bicycle touches the BPS.

6.5 Positioning effort

Test method
The effort needed to position a bicycle into the BPS is determined empirically.

Measuring equipment: a push- pull spring balance, measuring range 0 - maximum 500 N, measuring accuracy +- 5%.

Bottom-layer parked bicycles
- bicycle type B.

Test procedure:
1. position the spring balance against/at the saddle pin immediately over the seat tube of the bicycle;
2. exert a slowly increasing force on the bicycle by means of the spring balance; the direction of the force should be parallel to the bicycle's direction of motion;
3. record the maximum readout of the force;
4. repeat this procedure five times;
5. the minimum value of the recorded measurements is the reference value.

Top-layer parked bicycles
- bicycle type B.

The motions to position a bicycle in a top layer may consist of multiple steps. An elaborate description is provided in appendix 4.
These steps may consist of:
1. positioning the entire bicycle in the bottom part of the BPS top layer, allowing it to be stable (for instance pushing it upward in a groove);
2. moving the bicycle upward in the BPS;
3. parking the bicycle (horizontal motion);
4. retrieving the bicycle (horizontal motion);
5. lowering the bicycle in the BPS;
6. removing the entire bicycle.

The execution of the test is further elaborated in appendix 2.

Recording of forces
The forces needed are recorded as either force for initiating the motion or force during an ongoing movement.

The forces are recorded in the following manner:

1. Determine where the force may best be exerted on the bicycle or the bicycle parking system, for instance seat tube, luggage carrier or handlebars.
2. Secure the spring balance to this point, in order to avoid transmission of moment to the balance.
3. Exert a slowly increasing force on the bicycle or the bicycle parking system by means of the spring balance, setting the system in motion. The direction of force should, as much as possible, be in line with the direction of motion.
4. In case a balance with a recording function is employed:
   a) record the force required to set the system in motion, and;
   b) record the maximum force registered *after* the system has been set in motion.
5. In case a balance without a recording function is employed:
   a) record the force required to set the system in motion, and;
   b) in a separate procedure: record the maximum force registered *after* the system has been set in motion;
6. Record the maximum height of the point of application of the forces.
7. Repeat these measurements nine times.
8. The minimum value of the measurements recorded is the reference value, provided it is not below 80% of the median (the middle value). In that case the reference value is considered to be 80% of the median.

Requirement

The forces required to operate an empty BPS as well as those with bicycles should not exceed the stated value.

In case other forces than previously stated need to be exerted in operating the bicycle parking system or otherwise when positioning or removing the bicycle, the force required will be recorded as best as possible.

The requirement is described in paragraph 4.3.3. Moreover moving the bicycle into the BPS (step 1) should meet the requirements of paragraph 4.1.9.

6.6 Effort of anti-theft feature

Test method

In case an anti-theft feature is present, the effort required to operate the anti-theft feature of the BPS is determined empirically.

Measuring equipment: push-pull spring balance, measuring range 0 - maximum 500 N, measuring accuracy +- 5%.

Test procedure:

1. Position the measuring device (push or pull spring balance) against/at the feature concerned. If present, use a lever on the feature as best as possible, but leave a space of at least 2.5 cm between the measuring device and the end of the lever.
2. Exert a slowly increasing force on the feature, by means of the spring balance. The direction of force should be parallel to the direction of motion of the feature.
3. Record the maximum readout of the force.
4. Repeat this procedure five times.
5. The minimum value of the recorded measurements is the reference value.

Requirement

As described in paragraph 4.3.5.

6.7 Impact strength

Test method

The council of experts has requested the impact strength of the BPS be demonstrated in the following manner. In order to test the impact strength, the BPS is to be subjected to all possible forces, for instance being jumped on or kicked against. To that purpose a worst-case plan of attack is drawn up, describing at which points and at which angles the attack should occur. The plan should be provided for inspection to the buyer of the system, if requested.

Prerequisites for the plan:

- Arrangement of the BPS as in actual practice, without bicycles.
- Vandalism mimicked by a blow with a lead ball: a horizontal force by giving the ball an oscillating movement, a vertical force by dropping the ball.
- The size of the horizontal blow (oscillating movement) depends on the height of attack: height of attack below 70 cm: vertical displacement 60 cm, height of attack above 70 cm, vertical displacement 50 cm.
- The vertical blow is only to be executed when the height of attack is less than 30 cm above a walkable part of the BPS; height of drop of the ball 50 cm.
- Improper forces on freely movable components of the PS should be included in the plan of attack and tested on bending (sideways force approx. 500 N), upward force approx. 250 N. Vertical force according to description vertical blow.
- Suspension from components of the BPS that are within reach of the walkway, at heights between 150 and 250 cm above the walkway. Attach static weight of 100 kg at 5 cm from the end of the BPS component.

Lead ball: football filled with lead shot, overall mass 25 kg.

Requirement
As described in paragraph 4.4.1.

6.8 Fatigue strength non-rigid systems

Test method
The council of experts has requested the fatigue strength of the BPS be demonstrated in the following manner. In order to test the fatigue strength the BPS is to be subjected to alternating loads in accordance with actual practice. To that purpose a plan is drawn up, describing at which points and at which angle the alternating load should occur. The plan should be provided for inspection to the buyer of the system, if requested.

Prerequisites for the plan:
- air cylinder or equivalent for alternating load;
- arrangement without bicycles.

Equipment to be used
Air cylinder (or equivalent) with an alternating push-pull force of 250 N +- 5% to be attached to the BPS. The minimum number of alternating loads is 20.000 (one push and one pull = 1 alternating load).

Requirement
As described in paragraph 4.4.1.

6.9 Attack test fastening feature

Test method
The fastening feature is intended to prevent theft of the bicycle. When testing the BPS this means that the BPS should not be the weakest link in the overall chain of theft prevention of a parked bicycle. In other words: the BPS should be stronger than the lock. Tests have been developed by Stichting ART for bicycle locks. The test of the anti-theft feature is based on the tests for bicycle locks.

Test procedure:
- a single bicycle is positioned in the BPS and fastened with a cable lock or chain;
- an attack with a metal saw (HS/HSS) should be withstood for 90 sec.;
- an attack with bolt cutters (60 cm) should be withstood for 90 sec.;
- the tools to be used at own discretion;
- if the bicycle is damaged as a result of the test, this is acceptable provided it does not interfere with the bicycle's performance;
- the BPS is rejected if the bicycle can be freely moved within an attack time of 90 sec.

Requirement
As described in paragraph 4.4.2.

7

Terms and definitions

7.1 Terms and definitions

Anti-theft feature
Feature on a BPS that allows fastening a bicycle to the BPS, possibly by means of a lock.

Bicycle parking facility
The bordered space designated for parking bicycles.

Bicycle parking system (BPS)
Construction designed to provide sufficient stability to one or more bicycles parked in or against the system.

Bottom-layer bicycle parking
Arrangement where bicycles are parked in the first horizontal layer, below those parked on top (in one or more tiers).

Fastening feature
Feature on the BPS that allows fastening of a bicycle to the BPS by means of an external lock.

Guarded environment
The location is guarded by staff.

Heart to heart (HtH)
Distance between the midpoints of two adjoining bicycle places (measured perpendicular to the heart line of the place).

High/low (H/L)
A BPS with alternating high and low bicycle parking places.

Installation distance
The distance between the midpoints of two bicycle parking places.

Lift height
The difference in height between the ground and the height where the effort is reduced thanks to (some) support of part of the BPS.

Multi-stack bicycle parking
Multi-stack bicycle parking refers to a situation where bicycle are parked in two or more horizontal tiers on top of each other. The owner of the bicycle remains at ground level.

Non-rigid system
A BPS or one of its components that deforms elastically by 10 cm under a load of 250 N or less (upon removal of the load the component reverts to its original position).

Oblique arrangement
Arrangement of bicycles in one or more BPS where the bicycles are not perpendicular but at an angle to the construction of the BPS. (The angle provided is the angle of rotation of the bicycle place.)

Rack
BPS meant for more than two bicycles.

Straight arrangement
Arrangement of bicycles in one or more BPS where the bicycles are perpendicular to the construction of the BPS (angle 0^{o}).

Threshold height
The difference in height between the ground and the highest level in the BPS that the front wheel of a bicycle has to clear in order to be positioned in the BPS.

Tiered stand (double layer bicycle parking)
The BPS allowing parking of bicycles both at (or slightly above) ground level and at a height (of approx. 1.25 m).

Top-layer bicycle parking
Parking a bicycle in the second or higher horizontal tier, on top of the bicycles parked in the bottom layer.

Two-sided (TS)
A BPS where bicycles can be parked on either side of the system.

Appendix 1A

Description of bi-cycles and locks

Standard bicycles

The table provides a list of the particulars of the standard bicycles.

	standard bicycle a	standard bicycle b	standard bicycle c
	city bike large	hybrid large	city bike small
wheel size	28”	28”	26”
tyre width	40 mm (1)	40 mm (2)	30 mm (3)
handlebar width	650 mm (4)	650 mm (5)	550 mm (6)
handlebar height including bell	121 cm (7)	121 cm (8)	105 cm (9)
bell height	3 cm (10)	2 cm (11)	3 cm (12)
seat height	110 cm (13)	108 cm (14)	90 cm (15)
bicycle length	187 cm (16)	183 cm (17)	170 cm (18)
mass	22 kg (19)	23 kg (20)	16 kg (21)
brakes	hand-operated cable brakes ex factory	hand-operated cable brakes ex factory	hand-operated cable brakes ex factory
light	wheel dynamo left front headlight 9 cm diameter on stem	wheel dynamo left front headlight 7 cm diameter over front fork (top light at 15 cm above top front wheel)	wheel dynamo left front headlight 8 cm diameter on stem

1 96% upper limit from measurement city bikes
2 97% upper limit from measurement hybrids
3 10% lower limit from measurement city bikes
4 98% upper limit from measurement city bikes
5 98% upper limit from measurement hybrids
6 median (50%) from measurement city bikes
7 90% upper limit from measurement city bikes
8 80% upper limit from measurement hybrids
9 9% lower limit from measurement city bikes
10 lower limit additional sample
11 lower limit additional sample
12 lower limit additional sample
13 95% upper limit from measurement city bikes
14 95% upper limit from measurement hybrids
15 >4% (10%) lower limit from measurement city bikes *
16 95% upper limit from measurement city bikes

17 95% upper limit from measurement hybrids
18 >5% (29%) lower limit from measurement city bikes *
19 95% upper limit from measurement city bikes without attributes
20 90% upper limit from measurement hybrids without attributes
21 > 6% (12%) lower limit from measurement city bikes *

*) At the low end of the measurement range seat height, bicycle length and mass increase abruptly. A decision was made to use the standard (higher) values instead of the unusual lower values.

Locks

To determine the usefulness of the anti-theft feature the following locks (including keys) are used:

- chain lock (for instance ABUS Granit City chain x-plus 80-100 cm);
- U-lock (for instance Luma Solido Shackle (140 x 100 mm, 140 x 250 mm or 140 x 310 mm).

Appendix 1B

Test bicycles

Equivalent to the standard bicycles as described in appendix 1A the following test bicycles have been purchased, available at that particular time (2010 models):

Standard bicycle A

- city bike large: Gazelle Orange Excellent 65 cm, men's type;
- wheel size 28 inch;
- length 187 cm;
- with dynamo;
- handlebar and seat heights set in accordance with standard bicycle;
- pannier, if any: width 15 cm.

Standard bicycle B

- hybrid: RiH Z-700 65 cm, men's type;
- loaded with additional weight to the frame, at the bottom bracket spindle, to an overall weight of 23 kg;
- wheel size 28 inch;
- length 183 cm;
- with dynamo;
- handlebar and seat heights set in accordance with standard bicycle;
- pannier, if any: width 15 cm.

Standard bicycle C

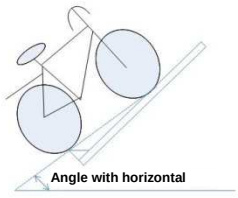
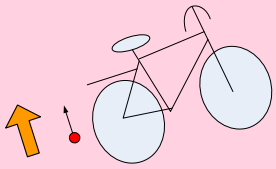
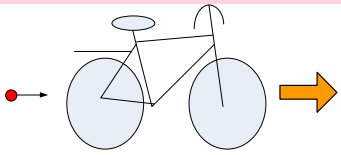
- city bike small: Alpina Twirl 42 cm, ladies type;
- provided with adapted handlebars at a width of 55 cm;
- wheel size 26 inch;
- length 173 cm;
- with dynamo;
- handlebar and seat heights set in accordance with standard bicycle;
- pannier, if any: width 15 cm.

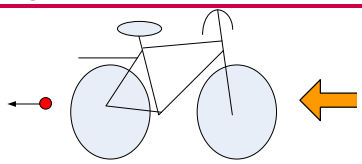
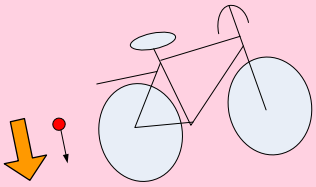
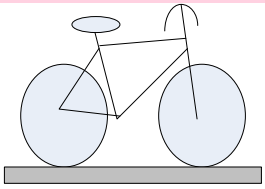
Appendix 2

Execution operational forces

Legend
Bicycle direction of movement

Application point force

step	description	figure	record force without bicycle	record force with bicycle
1	Place the entire bicycle in the BPS in a stable position (for instance riding upward in a groove).		Not applicable.	- No force measurement. - Lift threshold maximum 42 cm. - Maximum angle bicycle and horizontal 42º.
2	Move stabilised bicycle upward.		- Application point force at handle BPS. - Record ongoing force and initial force perpendicular to pivot point, if any.	- Application point force at BPS handle. - Record ongoing force and initial force perpendicular to pivot point, if any. - Stabilisation of bicycle by other means than BPS not allowed.
3	Park bicycle, horizontal movement.		- Application point force at handle BPS. - Record ongoing force and initial force in line with direction of movement.	- Application point force at BPS handle. - Record ongoing force and initial force in line with direction of movement. - Stabilisation of bicycle by other means than BPS not allowed.

step	description	figure	record force without bicycle	record force with bicycle
4	Remove parked bicycle, horizontal movement.		- Application point force at handle BPS - Record ongoing force and initial force in line with direction of movement	- Application point force at handle BPS - Record ongoing force and initial force in line with direction of movement - Stabilisation of bicycle by other means than BPS not allowed
5	Lower bicycle.		- Application point force at handle BPS. - Record ongoing force and initial force perpendicular to pivot point, if any.	- Application point force at handle BPS. - Record ongoing force and initial force perpendicular to pivot point, if any. - Stabilisation of bicycle by other means than BPS not allowed.
6	Remove bicycle from BPS and put unsupported on ground.		Not applicable.	- If applicable in system. - No registration of force. - Lift threshold maximum 42 cm.

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