

Monitoring and continuous maintenance of monuments and historic buildings

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Monitoring and continuous maintenance of monuments and historic buildings

1. The traditional and modern structural system of the buildings
2. Use of the historic technologies
3. Existing maintenance systems
4. Development of maintenance systems
5. The work of maintenance systems



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The traditional and modern structural system of the buildings



traditional



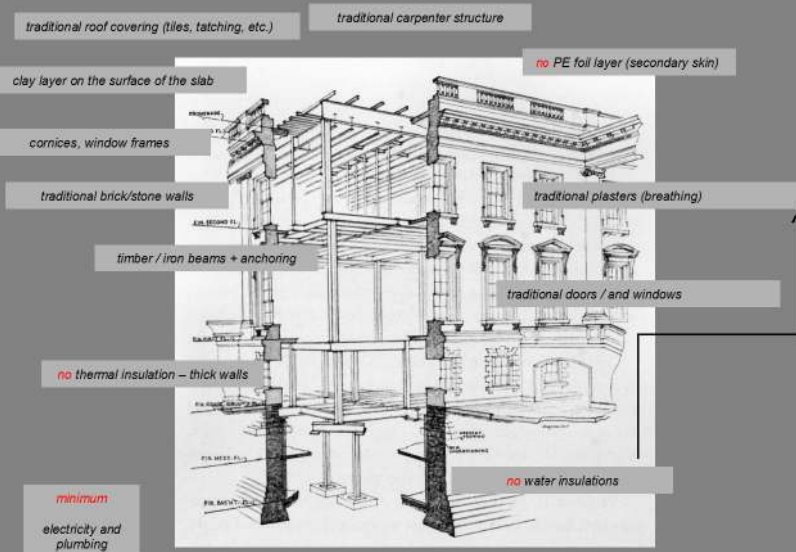
modern

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The traditional structural system

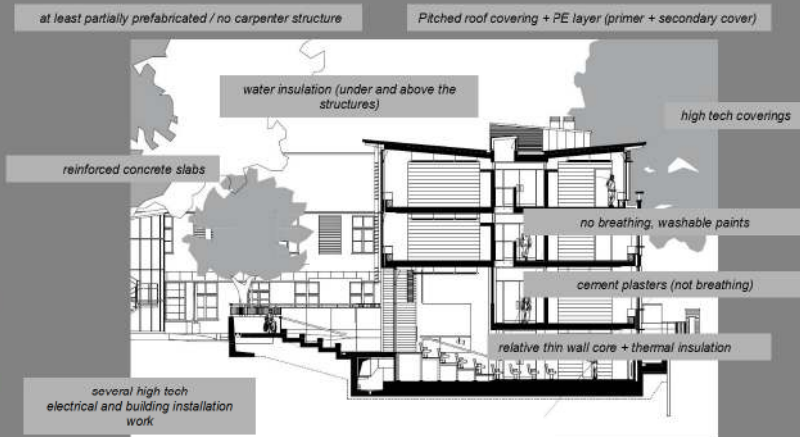


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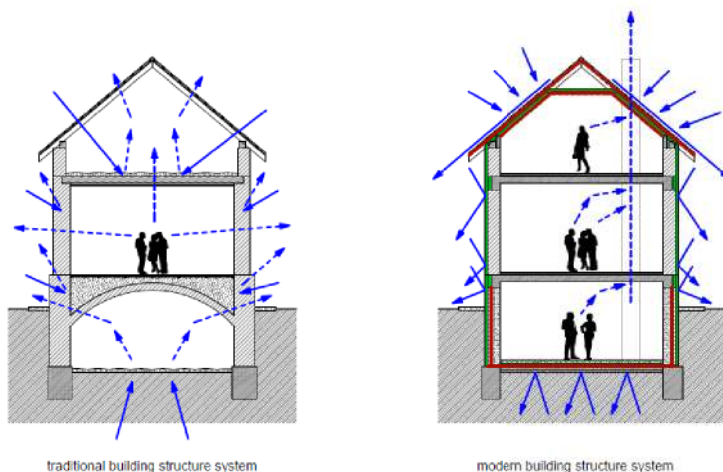
The modern structural system



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The structural system of the buildings

*heat insulation with the
mass of material*

insulation with coating

*the system lets
moisture (vapor) in the
structure, and helps it to
evaporate*



*The system does not let
moisture in the
structures*

*to be restored with
traditional materials
(+ technology)*

*to be restored with
modern materials
(+ technology)*

traditional

modern

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Historic technologies

...technologies of
historic trades, that not
anymore used among
the modern
construction activities



time-consuming decoration
techniques - appear as
applied art

replaced by advanced techniques

e.g.

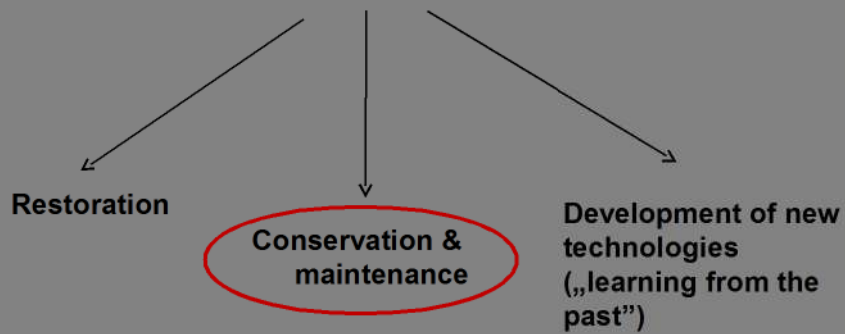
- pargetting
- traditional plasters
- smithcraft
- stone masonry
- traditional carpentry

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The application fields of historic technologies



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maintaining
and
restoring

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Maintenance:

Preservation of the proper state of buildings with continuous monitoring and correction of failures.

Restoration:

Construction process aiming the proper state of the building, after it has been more or less lost.

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The importance of the maintenance systems

DEF.:

a **service system** for the regular control and continuous maintenance of the buildings

- performed by non-governmental, non-profit organizations
- voluntary to be joined
- specialized trade personnel are employed

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Organizations

Monumentenwacht Neederlanden, Netherlands

- the first maintenance service
- founded in 1973 as a private initiation
- territorial organizations and a national umbrella organization
- 52 group - 15 000 investigated building
- partially supported by the state – for a minimum amount of monitoring activity
- being a member of maintenance service is a necessary condition of the national grants for restoring buildings

Monumentenwacht Vlaanderen, Belgium

- founded in 1991
- follows the Dutch model
- today nearly 10 000 buildings are investigated

Maintain our Heritage + Bath Preservation Trust, United Kingdom

- operating since 1999 – a federative organization of some maintaining services
- pilot project in 2002-2003

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Organizations

BAUDID, Germany

- federative organization of different monument services

Byngingsbewarings, Denmark

- the total costs of the organization are paid from the fees of the owners exclusively

MAMÉG, Hungary

- since 2006
- independent foundation
- the Dutch Monumentenwacht was the model
- centre in Veszprém - representatives in many counties

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Organizations

Historic Scotland, United Kingdom

- governmental organization
- provide information and professional help to the owners for continuous maintenance

NIKU, Norway

- non-governmental foundation
- researches on monuments
- help the owners to maintain and restore the buildings properly

Porta Speciosa, Hungary

- since 1995
- non-profit organization
- federation of professional maintenance specialists
- focusing on the challenges of the monitoring

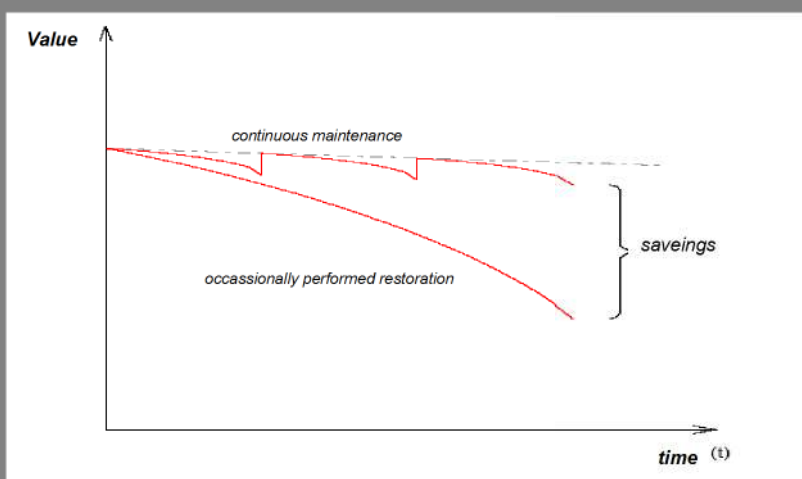
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What is the benefit of the maintenance service?



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What is the benefit of the maintenance service? - Validation



six historic buildings

- a treadmill,
 - a cottage,
 - two villas,
 - a traditional apartment-house,
 - a church
-
- different size
 - (more or less) different functions
 - no restoration in the last decades (15 years)

visual diagnostics (on the present state)

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What is the benefit of the maintenance service? - Validation

+

reference building

- regular inspected
- continuously maintained

listing the maintenance works of the last few year

calculation of the fictive annual cost of the
maintenance for every six buildings

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What is the benefit of the maintenance service? - Validation

Comparison of costs in case of occasionally performed renovation and continuous maintenance

Building type	Annualized cost of the restoration after 15 years of negligence (EUR)	Annual average costs in case of regular maintenance (EUR)	Savings (EUR)	Savings (%)
treadmill	335	183	152,03	45%
cottage	2 359	1 337	1021,84	43%
smaller villa	2 518	2 095	423,72	16%
church	1 124	722	401,71	36%
larger villa	4 596	839	3757,56	82%
apartment house	2 555	419	2135,97	84%

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How can the optimal operation be ensured?

- *adequate approach of the **owners***
- *development of a **maintenance / conservation system***
- ***support** of the **state** (legal, financial)*
- ***support** of the **professionals***
- *standards, **guidelines***

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How were organizations established ?

- **development** of the system of the services
 - non-profit (e.g. foundation) / profit oriented company*
 - by location / by function*
- the **characteristics** of the federative / umbrella organization
 - governmental / non-governmental*

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What are the main challenges?

- there is **no** received **standardized system**
- there is non-satisfying amount of standards, **guidelines**, regulations
- **limited** financial **sources** of the owners
- **lack of specialists** and experts (technician, engineers, skilled worker)

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The possible solutions

- establishing **umbrella organizations**, ensure cooperation of the existing initiatives, development of guidelines or standards
- training more **skilled workers** and technicians (governmental responsibility)
- governmental **support** system
- **informing** and supporting the owners

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The work of maintenance systems

- Diagnostics for monitoring historic buildings
- Indicators -> actions / treatment

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The possible procedures

Three different level of diagnostics

- **local monitoring** (e.g. by caretaker/owners) (site-based diagnostics)
- **start-up diagnostics** (structure- and impact-based diagnostics)
- **continuous – maintenance monitoring diagnostics** (structure- and impact-based diagnostics)

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Maintenance protocol for owners and caretakers

Daily work	After storm, windstorm, earthquake
handling of doors and windows (providing fresh air, closing windows before rain or in case of wind, etc.)	controlling the rainwater goods, the roof coverings, the soundness of the doors and windows (in case of storm, windstorm)
removal of the fallen leaves (at accessible places), take care of vegetation around the building	controlling soundness of load bearing structures, façades (in case of major storm, earthquake)
cleaning the windowsills, the terraces, and the sidewalks around the building	controlling the soundness of superstructures on roof (antenna, cable-pylon, chimneys) (in case of storm, windstorm, earthquake)
removal/handling of snow and ice (avoiding salt if possible)	removal of debris, bough, etc. from roof, sills, balconies, terraces (in case of storm, windstorm)
controlling, cleaning and treating the claddings, coverings and the furniture	
controlling the installations (heating, water supply, etc.)	
controlling the lamps, changing light bulbs in time	
In case of need call for the monitoring service!	

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Types of diagnostics used for the service system

	visual	instrumental
site-based	X	
structure-based	X	X
impact-based	X	X

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Site-based diagnostics

The state of the building is recorded by the sections of it e.g.:

- *facade sections*
- *rooms*

In most of the cases

- *monitoring is performed by the caretaker*
- *simple state recording*

mainly visual diagnostics

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Structure-based diagnostics

The state of the building is recorded by each structural part e.g.:

- foundation
- wall structure
- slabs
- roof structure
- claddings
- etc.

Typical at the specialist (e.g. static) investigation

- before restoration
- at case of sale
- after disaster

visual and instrumental diagnostics

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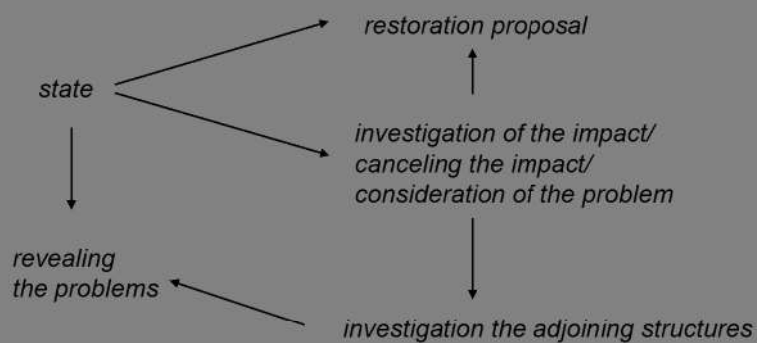
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Impact-based diagnostics

Recording the state of the building by the impact on the building



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Typical impacts / groups of impacts

- rain
 - windblown rain
 - failure of the rainwater goods
 - failure of the roof
- humidity
 - broken pipes
 - vapor
 - moisture from the soil
- biological impacts
 - plants around the building
 - biological pests (fungi, insects)
- movement of the building
 - sinking
 - vibration
- air
 - wind (erosion)
 - air pollution (corrosion)
- material incompatibility
- alteration of the climatic conditions
 - new function (vapor, lack of ventilation)
- construction failures

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Non-destructive testing

Material	Structure	Testing methods
wood	carpenter structures, railings	sampling, fungiology
	wooden floors	
	doors, windows	
	wooden wall coverings, furniture	
	shingles	sampling (element)
concrete, reinforced concrete, artificial stone	foundation walls	Schmidt hammer – surface hardness test, concretoscopy, corrosion test of the steel reinforcement, carbonation test
	walls	
	beams, slabs	
metal (wrought iron, steel, cast iron, copper, bronze etc.)	grills, railings	hardness test, ultrasonic and X-ray test, penetration test, sampling
	metal roof	thickness test, corrosion test
	Installation, wiring (pipes, radiators, lamps)	corrosion test, surface hardness test
ceramic	wall	sampling, microscopy
	tiling (ceramic tile)	sampling (elements), microscopy
	slab system	sampling, microscopy
	floor and wall tiling	sampling, microscopy
stone	wall	sampling, microscopy
	facade covering	sampling, microscopy
	floor	sampling, microscopy
	stair	sampling, microscopy
	slate (roof covering)	sampling (element), microscopy
mudbrick	wall	sampling, strength tests, composition analyses
mortar (cement mortars, lime mortar)	joints, pointing	sampling, composition analyses
	plaster	sampling, mineralogical analyses
glass	window glazing (simple, stained glass)	sampling

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Destructive testing methods

Material	Structure	Testing methods
wood	carpenter structures, railings	sampling, strength test
	wooden floors	
	doors, windows	
	wooden wall coverings, furniture	
	shingles	
concrete, reinforced concrete, artificial stone	foundation walls	sampling, strength test
	walls	
	beams, slabs	
metal (wrought iron, steel, cast iron, copper, bronze etc.)	grills, railings	sampling, strength test, metallography
	metal roof	
	Installation, wiring (pipes, radiators, lamps)	
ceramic	wall	sampling, strength test
	tiling (ceramic tile)	
	slab system	
	floor and wall tiling	
stone	wall	sampling, strength test
	facade covering	
	floor	
	stair	
	slate (roof covering)	
mudbrick	wall	load capacity test
mortar (cement mortars, lime mortar)	joints, pointing	large-scale sampling (composition analyses, strength test)
	plaster	
glass	window glazing (simple, stained glass)	sampling, composition analyses

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Indicators

DEF.:

The indicator helps us to evaluate a procedure:

- **Where are we standing?**
- **Which direction** we have to follow?
- **How far** are we from the aimed goals?

Proper indicators indicate the problems in proper time, and help to recognize the duties to be done.

indicators

Which case do we need intervention for?

Which case have to be a contractor involved in the restoration works?

Which case have to be specialists involved in?

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Indicators

1. When do we need intervention?

If the failure of a structure likely

- to cause the further damage of the structure
- or to jeopardize the soundness of another structures.

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Structure		State Indicator
Pitched roof	covering	missing, dislodged, broken elements
	carpenter structure	discoloration
	flashings	corrosion spot, fracture, hole
	rainwater goods	silt, dislodging elements
	eaves	lack of paint, (moisture) staining
Flat roof	surface	lumpy surface, puddles, optical mutation of the insulation material, obturation of downpipes
	flashings	corrosion spot, minor holes, cracks
Walls	plaster	staining, planar grows, missing spot
	wall	minor cracks, staining, damp
Slabs	wood	staining, failure of the surface
	stone, brick	minor cracks
Inner coverings	wood	staining, wearing of coating (paint, lacquer), deformation
	ceramic, stone	crack, failing elements, deterioration
Footing	staining, cracks, dislodging	
Doors, windows	metal	distortion, failure of the painting, broken glass, missing putty
	wood	distortion, failure of the coating, broken glass, missing putty
Railings, grills	metal	missing paint, corrosion spot, missing fixing elements
	wood	damaged coating, abrasion, missing fixing elements
Surroundings of the building	pavement	cracks
	plants	plants, vegetation in the direct surrounding of the building

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Indicators

2. Which case have to be a contractor involved in the restoration works?

*If the volumen of the work is too large
or the technical preparedness
of the monitoring personnel is not enough
for the on-site repair.*

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Structure		State indicator
Pitched roof	covering	remarkable amount of damaged elements
	carpenter structure	damaged structural element
	flashings	remarkable amount of corrosion spot, fracture,
	rainwater goods	failing parts, fatal damage of components
	eaves	material decay
Flat roof	surface	flooding
	flashings	remarkable amount of corrosion, holes, etc.
Walls	plaster	large scale crumbling
	wall	damaged wall sections
Slabs	wood	damaged beams
	stone, brick	breakthrough
Inner coverings	wood	remarkable bending, material decay
	ceramic, stone	material decay
Pitched roof	covering	remarkable amount of worn, cracked, missing elements
Footing	major crumbling and dislodgement	
Doors, windows	metal	major corrosion
	wood	material failure
Grills, railings	wood, metal	remarkable decay of material
Building installation	brick chimney, stove	cracking, failure of the elements
	metal, ceramic, enamel pipes	leakage
Surroundings	pavements	sinking, dislodgement
	plants	structural damage caused by plants

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Indicators

3. Which case have to be specialists involved in?

- If the state of the structure can not be detected by visual diagnostics (e.g. instrumental diagnostics)
- If the monitoring personnel are not competent in the required (special) fields of knowledge (e.g. statics, fungiology)

The studies of specialist experts have to be done before the restoration works starts!

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Structure		State indicator	Needed specialist
Carpenter structure		distortion, dislodgement, damage	statics
		damage by fungi or insects	fungiology, insectology
Flat roof		flooding	building insulation
Foundations		sinking, leaning	statics, geotechnician
Walls	plaster	large scale damage	material composition analyses, petrography
	wall	major crackings	statics
		crumbling of the material	material composition analyses,
Slabs	wood	damage of the beams	statics
		damage by fungi or insects	fungiology, insectology
	stone, brick	braktrough	statics
	Reinforced concrete, steel beams	major bending, damage	statics, material composition analyses
Inner coverings	wood	damage by fungi or insects	fungiology, insectology
Footing (stone, brick, mortar)		major damage or dislodgement	material composition analyses, petrography
Doors, windows	metal	remarkable corrosion	material composition analyses, metallography
	wood	decay of the material	fungiology, insectology
Grills, railings		remarkable corrosion, decay of the material	material composition analyses, metallography, fungiology, insectology
Building installation	chimney walls, stoves	major cracks and damages,	statics, building installation specialist
	Metal chimney, pipes, iron stoves	corrosion, cracks, fracture	metallography, metallurgy, building installation
	non-metallic pipes	hole, fracture	building installation
Surroundings	plants	structural damage caused by plants	statics, gardening
	soil	dislodgement, landslide	soil mechanics

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Treatments

1. diagnostics of the state
2. decision about the fact, whether treatment is required
3. analyses (getting information on the building and on the technologies)
4. decision about the treatment (material and technology)

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Influencing factors (choosening technology and material)

1. Protection of the building (legal)
2. The original structure (material, technology)
3. The use of the building (function)
4. The aim of the restoration

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Thank you for your attention!

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