Question forms must be handed in!

Faculty of the Built Environment
Unit BPS

Exam : 7S7X0 Materialization of facades and roofs
Time : 18:00 – 21:00 hrs.
Date : 29 June 2017

Student number: ……

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ANSWERS ARE AVAILABLE, SEE LAST PAGES.

Question 1

Describe the general (= typical, = characteristic) long term behavior of a normal reinforced concrete (: a column, a roofing beam, a floor slab, etc.). *Note: do not describe damages!* (1 points)

A) ……
……
……

B) Name & sketch three modes of failures of concrete that can occur, due to circumstances. (2 points)

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Question 2

A) Describe the general (= typical, = characteristic) long term behavior of a wood element. *Note: do not describe damages!* (2 points)

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B) Name and sketch two modes of relevant failures that might occur, due to circumstances. (2 points)

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Question 3 (3 points)

Which are two essential differences between monolith facades (: one-material structures) and the modern façades with concern to its *resulting performances*?

A) Structural load bearing; waterproofing.
B) Wind loads transfer; occurrence of vapor diffusion and application of a vapor barrier.
C) Occurrence of vapor diffusion and application of a vapor barrier; structural load bearing.
D) Waterproofing; wind loads transfer.

Question 4 (4 points)

Give and describe four different types of air cavity façade, and make adequate sketches of two of them in which *air flow* is important. (: Schematic). Note that full points are for a fully satisfactory answer only.

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Question 5 (3 points)

A drawback of a curtain façade is keeping an indoor climate stable temperature-wise. Therefore one may need some help from the façade; how could one possibly arrange this?

A) If one could use a variety of glazing with a high rate of selectivity.
B) If one may reduce the thermal mass of the façade and rooms.
C) If one could unblock solar radiation as possible.
D) If one could apply a cavity in connection to both indoor and outdoor environments.

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Question 6 (3 points)

Describe in proper (= explanatory) terms any mass diffusion process, and give an example.

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Question 7

A) Two kinds of moisture contents of wood are often used in practice. How are these data related to some microstructure of wood, so indicate in it where the water is measured? (3 points)

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B) Give a clarifying sketch of sap wood's microstructure and register where moisture can be positioned. (3 points)

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Question 8 (4 points)

Procedure /method: One of the novel and interesting methods to be understood for assessing facades and roofs is the application of the method called: Failure Modes and Effect Analysis.
What is its much applied 'internal categorization', and give two agent-examples per category.

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Question 9

A) Which process is responsible for a progressive deformation if loads are constant? Give also a definition of it. (2 points)

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B) For which building applications and/or (building) materials is this process best known and should it be carefully checked or researched? Mention two. (2 points)

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Question 10

A) If one considers a choice between different possible materials for one application, one analyzes systematically the pros and cons. Give at least six pro's or cons (: points of attention) when you must argue *for* or *against* a façade that is going to be made out of: - glass or - PMMA /PC. (3 points)

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B) Illustrate for two of the given arguments the importance by a clarifying sketch showing the meaning of this argument for the performance or design of the roof. (2 points)

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Question 11

Sketch an inverted roof, and name its regular (material) components. (4 points)

Sketching space: use the backside of this page

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Question 12 (3 points)

Draw the principle of a pressure equalizing, insulated and double-layer wall structure.
PS.: Indicate in the sketch the functions of the different parts and of the relevant aspects.

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Question 13 (3 points)

The steel reinforcement in hardened concrete is no longer passivated if:

A) Fe_2O_3 part of matrix is absent.
B) Water has entered the concrete.
C) $Ca(OH)_2$ part of matrix is consumed.
D) C-S-H part of matrix is depleted.

Question 14 (3 points)

Which of the following statements regarding green facades is true?

A) In the system with pre-fabricated 'growth plates', lined with membranes, in which plant bags are made and the whole is mounted on a steel base frame, wetting takes place by an overflow system.
B) Vegetated walls are usually wetter than not-covered walls.
C) Vegetated walls are usually dryer than not-covered walls.
D) The contribution of greening facades to the binding of particulate (fine) dust is generally modest to bad.

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Question 15

The photo shows a detail of an innovatively constructed facade.

A) What kind of facade variety is applied here most probably? (2 points)

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B) Argument the pros and cons of the facade in terms of performance and behavior? (4 points)

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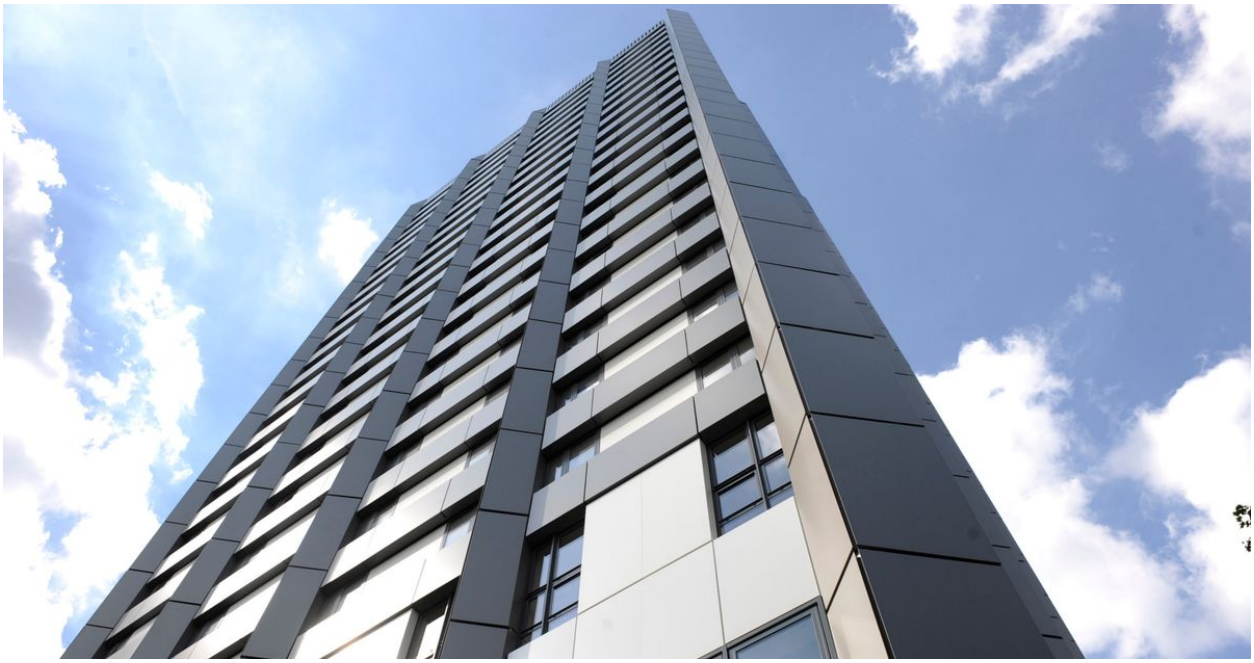

Photo: Grenfell Tower, London. (Actual news: Known for catastrophic combustion)

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Question 16 (3 points)

Which statement about concrete is correct?

A) CEM II is a Portland cement and CEM I a blast furnace slag cement.
B) CEM II is a Portland fly ash cement and CEM III a blast furnace slag cement.
C) CEM I is a Portland fly ash cement and CEM III a blast furnace slag cement.
D) CEM III is a Portland fly ash cement and CEM I a blast furnace slag cement.

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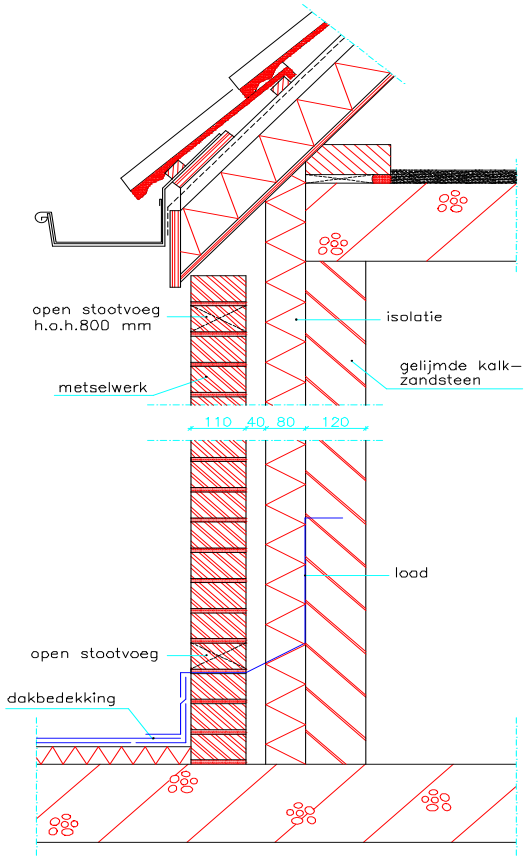
Question 17 (3 points)

The figure shows a cross-section of a masonry facade. Which of the following statements about the structure or details is true?

A) The open vertical joints do not have a meaning to the upper side of the outer leaf.
B) All varieties of brick can be used in this construction.
C) It is essential that the inner leaf is air tight.
D) It is of importance that the air cavity is ventilated with outdoor air.



English legend:

Notes left:
- Open butt joint, regular distances of 800 mm.
- Brickwork
- Open butt joint

Notes right:
- Thermal insulation
- Glued calcium-silicate brick
- Lead flashing

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Question 18

The following picture shows an example of an integrated PV system in a sloping, tiled roof.

A) What has been done wrongly in this example? (1 point)

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B) In applying sun-energy systems on pitched roofs, one choses in these days much more often for an integrated system; name three important aspects for assessment. (3 points)

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C) Name 2 important requirements that must be attributed to the substructure or subsystem of the roof. (2 points)

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Question 19 (3 points)

The strength of concrete is increased if one uses:

A) Silica fume and a superplasticizer.
B) Crushed concrete as aggregates, and silica fume as filler.
C) Alluvial aggregates and a superplasticizer.
D) Blast furnace slag cement and course gravel.

Question 20

Explain by sketching plus some explanation, the freeze thaw mechanism inside porous and brittle materials. (Stone, bricks, concrete, etc.). Answer as well:

- Why (: what is the material-critical point (2 point)
- When exactly (: in which time-bound, geometrical / physical condition(s), (2 points)

(Total: 4 points)

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Question 21 (3 points)

Using photocatalytic TiO_2 on a concrete surface makes:

A) The surface hydrophobic and air-purifying.
B) The surface hydrophilic.
C) The surface hydrophobic and self-cleaning.
D) The surface hydrophilic and self-cleaning.

Question 22 (4 points)

When and why can you use a (much more expensive) aluminium roof substructure?

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Question 23 (4 points)

Name four important metal alloys used in the building industry, and deliver for each a possible sketch for one of their applications.

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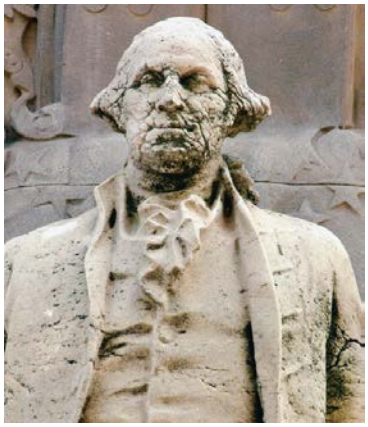
Question 24 (4 points)

These metal degradations are essentially different. What is their difference? Explain briefly.



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Question 25 (4 points)

Some metals, and also other materials, have a natural layer which protects them against aggressive circumstances.
How is this layer called (1 points), and how does it work in detail (2 points)?

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Question 26 (4 points)

An architect has the idea to apply a metal façade- or roof cladding, using different metals for each plate according to the precise pattern that you see in the picture below.
Analyze occasional problem(s), and further on: sketch a solution.

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Sketch on backside.

The End.

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Dear student,

Each year the exam of this course has a little bit of focus. In the year 2016-17 the focus was certainly durability. That is why there are so many questions here on this topic.

The focus of 2017-2018 will be a bit less on durability, but anyhow it is appropriate to study these questions. Below I have answered them; we hope it will help you to prepare for the next exam(s).

Answers:

1): A Mechanical stable; although can be prone to elastic deflection or to creep.
Physically /chemically stable if the cover is appropriate (wide enough) and the materials density is adequate and the surface is homogeneous (: of composition).
(Biologically stable if pH of surface is still alkaline; later it can be grown with mosses or algae.)
B Freeze-thaw attacks (flaking); leaching out of whitish Ca(OH)2; tension relaxation + deflection (post-tensioned members); carbonation (rust of steel reinforcement); chloride ingress, etc.

2): A Mechanical and chemical stable except for creep when a member is much loaded.
Physically wood is not stable: it reacts on water ingress and on vapor (: hysteresis) and absorbs water in two of its internal systems.
Biologically timber is also not stable: it may rot and be eaten by insects. There are as the book shows, many varieties in this degradation mechanism.
B Failures are wood rot in the corners of window frames, or in any place where abundance of water can be stacking. Another is warping, another is shrinking when it is not allowed. Think for yourself an application where this is valid. Also algae growth or uneven discoloration are to be seen as failures.

3) Waterproofing performance is (quite) the same; some leakage water is in both allowed, but it should not actually penetrate into the interior.
Wind load transfer is an equal performance as interpreted in these systems as well: walls should resist pressure- and suction forces of wind; a layered system is no benefit or disadvantage to this.
Left is only: C), occurrence of vapor diffusion and application of a vapor barrier and structural load bearing.
Explanation: in the occurrence of vapor diffusion and application of vapor barrier it can make a difference, as in the monoliths it is usually <u>not</u> necessary to apply vapor barriers. Also does the structural load bearing performance differ between monoliths and cavity walls; monoliths carries loads integral, while in cavity walls loads are carried by inner leafs only.

4) Drawings of a: - warm cavity walls, - a cold cavity walls, - a double cavity wall (second skin on outside), - a climate facade (second skin on inside). An explanation is asked on the various functions of

these systems for building physics. E.g.: extra internal comfort, extra energy saving, extra ventilation comfort, extra inside-outside space utility, etc.

5) Answer A: If one could use a variety of glazing with a high rate of selectivity, **is good.**

6) Mass diffusion is a process by which a volume with a higher concentration of some material (gas, liquid, solid: very slowly) transfers into a volume with a lower concentration. Typical in mass diffusion is hence: the concentration gradient which determines the speed (magnitude) of the process.

Examples are: water diffusion (vapor) in wood by seasonal influences (hysteresis), or in ceramics (liquid water with solvents). It will leading to expansion, to shrinkage or to efflorescence of these materials. Also it occurs inside cavities of glass (by vapor intrusion), or with plasticizer in PVC, called plasticizer migration.

7) Two systems within wood are taken into consideration: - the lumen capacities and the cell wall pores capacities. Both can be filled (satisfied). Usually the water is measured from the cell wall tissue, up to ca. 30% moisture content. Later the lumen capacities is added on this, up to 200% moisture content. Moisture content is taken against a dry weight of the wood, so against moisture content 0%. Sketches: tissue sketch 3D (look up) and cell wall sketch indicating the pores within.

8) Questions on F.M.E.A. will not be asked this year.

9) A) This is the process called creep. Definition: creep is a process of deflection of a solid over time which is subjected to a continuous and stable load.

B For: timbers and polymers. For these materials the effect can be significant after a time: -> several times the initial elastic deflection.

10) Pro's of glass: - hardness (surface property); - stiffness (: bigger spans possible); - less creep (id.); - acoustic insulation (: mass related); less thermal expansion; durable for many agents; (costs!); quite safe in case of a fire.

Pro's of polymeric sheets: - less density (: weight reduction); - larger spans; - better impact resistance; better thermal insulation; - better transfer of UV radiation (plants growth is better possible).

Easy sketching.

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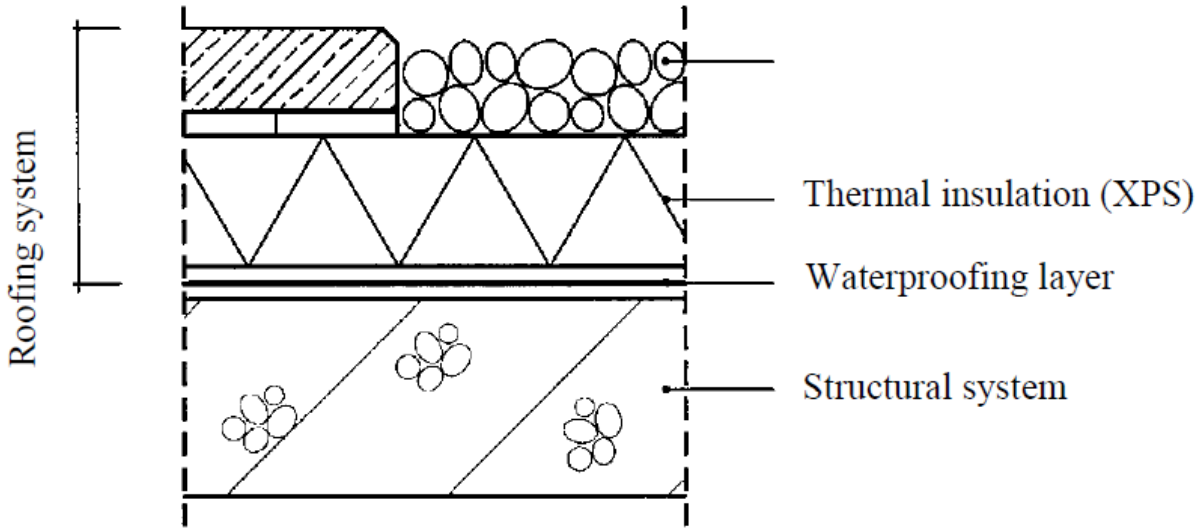
11):



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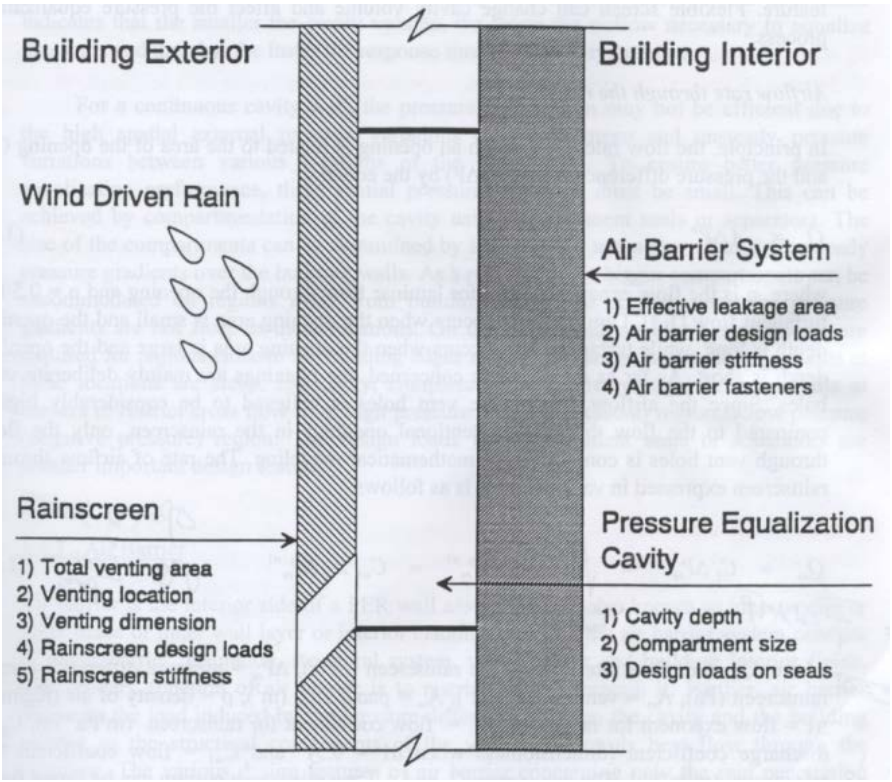

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13) Answer: C.

14) Answer: C.

15) A. Insulation of existing housing. (een zgn. na-isolatie systeem). See the reveals which are deep.

B. Applied panels are sandwich panels of aluminium and plastic foam.
- Moisture: a vapor closed finish of an existing wall is not optimal.
- Durability: aluminium coat is not sensible to algae growth etc. (if cleaned)
- Fire safety: it appeared to be a disaster last year. (See text under the photo)

16) Answer: B.

17) Answer: C.

18) A. Water run-off is here the problem, due to the absence of (counter) battens.

B. – Keep the holes in the substructure as airtight as possible (pressure equalization)
- Internal condensation could be a problem, so a little ventilation is needed
- The system should fit into the connections and in between the tiles.
- Some cooling must also be provided, see B2.
- Substructure must be sufficiently waterproof.
- Proper cabling is required (not easy accessible)

C. - It must be sufficiently flat (or in case of a pitched roof: even.)
- It needs a closed outer substructure, an open-box element will not do but a sandwich element is required.
- Substructure must be sufficiently waterproof.
- Keep the holes in the substructure as airtight as possible (pressure equalization)

19) Answer A.

20) Freeze thaw mechanism is expansion of frozen water in a limited space (pore-sized), which destructs the inner pore wall material, and flakes.
Answering the Why question is due to: saturation of pores with water.

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Answering the when exactly question: ice forming should acts as a plug. So the fewer the thermal gradient is, the better. (An all-sided frost action is best for an increased frost damage.)

21) Answer: C.

22) Primarily: in case of huge spans. Then is the lower weight appropriate and the high cost acceptable.
Secondly: in case of otherwise unavoidable moisture (vapor) problem, so in case of a reconstruction maybe.

23) Brass, bronze, steel, wrought iron, aluminium alloys (: 1000, 3000, 5000, 6000.), stainless steel, cast stainless steel, weathered steel.

Use your imagination + your learned professional knowledge for the sketches!!

24) They are essentially different because a different process is involved. At left we see a material due to wet corrosion circumstances, and at right we see a material prone to a process called dry corrosion. Here the now and then occurring dampness gives the latent corrosion due to (most salty) contaminants, each time a push.

25) The layer is called: patina. It is a layer of oxidized metal which became so dense that it can protect the metal underneath from continued corrosion.

26) = Bad idea due to the risk of contact corrosion!
In the distribution of metals miscellaneous, redox reactions will happen, where a less noble metal is sacrificed for a more noble metal, see the Electric Potential Series of metals (SCHAIJK, sheet 5.52.)

A solution is achieved only when the metals do not make contact to each. So spacers must be used. Differentiated distribution can also be based on the same metal with other coatings, but this is basically a fake idea compared to the original.