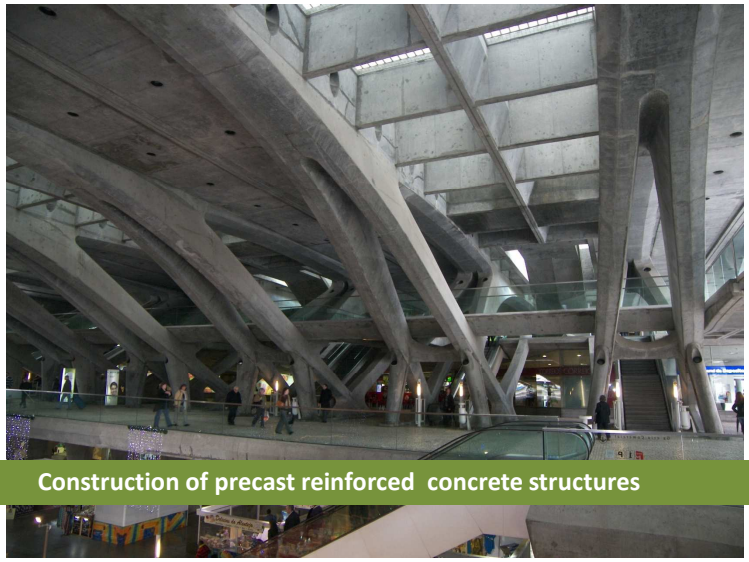


Construction of precast reinforced concrete structures

István Vidovszky PhD

definition

2

Prefabricated reinforced concrete construction:

Construction of RC components of buildings, the majority of which are **standardized** and **produced either at the construction site**, or (much more often) **in plants in a location away from the building**, and then **transported to the site** for assembly.

general characteristics of precast structures

4

advantages

- economic use of auxiliary materials (formwork, scaffolding) - several repetition (at least 30 identical casts /mould)
- reduced construction time - larger quantity of components is possible at the same time
- less skilled labor is required

limitations

- size of the units
- location of window openings has a limited variety
- joint details are predefined
- site access and storage capacity

types

3

Site-cast (local precast):

-no transportation
-the size limitation is depending on the elevation capacity only
- lower quality because directly affected by weather
- proper, large free space required

precast at a plant:

- transportation and elevation capacity limits the size
- higher, industrialized quality – less affected by weather
- no space requirement on the site for fabrication
- „unlimited" opportunities of architectural appearance
- option of standardized components (precast catalogue)

material

5

reinforced concrete

SCC (self-compacting (consolidating) concrete)

– for fair faced concrete

CRC (compact reinforced composite)

– high strength material for slender structures

GRC (glass-fiber reinforced concrete)

disadvantages of precast structures

6

architectural options – surface appearance

plant casting :

– allows high quality control

– allows greater option of finishes

– enable interaction between design phase and production planning

options of surface appearance

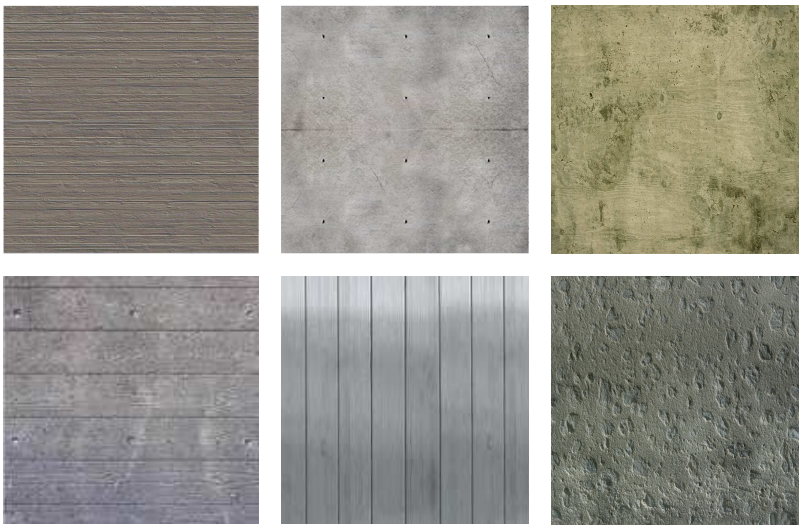
7

surfaces with surface treatment of the material

options of surface appearance

8

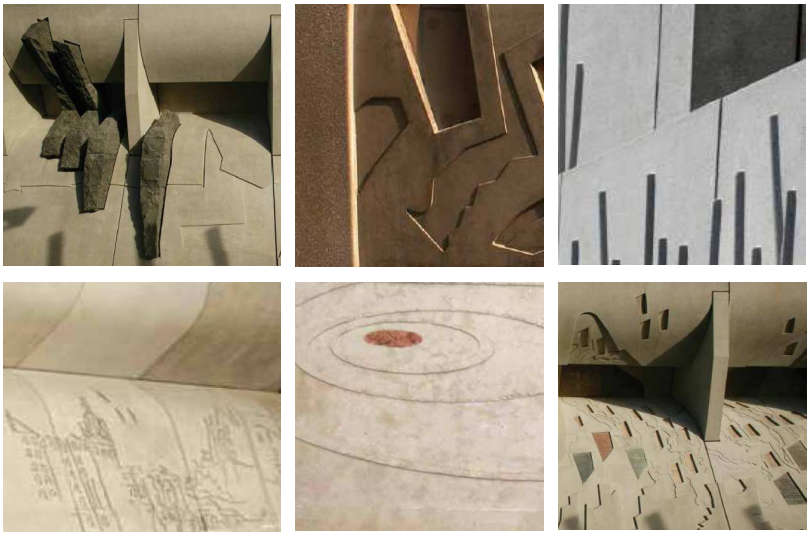
classical patterns – with the surface of the form-faceing



options of surface appearance

9

advanced patterns – with special designed form-facing / CNC-cut patterns



options of surface appearance

10

advanced patterns – with special designed form-facing / CNC-cut patterns

1. cutting

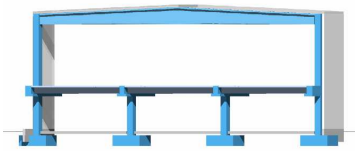
2. wood/plywood form-facing

3. concrete surface

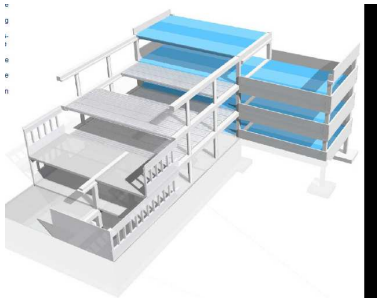
building types

11

One or two storey hall-like buildings



Multi-storey buildings



structure types

12

categories of load-bearing structure

- large-panel systems
- frame systems
- slab-column systems with shear walls
- mixed systems

structure types

13

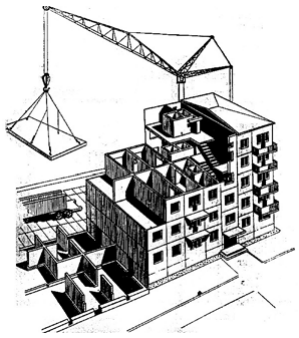
large-panel systems

- box-like structure,

- both vertical and horizontal elements are load-bearing

- one-story high wall panels (cross-wall system / longitudinal wall system / two-way system)

-one-way or two way slabs



structure types

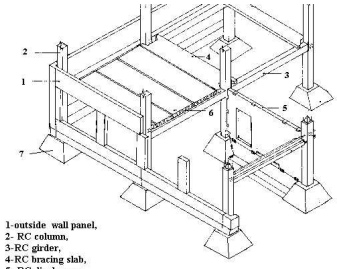
14

frame systems

- components are usually linear elements (beam-pillar frames are rare because difficult to handle)

- the beams are seated on corbels of the pillars usually with hinged-joints (rigid connection is also an option)

- joints are filled with concrete at the site



1-outside wall panel,
2- RC column,
3-RC girder,
4-RC bracing slab,
5- RC diaphragm,
6- RC ceiling slab,
7- RC foundation

structure types 15

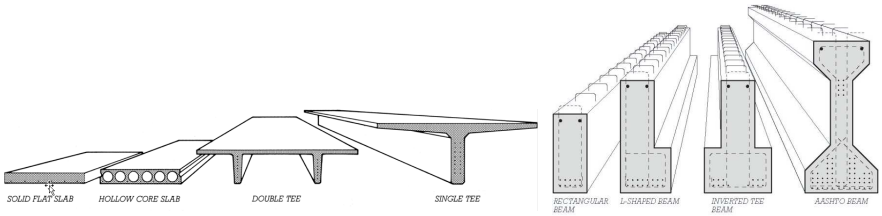
prestressed slab-column systems

- 2-3 storey high pillars

- prestressed beams and slab panels (by means of prestressing tendons)

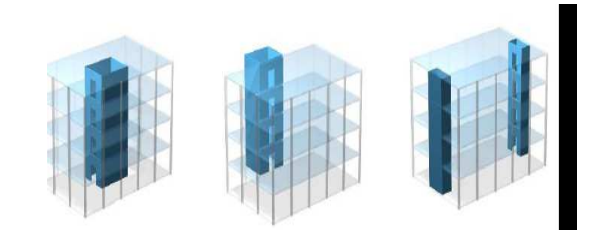
- in-situ concreted joints

- shear walls (precast or cast-in-place) positioned between the columns at appropriate locations (shear system)

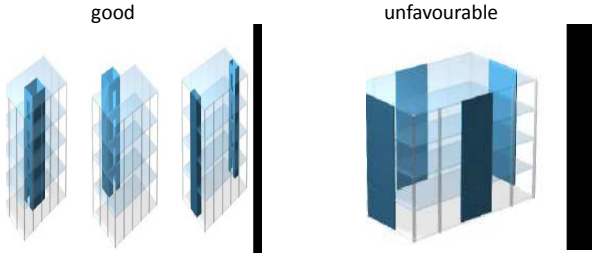


structure types 16

prestressed slab-column systems – arrangement of shear walls



good unfavourable



unfavourable optimal

structure types

17

lift-slab systems

- partially precast in plant (pillars) / partially precast on-site (slabs)

- one or more storey high pillars (max 5)

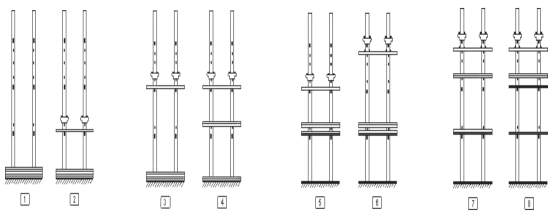
- up to 30 storey high constructions

- special designed joints and temporary joints

-slabs are casted on the ground (one on top of the other) – then lifted with crane or special elevators (two lifting methods: Bulgarian, American)

lift slab procedure

18



1.pillars and the first package (e.g. 5 pieces) of slabs prepared at ground level

2. lifting jacks are mounted on the pillars + a single slab lifted to the first floor level

3-8. boxes are sequentially raised to higher positions to enable the slabs to be lifted to their required final position - slabs are held in a relative (temporary) positions by a pinning system

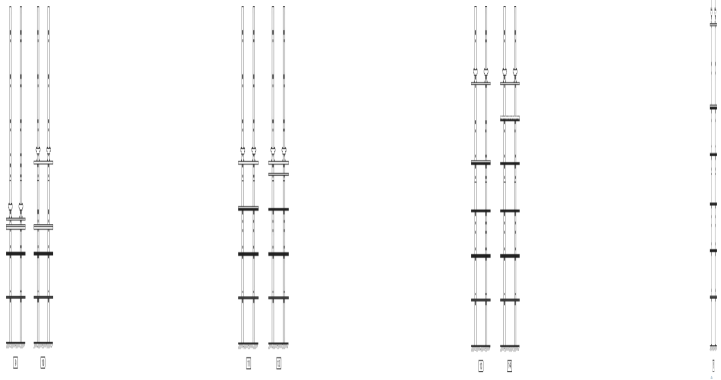
lift slab procedure

19

9. extension of pillars

10-14. the first package of slabs are lifted further to make space for the next package of slabs / or new slabs can be fabricated on at a higher level not to disturb the further construction works at the first levels

At the end of the lifting process the lifting jacks are removed from the top of the pillars



preparatory work phases

20

1.Design of the building

2. Preparation of element consignation

3. Planning the transport routes

4. Planning the lifting sequence of the elements and the temporary bracing system

5. Planning the lifting operations – step by step for each elements – Non-isotropic , vulnerable components!!!

6. Selection of the temporary structures of the assembly

7. Planning the site arrangement

preparatory work phases

21

Design considerations

-final position and loads

-transportation requirements – self load and position during transportation

-storing requirements – self load and position during storing – (avoid or store in the same position as it transported / built in)

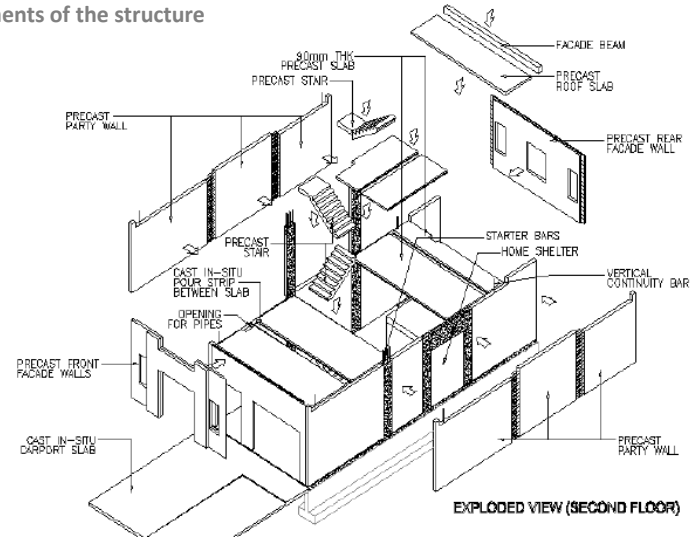
-lifting loads – distribution of lifting points – optimal way of lifting (selection of lifting and rigging tools)

-vulnerable points (e.g. edges) – reduction of risk (e.g. rounded edges)

preparatory work phases

22

Elements of the structure



preparatory work phases

23

Element consignation

	ID	Function	Figure (drawing + lifting points + reinforcement)	Geometry (cm)	Weight (t)	Amount
1.	RcW-01	rc wall panel		400x300x12	3,6	36
2.	RcP-01	pillar		300x20x20	0,3	40
3.	RcS-01	hollow slabpanel		400x750x30	13,2	18
…						

preparatory work phases

24

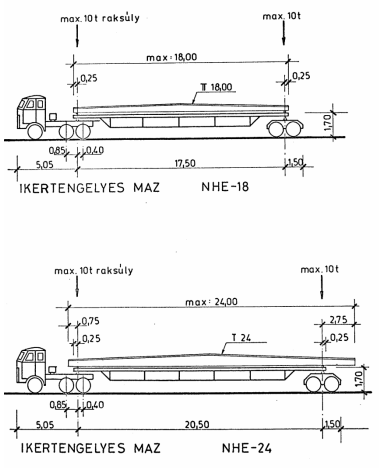
Planning traffic route

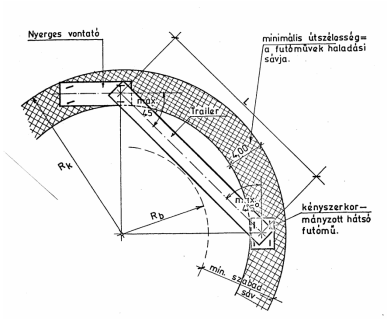
- How long transport-vehicle is required?
- What is the required load capacity of the transporter vehicle?
- What is the maximum vertical extension of the shipment?
- Is route permission required?
- Routs on the site

preparatory work phases

25

Planning traffic route



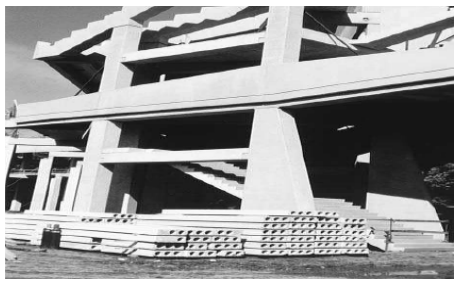


TRAILER	L	R_k	R_b
NHE-18	17,50	15,30	9,50
NHE-24	20,50	18,00	9,50

preparatory work phases

26

Site arrangement - storing elements on site



Optimal to avoid storing on site!

If it is not possible - elements recommended to be stored in similar position to their future built-in position!

If it is not possible either - design consideration have to be made for storing regarding to the reinforcement!

preparatory work phases

27

Elevation plan

- work sequence

- plan of the elevation step by step for each element (pillars, beams, slabs, wall panels)

- temporary bracing, supporting system and final shear walls

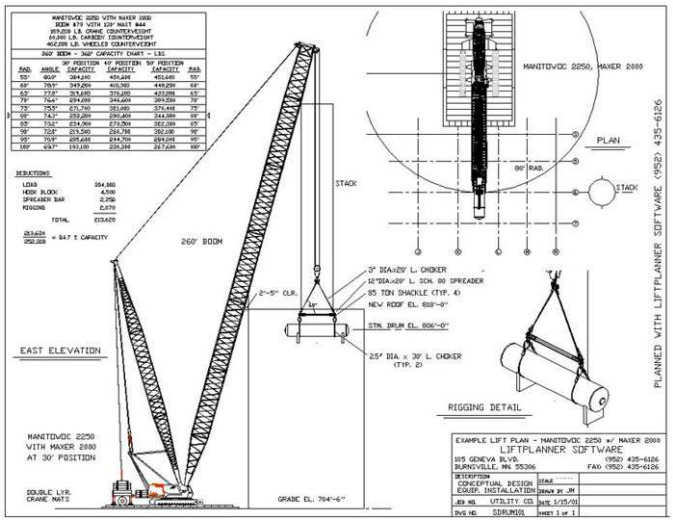
↓

Temporary structures & site organisation plan!

preparatory work phases

28

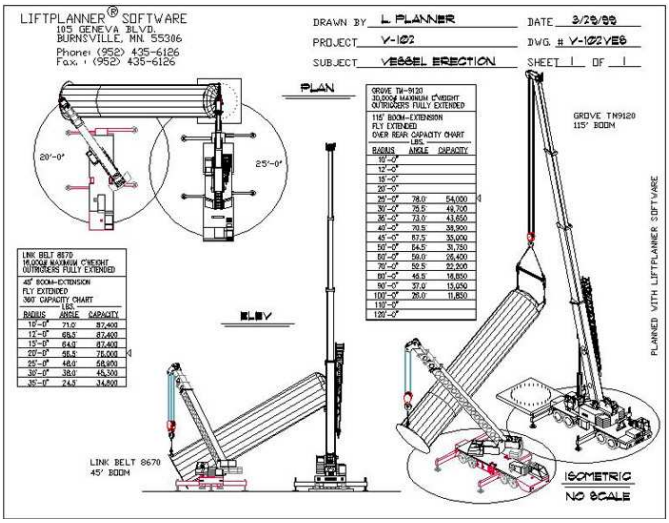
Elevation plan (example)



preparatory work phases

29

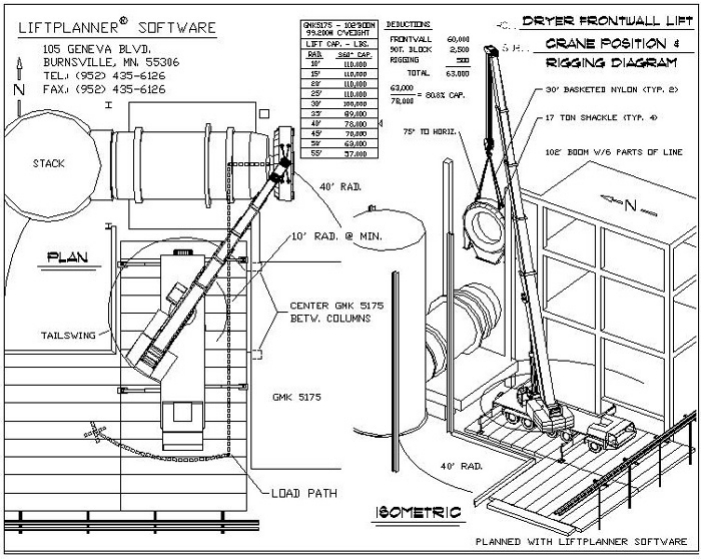
Elevation plan (example)



preparatory work phases

30

Elevation plan (example)



equipments

31

cranes:
-moblie crane
-tower crane (above 3 storeis)

lifting tools:
-spreader beams
-wire rope slings

→ to eliminate extra load from lifting

rigging tools:
-eye bolt
-shakles
-hooks

→ on the elements (lifting points)

→ for the crane

selection of mobile crane

32

relevant parameters:

1.Lifting heights =

= the level of the final location of the element

+ the height of the highest element +

+ the height of the equipment (lifting and rigging tools) +

+ 1m

2. Lifting weight =

= the weight of the heaviest element to lift

work sequence of the assembly

33

I. floor

- vertical load-bearing structure (e.g. pillars or walls)
- temporary supports (if needed)
- shear walls
- horizontal load-bearing elements (e.g. beams + slabs)
- preparation of the structural joints
- Non-load-bearing elements (e.g. non-load-bearing wall panels)

II. floor

… … …

assembly

34

erecting multi-storey pillars

lifting wall elements

assembly

35

wallpanels with temporary supports

lifting slab panels

5. preparing structural joints

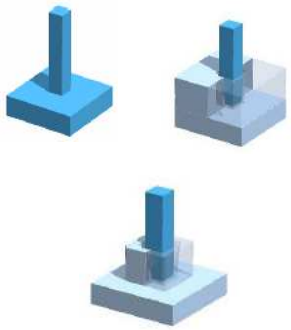
36

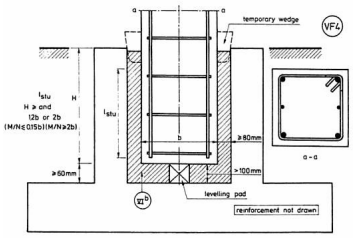
Foundation types:

A. plain reinforced concrete

B. Stepped reinforced concrete

C. mass concrete

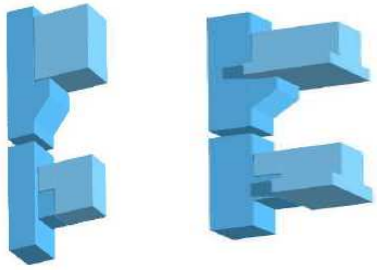




preparing structural joints

37

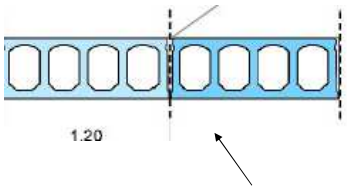
Pillar-beam joints



preparing structural joints

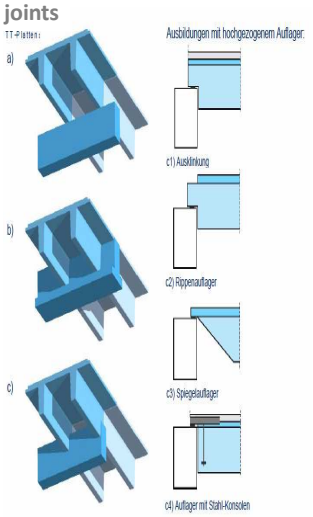
38

Slab-slab joints



on-site grouted

Beam-slab joints

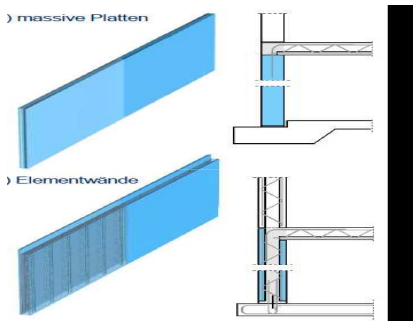


preparing structural joints

39

solid wall panels

sandwich panel system



Wall-joints

scheduling

40

some aproximate data for installation

emplacement of hollow core floor slabs - 300 m2/day

erection of pillars/columns - 8 pieces/day

emplacement of beams - 15 pieces/day

emplacement of double tee slabs - 25 pieces/day

emplacement of walls - 15 pieces/day

construction of stair and elevator shafts - 2 floors/day

examples

41

GRC facade wall elements, Office building, 25 – 35 Park Lane, London, United Kingdom

examples

42

SCC construction elements, Office building, 35 Homer Road, Solihull, United Kingdom

Thank you for your attention!

References

R

[1] Szőnyi L.: Construction of prefabricated reinforced concrete buildings, 2011 (Presentation)
[2] Benett, D.: Concrete Elegance 2004. Concrete Centre, 2005
[3] Precast Concrete Structures. www.paradigm.in 2012.10.10
[4] *S. Brzev, T. Guevara-Perez:* Precast Concrete Construction. http://business.management6.com/PRECAST-CONCRETE-CONSTRUCTION-pdf-e13174.pdf 2012.10.10
[5] Sonjoy Deb: Precast Concrete for Building Systems http://masterbuilder.co.in/Archives/Building%20Materials/Concrete/Precast%20Concrete%20for%20Building%20Systems.pdf 2012.10.10
[6] Lift slab system - http://webs.demasiado.com/forjados/patologia/lift_slab/aspect/index.htm 2012.10.23
[7] http://www.liftplanner.net/steamdrum.html 2012.10.23
[8]