INTRO

- fascination
- problem statement
- approach methodology

→ BODY

- case study
- script & prototyping
- detailing of the case

→ CONCLUSION

STRUCTURE OF THE PRESENTATION
Double ruled surface
Parabolic hyperboloid
Catenary
Complex geometry & its structure

Catalan vault – barrel vault
Poleni – Cremona – Shukov
Gaudi – Gustavino – Dieste - Isler

FASCINATION AND EXAMPLES
STATEMENT
APPROACH METHODOLOGY

INTRO OF THE PROJECT
Distributed intelligence
Tensional pattern in nature

Cell proliferation
Bodyplan & adaptation-specialization
Bone’s formation
Tensegrity body

FASCINATION AND EXAMPLES

STATEMENT

APPROACH METHODOLOGY

INTRO OF THE PROJECT
• Form finding as design strategy.
  Between Aesthetics and structure...

Mumbai as case study
Assumption
Operative approach
Design-structural approach
Architectural translation
developing masonry-brick structure

FASCINATION AND EXAMPLES

STATEMENT

APPROACH METHODOLOGY

Assumption
Operative approach
Design-structural approach
Architectural translation

INTRO OF THE PROJECT
[Video 1...]
Therefore the operative approach ...
1. Developing a script that performs form finding using a PARTICLE SPRING SYSTEM

2. Searching a pure tensional pattern & extrapolate a pure compressive pattern

3. Establishing degrees of user interactivity to research an optimum solution [spatial-structural]

FASCINATION AND EXAMPLES

STATEMENT

APPROACH METHODOLOGY

Assumption
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Architectural translation

INTRO OF THE PROJECT
1. formulating constraints
   conditions those define the site
   where the TENSIONAL pattern
   operates

2. considering LINEAR ELASTIC
   behavior of structural elements
   [on compression]

FASCINATION AND EXAMPLES

STATEMENT

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INTRO OF THE PROJECT
3. **ON THE SIMULATION:**

MASS NEGLIGEABILITY of elements [SPRING&NODE] compare to set of external forces applied by the spring to reach equilibrium state.

**ON THE STRUCTURE:**

dead load as UNIQUE CASE STUDY for the definition of the pattern.

**ON STRUCTURAL ANALYSIS:**

ADDITIONAL LOAD CASEs & Finite Elements Analysis to study LOCAL/GLOBAL BUCKLING and needed CROSS SECTION.

**FASCINATION AND EXAMPLES**

INTRODUCTION \(\rightarrow\) STATEMENT

APPROACH METHODOLOGY

Assumption

Operative approach

**Design-structural approach**

Architectural translation

INTRO OF THE PROJECT
4. developing a partitions system by RULED SURFACE from a equilibrated frame pattern [compressive]

FASCINATION AND EXAMPLES

STATEMENT

APPROACH METHODOLOGY

Assumption
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Design-structural approach
Architectural translation

INTRO OF THE PROJECT
1. PROTOTYPING according with different set of constraint and different axial site configurations.

2. SELECTION of an OPTIMUM PROTOTYPE as case study
BODY

- case study
- script & prototyping
- detailing of the case
case study
script & prototyping
detailing of the case
MUMBAI

FORMAL SETTLEMENT

linked to

LEGALITY - urban planning
social hierarchy
DELIBERATIVE DEMOCRACY
[ R. Sennet+E. Makarova emphasize collective decision making greek theatre ]

INFORMAL SETTLEMENT

ILLEGALITY - local self-planning
social cluster
ASSOCIATIVE DEMOCRACY
[ R. Sennet+E. Makarova - create heterogeneous community agora ]

case study
script & prototyping
detailing of the case
ISSUE: WHERE THE FORMAL END & THE INFORMAL START

Dharavi
the slum & the informal life-economy

Mumbai

Case study
script & prototyping
detailing of the case
SOCIAL ENVIRONMENT
- highly dense/populated
- clustered in community
- mixed society [culture-use-value]

CASE STUDY
- Concept prototyping
- detailing of the case
PHYSICAL ENVIRONMENT
-highly polluted
-highly dense opposed to emptiness
-commision of function [housing + industrial production+…]

CASE STUDY
(script. & prototyping
detailing of the case)
INFRASTRUCTURAL ENVIRONMENT

- facility are rare & bad distributed
- discontinuous / disconnected
- limited maintenance & efficiency

case study
script & prototyping
detailing of the case
- LINEARITY on the PROCESS of MAKING → FORMALITY

- NON-LINEARITY on the PROCESS of MAKING → INFORMALITY

- ADAPTIVITINESS on the PROCESS of MAKING → INFRASTRUCTURE in between

case study
script & prototyping
detailing of the case

BODY

EVENTUAL REPRESENTATION of the LANDSCAPE
Therefore

An EVENTUAL LINK between FORMALITY & INFORMAIY would be an ADAPTIVE SYSTEM

The INFRASTRUCTURAL SYSTEM [I.S.] in such sense would work as MEDIATOR between TWO PROCESS of MAKING

To do so HAS TO BE
- flexible
- global sensitive
- local sensitive

case study
script & prototyping
detailing of the case
There are two scales to consider

- A GLOBAL SCALE   BASILAR NEED

- A LOCAL SCALE   LOCAL NEED

case study
script & prototyping
detailing of the case
That means

A GLOBAL SYSTEM (from GLOBAL PARAMETERS) as result of

- general site location
- related trend activity on site → influence the technical configuration of the global infrastructure
- typology of pollution → influence the purpose of the infrastructure on global scale
- existent infrastructure → influence the spatial configuration of the global infrastructure

-A LOCAL SYSTEM (from LOCAL PARAMETERS) as result of

- specific site on the site
- local activity operating → influence the spatial configuration of the local infrastructure
- presence of landmark of relevance → influence the spatial configuration of the local infrastructure

case study
script & prototyping
detailing of the case
Therefore

about the general site DHARAVI…
For the WHOLE area a STRATEGY could be:

- a GLOBAL SYSTEM – infrastructure for  
  - WATER DISTRIBUTION

- TRAFFIC FLOW DISTRIBUTION

- a LOCAL SYSTEM – infrastructure for  
  - SOCIAL PROGRAM [social activity – social utility]
“In such a sense a brick structure should work as infrastructure on both global and local scale of plan”
… about the specific site

IN DHARAVI
case study
script & prototyping
detailing of the case
case study

script & prototyping
detailing of the case
case study
script & prototyping
detailing of the case

SPECIFIC SITE
case study
script & prototyping
detailing of the case
... what is local
... what is global

ON THE SPECIFIC SITE
LOCAL PARAMETER
GENERIC WORKSHOP
HEIGHT
fix point at ground level 0 m
Btw 0 - 3 m = ground floor
LOCAL PARAMETER
TEXTILE PRODUCTION
HEIGHT
variable level starting from 3 m
Btw 0 - 6 m = top floor
LOCAL PARAMETER RECYCLE ACTIVITY HEIGHT
variable level starting from 4 m
Btw 0 – 9 m = ground floor
LOCAL PARAMETER
COMMERCIAL ACTIVITY
HEIGHT
fix points at ground level 0 m
Btw 0 – 3 m = ground floor
LOCAL PARAMETER
NETWORKING TRANSPORTATION
HEIGHT
variable level starting from 0 m
Btw 0 – 5 m = extended ground floor
PARAMETER - from LOCAL to GLOBAL

LOCAL PARAMETER

WORSHIP - MOSQUE

% INTERACTION - user task
PARAMETER - from LOCAL to GLOBAL

GLOBAL PARAMETER

EXISTENT INFRASTRUCTURE

% INTERACTION - user task
Summary of SITE FEATURE:

- INDUSTRIAL ACTIVITY
- DWELLING
- EXISTENT INFRASTRUCTURE
- EXISTENT LANDMARK
- EXISTENT NATURAL RESERVE
Therefore

An EVENTUAL INFRASTRUCTURAL SYSTEM should provide

- on GLOBAL SCALE
  - prevent POLLUTION [air-ground - water]
  - distribute TRAFFIC [people-worker-track carriers]

- on LOCAL SCALE
  - temporary workshop
  - temporary worship space
  - leisure space
  - sleeping space
  - walking space
Moreover

the URBAN BORDER of the MAIN AXIS has to be rethought as PERMEABLE BORDER

Where a URBAN MEDIATOR operates
As conclusion from the site

As INFRASTRUCTURE, a structure in bricks, would need to consider in Its design as INPUT PARAMER
- GLOBAL CONSITION – the facility infrastructure system
- LOCAL CONSITION – the social infrastructure system

specifically referred to the area and with certain degree of FLEXIBILITY
about the script...
[videos...]
- DEFINITION of the EXISTENT ENVIRONMENT – axial representation

Video 1

case study

script & prototyping
detailing of the case

BODY
- re-DEFINITION of the ENVIRONMENT by its EXISTENT GLOBAL/LOCAL ATTRACTOR/REPULSOR

of first degree – MAIN LANDMARK
of second degree – SECONDARY LANDMARK

USER INTERACTIVENESS required
PRE-SETTED IMPORTANT NODEs required

Video 2

case study
script & prototyping
detailing of the case

BODY
- re-DEFINITION of the ENVIRONMENT by its EXISTENT LOCAL ATTRACTOR/REPULSOR

of first degree – MAIN LANDMARK

of second degree – SECONDARY LANDMARK

USER INTERACTIVENESS required

PRE-SETTED IMPORTANT NODEs required
- re-DEFINITION of the ENVIRONMET by its ADDITIONAL INFRASTRUCTURAL NODEs

- PRE-SETTED AMOUNT of ADDITIONAL NODEs required
- DISTRIBUTED UNIFORMLY ACCORDING to
  - reciprocal distance between nodes
  - distance between node and axis
  - distance refer to the position of axial-link & the position of axial-center

Video 4

case study
script & prototyping
detailing of the case

BODY
- CREATION of the LINKING PATTERN between NODEs – AXIS – MAX/MIN FLOOR HIGH
  - PRE-SETTED AMOUNT of POSSIBLE LINK on each NODEs required
  - PRE-SETTED AMOUNT of MINIMUM/MAXIMUM DISTANCE between NODEs ABLE to be CONNECTED
  - PRE-SETTED AMOUNT OF ORIGINAL SPRING LENGTH
  - PRE-SETTED CONDITION of CONSTRAINTs for NODEs on the LINK

  STRUCTURAL PARAMETER [ISOSTATIC]
  STRUCTURAL PARAMETER [LENGTH LIMIT for COMpressive MEMBER]
  STRUCTURAL PARAMETER [AXIAL FORCE APPLIED BY THE SPRING F=K\(\Delta X\)]
  STRUCTURAL PARAMETER [PHYSICAL CONSTRAINTS- TRANSLATION free/constrained/semi constrained]
- re-CONFIGURATION of the AXIS according to the GENERATED LINKs
- FORM-FIDING research of an EQUILIBRATED SPATIAL CONFIGURATION

STRUCTURAL CONFIGURATION – elements both in compression and tension
FORM-FIDING research of an EQUILIBRATED SPATIAL CONFIGURATION for a FULLY TENSIONAL PATTERN

STRUCTURAL CONFIGURATION – elements in ONLY TENSION

Video 8

case study
script & prototyping
detailing of the case
- TRANSLATION of the TENSIONAL PATTERN in COMPRESSIVE PATTERN
- DEFINITION of the ELEMENTS SIZE
- CALCULATION of the STRESS PER ELEMENT
- FINAL CHECK of the SIZE ELEMENTS according with the MAXIMUM STRESS
... about the prototype output

, an example
case study

**script & prototyping**

detailing of the case
case study

script & prototyping
detailing of the case

materialization elements 16 cm cross section

BODY
Given the output frame a system of surface span in btw members to create spatial partition

case study

script & prototyping
detailing of the case
case study

script & prototyping
detailing of the case
...where a particular spatial configuration come from a particular set of constraints

- functional constraints
- structural constraints
case study

script & prototyping
detailing of the case
...A STRUCTURAL VALIDATION by FEA

ADDITIONAL LOAD CASEs considering
-EXTERNAL ACTIONs [WIND, CONCENTRATED LOAD]
-ADDITIONAL LOAD of PARTITION and SHELL STRUCTURE

OUTPUT:
-CROSS SECTIONS
-GLOBAL/LOCAL BUCKLING
-NEEDED REINFORCEMENT
-TYPHOLOGY OF SECTION TO equilibrate local actions
“due to the property of “NON ISOTROPY” of the masonry, resulting from the bricks and the mortar, for simplicity the FEA considers a homogeneous material, elastoplastic, with property defined by the EURO CODE n°6 and refer to

Rots J. G (1997) Structural masonry an experimental/numerical basis for practical design rules, Balkema, Rotterdam The Netherlands
BODY

case study

script & prototyping
detailing of the case
case study

**script & prototyping**

detailing of the case
case study

script & prototyping
detailing of the case
DETAIL CONSTRUCTION:

STRUCTURAL CONSIDERATION

- SELF WEIGHT OF ELEMENTS CONSIDERED NEGLIGEABLE ON SIMULATION

- PROPER SECONDARY EFFECT DUE TO THE EFFECTIVITYNESS OF THE SELF WEIGHT [BENDING MOMENT ON THE AXIS OF THE BEAM]

- DEFINITION OF SPECIAL ELEMENTS, NOT FULLY IN COMPRESSION, THAT ARE GOING TO BE POST STRESSED BEFORE THE FINAL SETTING ON THE FRAME [CONSIDERED ALSO THE EFFECT OF THE EXTERNAL FORCE OF COMPRESSION FROM THE PERIPHERICAL STRUCTURE]

PARTICULAR BEAM ELEMENT BUILT ON SITE

- reinforcing bar for not fully compression element
- post-stressing plate
- fine concrete with light mix of stone and waste material [produced on the area]
setting of the brick along the straight axis (ruled surface)

setting a diffuse grid of bar to adsorb tangential forces along the hyperboloid surface
...going back to the case study...
ARCHITECTURAL MATERIALIZATION [ON THE CASE STUDY]

First conclusion:
-the COMPRESSIVE PATTERN defines the possible PARTITION and FRAMED SURFACE
-the PATTERN shape the INFRASTRUCTUAL SYSTEM [service + social] & its USE
-DIFFERENT DEGREE of FLEXIBILITY are ALLOWED along the INFRASTRUCTURAL SYSTEM
-The FRAME CONSTITUTE a FULL PERMEABLE MEDIATOR between two URBAN FRAGMENT
CONCLUSION

• using software simulation provide
  - flexibility on the process
  - fast architectural prototyping
• using Form finding as design strategy allows
  - combine the structure, the aesthetic and the functional requirements
  “…between AESTHETIC & STRUCTURE…”
…further development…

- refine the set of input parameters
- extend the interactivity of the user
- refine the structural performance for additional load case
… some question…

THE END 😊