SITE LAYOUT DESIGN

Dr. L . Neszmélyi – Dr. Z. A. Vattai

Department of Construction Technology and Management Budapest University of Technology and Economics

Engineering Programs in English Managing Civil Engineering Projects

SITE LAYOUT DESIGN

Features of Construction

- On-site production of immobile product
- Processing exposed to weather conditions

Features of Project

- Local estate
- Linear (long, track-like) structure

DRAWINGS

Site map (M 1:1000; M 1:5000)

Reviewing natural-, geographic-, and human neighbourhood of construction site

- Access routes transportation, haulage, material supply
- Highway, roads, temporary roads if needed
- Railway accesses if needed
- Near-by pits, mines, manufacturers
- Fresh water and power supply
 - Fresh water sources
 - Local supplier
 - Surface-water intake
 - Well
 - Electric power
 - Low voltage
 - Medium voltage

• General site-layout design (layout sketch-design) (M 1:500; M 1:1000)

General layout of construction site, arrangement of temporary structures, yards, stores, etc. – in relation with the structure to be constructed:

- Contour (location) of structure to be built
- Directions (pathes) of access routes
- Location of main equipments (e.g. tower crane, batching plant)
- Auxiliary workshops, plants, yards (e.g.: wood-yard; steel-yard)
- Location (assignment) of stores, deposits
- Temporary buildings, offices, (e.g.: container blocks)

Detailed site-layout design (M 1:100; M 1:500)

Detailed design of all on-site temporary- and auxiliary structures, supplies, stores, etc.

- Exact position (location) of main equipments
- Location and layout (inner layout too) of auxiliary worksops, plants, yards
- Locations and functions (assignments) of store areas, deposits
- Detailed design of temporary buildings, offices
- Detailed design (track, material, structure) of acces routes (roads) together with loadingand unloading areas, parking (waiting) lots (measures and areas)
- Power-supply equipments, devices and structures (e.g.: transformer, main fuse)
- Design of transmission lines, spotlights, light towers
- Design of fresh-water supply system (sources, pipelines, fittings, taps, valves etc.)
- Surface (storm) water drainage design
- Waste (contaminated) water handling (collectors, treatment devices, sewers)

Phase designs (Periodic site-layout design)

Periodic design of site layout management, indicating main characteristics (states and conditions) of construction site during periods (phases) of construction, including location of in-use stores, deposits, on-site equipments, materials, supplies, etc. – elaborated in details like those of the

Detailed site-layout design. (e.g. during "Preparing the site", "Foundation works" or "Underground works", "Structural works", "Cladding works", "Outer finishes" or "Landscaping", etc.)

Manoeuvre- or motion scenarios (M 1:50, M 1:100)

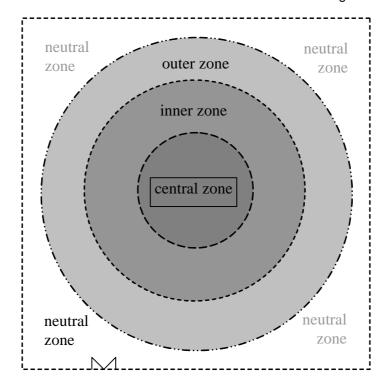
In case of extraordinary or complicated works and/or structures (unusually large structural unit, situation/movement of high danger, extreme environmental conditions) focusing on positions of equipments, auxiliary structures and other significant resources – including grabbing, moving, lifting, fixing, etc. of them (typical at lifting, placing and/or assembling large or heavy elements).

Main items of site layout design

- building/structure under construction
- main equipments
- auxiliary plants, yards, workshops
- stores and deposits
- site management offices
- sanitary/welfare rooms and buildings
- temporary roads
- electric power supply
- water supply
- storm-water drainage, dewatering
- waste/contaminated water treatment, sewer

Zoning the site

Areas/zones of construction site are identified/established in relation of building/structure to be built



Central zone

Right around and including the building/structure under construction (to be built). In the center of central zone some main equipments (e.g. tower cranes, lifting/boring equipments) are usually located. Sometimes zones are identified by (in accordance with) operating ranges (reaches) of central tower cranes. Central zone is the primary area of works/performances (building processes)

Inner zone

Close to the central zone, in the inner zone loading/unloading (pick-up) areas and active (short-term) stores, deposits (e.g. prefabricated elements/units/blocks of load-bearing structure, masonry blocks, roofing structure), together with main temporary acces roads (lanes) are to be located.

Outer zone

In the outer zone, within reach of main (tower-) cranes the auxiliary plants, workshops, yards are to be located, together with secondary ("general") stores and deposits. (e.g.: steel yard, wood yard, stores for on-roof HVAC devices, sealing/proofing materials, etc.)

Neutral zone

Neutral zone, inside the boundary fences of construction site, typically out of reach of main cranes, surrounding the building area, is accomodating auxiliary temporary structures such as site offices, parking lots, on-site production plants (e.g. batching plant), workshops, laboratories, equipment stores, earth/topsoil deposits, contaminated/waste water tanks, temporary waste material deposits (e.g. "dead concrete"), hazardous material stores/containers, etc..

Further considerations at zoning/designing the site

Type of project

- <u>development of a local estate</u> production/construction site is not moving during accomplishment (permanent location).
- construction of a linear structure (road, railway, canal, sewer, transmission line, etc.) production/construction site is moving during accomplishment (mobile site).

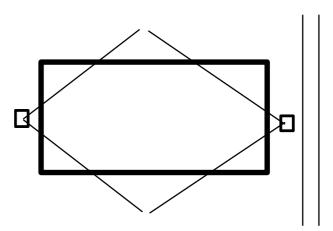
Term of project

- <u>short-term (some monthes) project</u> simpler site-layout design, less temporary structures, "transport" resources
- <u>long-term (more monthes, years) project</u>
 more developed temporary infrastructure, on-site production, stores/depos
- phases of building project (preliminary works, structural works, finishes, installations, etc.) if phases are few or numerous, lasting or changing rapidly, consecutive or overlapping, etc.

ON-SITE MAIN EQUIPMENTS

Cranes (towercranes)

- Manipulation area to be served/reached
- Location of other main equipments, cranes
 - Height of beam
 - Dimensions of effective lifting area served/reached



Assembly/mounting characteristics

- Base frame fixing (anchoring)
- (Pre-)Assembly of beam spreading
- Assembly of crane by autocrane climbing
- Other objects on the area to be served

Elevators

- Proper location of feeding/picking area has great effect on performance
- Easy delivery of materials into the building should be provided in long period of construction

Other main/heavy equipments

- Survey of occupied/needed area (e.g. at a pile driver), spatial relations of near-by equipments and processes (e.g. sheet-wall piling and excavation)
- Room necessary for operation, and for locating processed (excavated) material.
 (e.g. excavation, concreting and refill at/around a pier foundation)

AUXILIARY YARDS, PLANTS AND WORKSHOPS

Rest of work is organized to central production plants. Less on-site processing can be performed at (supported by) special on-site plants.

Potential auxiliary plants and yards

- Wood yard (formwork, shutter, timbering)
- Steel yard (reinforcement processing plant)
- · Batching (concrete mixing) plant
- On-site prefabrication/pre-assembply yard
- Lime and mortar plant

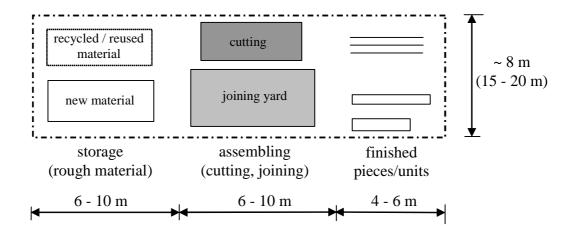
Yards and workshops functioning rather as stores

- Plumbers yard and workshop
- Electricians workshop
- HVAC assemblies store
- Tinsmith workshop.

Nowadays less typical: joiners' workshop, insulations' store, painters' store.

WOOD YARD

- Its significance is vanishing due to more and more wide-spread use of formwork systems
- Irregular/unusual forms in architecture may recover (revitalize) its use



Storage

On sleepers (e.g. on concrete beams) laid on spacers (ventillation/airing) - "lumber piles"

- lumber (6 m)
- log (rarely!) (4-10 m)

Cutting

Power-saws located under shelter

- band-saw
- circular-saw (properly located for to cut any sizes of log or timber)

Assembly

in joining yard

<u>Infrastructure</u>

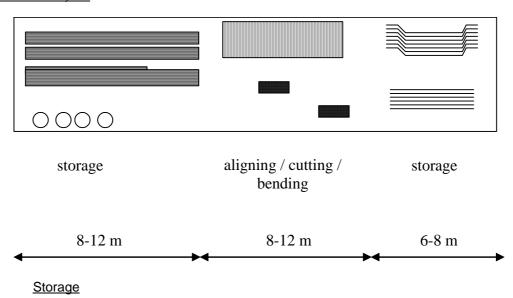
- electric power supply burried cable
- water supply fire plug (hydrant)
- road and surface

gravel-typed dry/hard surface access for transportation fencing/enclosing needed

STEEL YARD

Central steel yard (reinforcement processing plant) as industrial supply is tending to be typical

On-site steel yard



- Transportstraight rods and bars (length ~12 m)
 - rods and bars cut and bended (confected)
 - rolls of wires (e.g. for stirrups and for bonding)

Storage

by size and by mechanical characteristics (type, quality)

Cutting and bending

bending equipment(s), power tools

- linear
- parallel (overlapped)

Assembly

on workbench

Storing pre-assembled reinforcement (armature) elements

on the ground on wood holders (spacers)

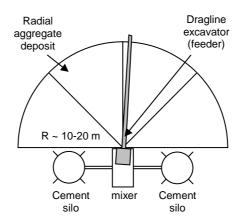
Infrastructure

- electric power supply burried cable
- water supply fire plug (hydrant)
- road and surface

gravel or any hard surface free access for transportation (fencing/enclosing not needed)

BATCHING (CONCRETE MIXING) PLANT

On-site batching (radial or tower-system) plants are typical rather at distant, ("greenfield") investments. At municipal (in-city) sites less frequently applied.



Functional units

- Mixer, stand, dozing partition
- Cement-silos
- Radial deposit for fractions of aggregates (+ dragline excavator/feeder)

Infrastructure

- Electric power supply (high consumption, separated supply)
- Water supply (high/intensive consumption)

Road and surface

- Access around the aggregate-deposit must be provided
- Receiving cement transport parking/loading bay
- Supply, reach/access/service of mixer height of stand
- Hard surface (cover) under aggregate-deposit

STORES AND DEPOSITS

Considerations

- neighbourhood (location) of site (eg. downtown or outskirt of a municipality)
- timing of use of material to be stored
- frequency and timing of transportation
 - reliability of transport
 - · financial conditions of accomplishment
 - cost (worth) of material to be stored

Calculating storage area

F=(V/n)*k

- F area of storage needed (m²)
- V volume (quantity) of material to be stored (unit)
- n storage standard (unit/m²)
- k extension factor representing needed area for access and manipulation (k>1)

Stores

- · closed (lockable) stores
- shelters
- open deposits
- · special stores

Closed stores

- mostly containers,
- · sometimes store houses, buildings, or
- parts/sections of some existing on-site buildings

Shelters

temporary structures (enclosed or fenced)

Open deposits

hard surface (covered and/or enclosed)

Special stores

special storage (safety, protection, hazard) regulations

SITE OFFICES AND OTHER BUILDINGS

Temporary building structures

located close to the only port/gate of site (in a "neutral zone/corner")

- container
- special ready-made (pre-assembled) building
- (separate section of) existing- or under-construction building

Site management offices

- office rooms, cabinets,
- · documents' archives, office-tecnology rooms
- · meeting rooms
- lavatory
- refreshment room, tea-kitchen, (drink/food automat)
- sub-contractors offices (as contracted)
- emergency- or "clean" room (first-aid room for case of accidents, wounds)

Changing room, dining room, shelter (if any)

sized for average workers' staff

- container
- shelter van

single container 2.44 x 6.05 m
double-sized container 4.94 x 6.05 m

- special ready-made (pre-assembled) building
- refreshment room, buffet van
- (drink/food automat)

Sanitary

sized for maximum workers' staff

- lavatory/wash-basin as fixture in container or in building
- toilet
 - wash-down toilet as fixture in container or in building
 - privy (set over a sewer-line man-hole)
 - mobile privy (e.g. "toitoi")

TEMPORARY ACCESS ROADS

Even if no any structure was constructed as temporary road free access to all location on site must be provided during over-all time-span of accomplishment!

Horizontal alignment

```
single-lane roundabout access controlled only entrance and exit (gate) turning and manoeuvres of wehicles R<sub>min</sub> designed in accordance with the traffic (usually 12-14m)
```

Vertical alignment

At designing slopes and vertical bends considerations of axle bases, vertical articulation (if any), overhanging, cross-country capacities and breaks of wehicles have great significance. Maximum ascent/descent of slopes (ramps): 10 (15) %

Width

```
traffic lanes
single lane: ~ 3.0 m
two lanes: ~ 5.5 - 6.0 m
berme: ~ 2,5 m
widening (amplification) in bends needed (!)
considering path of rear wheels and length of long wehicles
```

Road Structure

(Time-span of construction works)

- gravel
- earth concrete
- precast panels
- (permanent roads)

TEMPORARY ELECTRIC SUPPLY

Demand

- w_e: engine/equipment (pile driver, batching plant, tower crane, etc.)
- w_t: power tool (power saw, poker vibrator, vibro-hammer, etc.)
- w_i: illumination, lighting (lamp, spotlight, reflector tower, sign, office, etc.)

$$W_{\Sigma} = \Sigma(w_e \bullet k_e) + \Sigma(w_t \bullet k_t) + \Sigma w_i$$

Where w is the current consumption, k_e and k_t are coincidence factors selected or determined for typical sets of equipments representing likely simultaneous operations of all engines and power tools included.

e.g. in case of more electrically-driven pieces/units of

```
tower cranes : w_e = sum of current consumption of tower cranes; k_e = 0.7 – 0.8 pile drivers : w_e = sum of current consumption of pile drivers; k_e = 0.6 – 0.8 dewatering pumps : w_e = sum of current consumption of pumps; k_e =1.0 power tools : w_e = sum of current consumption of power tools; k_e = 0.2 – 0.3
```

Source

low voltage system (0,4 kV)

(Typical at developed dwelling/industrial areas with sufficient power-capacity of local/public supply)

medium voltage system (10-35 kV)
 (Typical in case of insufficient power-capacity of local/public supply)

current generator

(Typical at distant green-field construction sites or as redundant/emergency source)

Main devices of supply network

- transformer (Necessary when source is a medium voltage transmission line.)
- electric-supply meter (Unnecessary when electricity produced by generators.)
- main switch, main fuse panel
- distribution supply network (with disconnecting switches, fuses and connectors)

Transmission line

over-head transmission lines (hung on posts)

(Designing overhead transmission lines within operation radius of any cranes, and over any steel-yard should be avoided. Minimum height above the ground: 6 m.)

underground conduits, cables

(Designing underground transmission lines under any buildings, production yards, excavation areas, water/sewer lines, or in wet environment should be avoided.)

Connection / jointing

• single connectors, plugs, sockets

(Typical in fixed structures, buildings coupled with switches)

• jointing/conecting boxes/chambers

(Typical at production areas, on new buildings under construction – with extension cable connections and fuses)

To be supplied

- building (structure) under construction
- tower cranes
- batching (concrete mixing) plant
- steel yard
- wood vard
- site offices (buildings)
- workshops
- areal illumination (lighting)

TEMPORARY WATER SUPPLY

Demand

- technology (concrete, plaster, paint, earthworks, etc.)
- sanitary (drinking water, cleaning, washing, etc.)
- fire protection (emergency water tank or water reservoir)

Different timing, intensity and quality expectations

Source

local supplier

(At developed dwelling/industrial areas with sufficient capacity of local/public network)

well (drilled)

(In case of undeveloped dry area far from any surface water)

suface water

(In case of undeveloped dry area near-by a surface water – e.g. lake or river)

In the two later case test, qualification, and permit from responsible authorities are needed

Main elemenst/fittings of supply network

- drilled well (when water is provided from underground water bodies)
- pump + water-tower or hydrophore (when water can't be provided by local supplier)
- water-measure (when water is provided by local supplier)
- stop- and sectioning valves
- water outlets (faucets and nozzles)
- distribution pipelines (branch-pipes and/or loop pipes)

To be supplied

- building (structure) under construction
- batching (concrete mixing) plant
- steel yard
- wood yard (fire protection)
- site offices (sanitary rooms, kitchen)
- workshops (technology and/or cleaning)
- areal water supply (faucets for drinking, cleaning, dedusting)

WASTE- AND STORM WATER DRAINAGE

To be provided for

- technology wastes and cleaning (must be collected and treated/transported)
- sanitary (if possible can be driven to public sewer system, otherways must be collected)
- storm water and ground water (driven to natural outlet)

In later case isolating potentially contaminated areas (e.g. worksops, cement-technologies) is necessiated and obliged

Main elemenst/fittings of dewatering system

- gasoline traps, scummer, sedimentation tank (as part of on-site waste-water treatment)
- underground collector (gravity or vacuum) pipes and open storm-water canals
- access shafts (in case of gravity-conduits)
- underground collector tank (+ sewage pumps if needed)