Geo-IT: The Enabler Ingredient in the Infrastructure Construction Project Life Cycle Mix

Geospatial Technologies integrated with Building Information Modelling on Large Construction Site for Health and Safety Management

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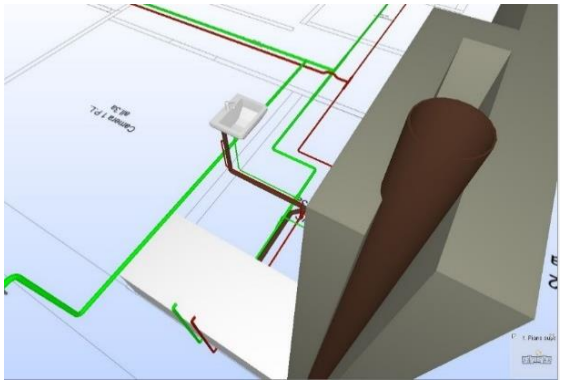
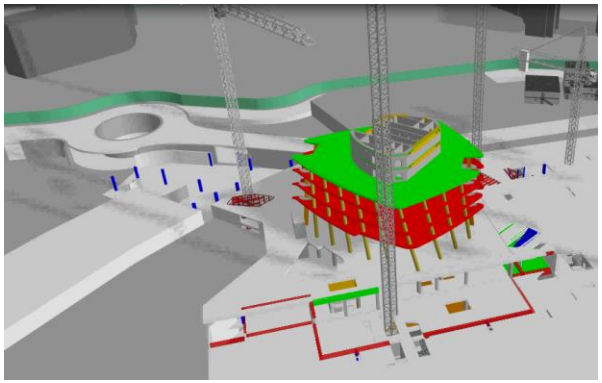
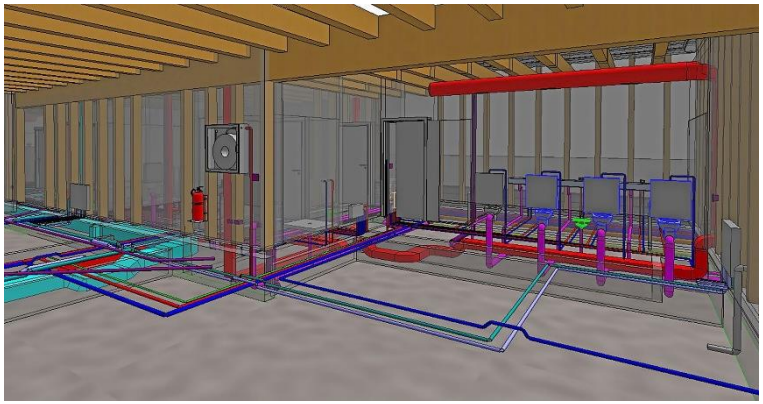
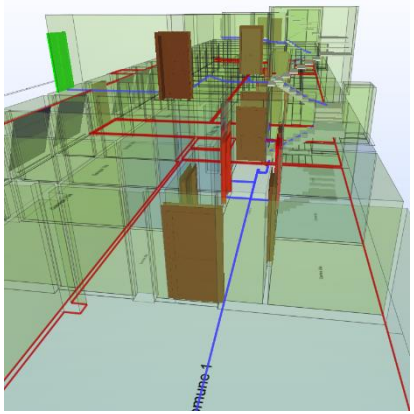
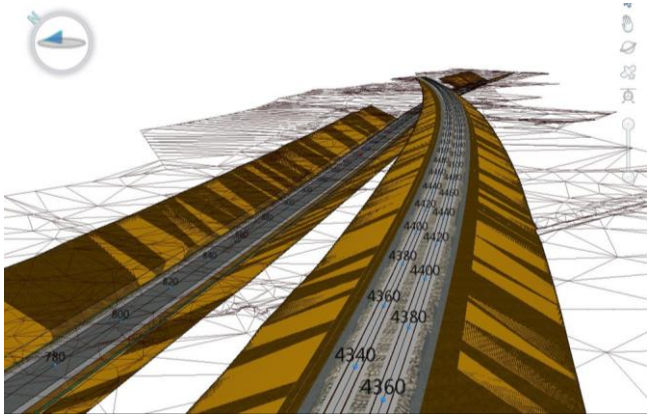
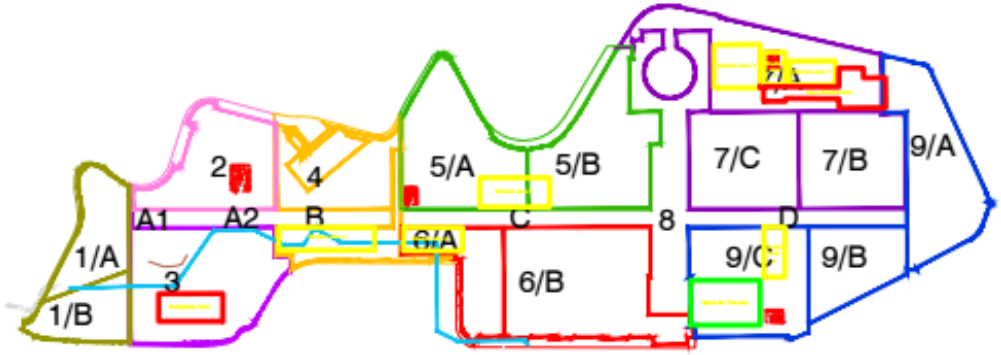
University of Brescia – BIM Research Group

Department of Civil Engineering and Architecture - DICATAM

Case Study – the «Piastra»



Lenght: **2 km**
Width: **from 350 m to 750 m**
Divided in **sub-construction areas**

- Hydraulic works
- Circulation routes
- Technological systems
- Renovation of an existing building

Surface: 7900 mq

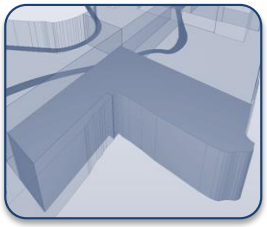
General Characteristics of an Infrastructure Construction Site

- **large** construction site
- organisation in **sub-construction areas**
- **horizontal** construction site with main directions - ie linear development for roads, energy and fluids transport, etc (vertical BIM vs and horizontal BIM)
- construction operations involving large volumes of **earth movement**
- **interferences** with over-ground and underground utilities
- large number of **workers concurrently on site**
- reduced number of construction site **accesses** in relation to site's extension and number of workers and vehicles

General Issues

- comprehensive **understanding** of the construction site to quickly update and manage information
- complex **traffic management** because of continues changes due to works on underground utilities
- **construction roads** modified from too many subjects and not constantly updated
- **subcontractors** working without a comprehensive knowledge of other sub-areas but operating on same construction roads and interferences
- **spatial constraints** due to interferences (ie space restrictions because of earthworks for both excavated and accumulated soil)
- risks such as **collapse of excavations and falling into excavations**: one of the main danger to workers in or near excavations

Objectives



Optimisation of construction resource management

- Resources managed as informative content of a parametric model

Optimisation of traffic management on site

- Open Street Map uploaded on mobile devices to support traffic management

Visualisation of Health & Safety issues

- BIM-based construction site layout & safety planning
- Customised ruleset for safety code checking

Construction Resource Management

workers and vehicles on construction site

Traditionally
Paper based documents
Verbal communication

Problems
Multitude of documents
Not shared knowledge
Weakness of the information delivery process
Subjectivity in data interpretation

Effective **management** of the construction phase

Clear **visualisation** of resources
- workers
- vehicles and machineries
- temporary equipment
- their space-time interrelation

Interferences between activities
Overcrowding of resources
Risk assessment

*Not a clear undestanding of the **number of workers** and their **location** on site*

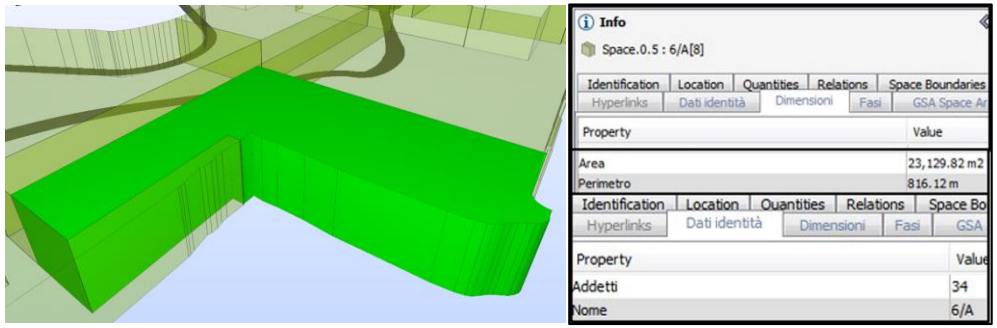
Site supervisor
Subcontractors
Safety coordinator
Contractors

LOTTO AREA		IMPIANTI/MEZZI/ATTREZZATURE UTILIZZATI DA OGNI IMPRESA	ADDETTI	D	L	M	M	G	V	S	D	NOTE DELL' IMPRESA - INTERFERENZE -
4 - 3			5						X			T SOSP IN ATTESA DI DEF
4 - 3			5						X			T SOSP IN ATTESA DI DEF
			2									
2		escavatore - mezzo d isollevamento - rullo	6		X	X	X	X	X	X		
1-8/A1	**AREA 1 - 8/A1:**	escavatore c/pinza - escavatore c/martellone	3		X	X	X	X	X			
3	**IDR Area 3:** Scavo canale tratto 10	4 Escavatore - 3 dumper - 1ruspa	8		X	X	X	X	X			
5/A	**IDR Area 5/A-B: canale tratto 6:** preparazione piani di posa fondo canale - scavo fondazioni spalle ponti e zattere (manodopera e mezzi CAZZARO)	1 escavatori - 1 ruspa - 1 rullo	3		X	X	X	X	X			
5/A	**IDR Area 5/A: canale tratto 6:** getto magrone fondo canale		3		X	X		X	X			
5/A	**IDR Area 5/A: canale tratto 6:**	autobetoniera - autopompa	2		X	X		X	X			
5/A	**IDR Area 5/A: canale**	Camion con gru - mezzo sollevamento	6		X	X	X	X	X	X		
6/A	**IDR Area 6/A:**	mezzo sollevamento	6		X	X	X	X	X	X		
6/A	**IDR Area 6/A**	autobetoniera - autopompa	1		X		X		X			
6/A	**IDR Area 6/A**	1 escavatore - 2 dumper	3		X	X	X					
5/A	**IDR Area 7/A:**	1 escavatori - 1 ruspa - 1 rullo	4		X	X	X	X	X			
7/A	**IDR Area 7/A: ca**	mezzo sollevamento	6		X	X	X	X	X	X		
7/A	**IDR Area 7/A: canale tra**											
7/A	**IDR Area 7/A: canale tratto 5:** fornitura cls fondo canale, fondazione e elevazione muri											
7/A	**IDR Area 7/A: canale tratto 5** posa guaina EPDM impermeabilizzazione fondo canale (fornitura **Maccaferri**)											
9/C	**IDR Area 9/C: canale tratto 2a:** casseratura e getto fondo canale e fosse giochi d'acqua											
9/C	**IDR Area 9/C: canale tratto 2a:** fornitura cls fondo canale e fosse giochi d'acqua (ausilio trasporto EST TICINO Calcestruzzi)											

Construction Resource Management

analysis of critical days – overcrowding of resources

***Objective: clear** and **effective visualisation** of data contained in traditional documents*



Information Management:

- sub-construction sites modelled as ***Spaces***, information container
- **H&S information** updated for a monitoring period of **four weeks**
- Data become input for **BIM-based analyses**

➢ **Information takeoff**

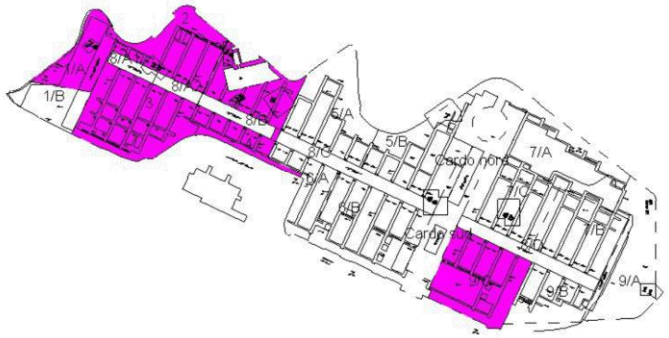
➢ **Visualisation**

➢ chromatic representation to visualise every sub-area with different colours according to the information about the number of resources and to immediately know which sub-area is critical for resources overcrowding

Construction Resource Management

analysis of critical days – hazardous activities

***Objective: clear** and **effective visualisation** of data contained in traditional documents*



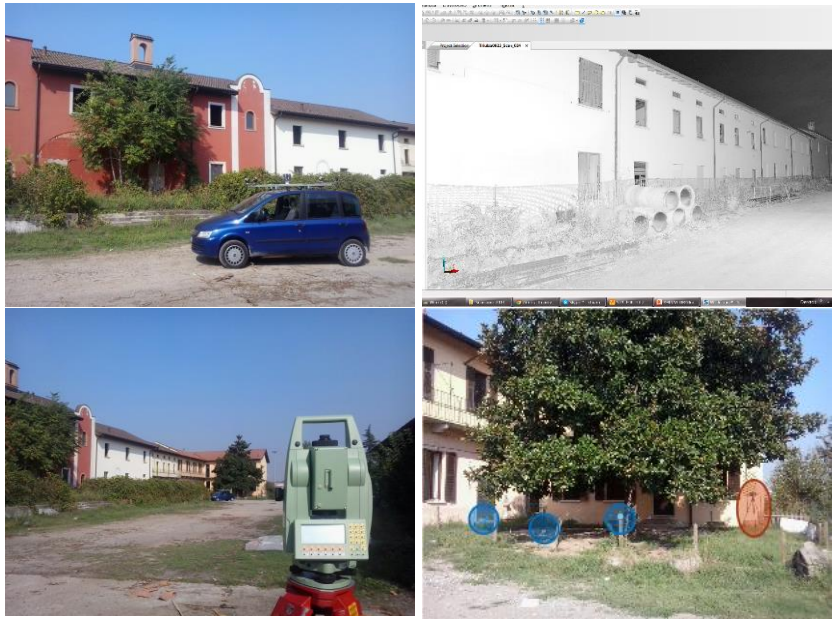
Weekly analysis of areas subjected to excavations

- **Knowledge** of which areas are potentially dangerous and should be checked
- Application of **safety measures** and presence of **safety devices**
- Areas can be effectively subjected to **strict prevention strategies**

Dati identità	
Numero	12
Nome	9/C
Impresa ATI	[redacted]
Impresa subaffidataria	
Impianti/mezzi/attrezzature	5 Escavatore - 2 dumper - 1 pulmino - 3 mezzi d'opera
Sintesi attività	Scavo fondazioni spalle ponti da traliccio direzione da Ov...
Addetti	13
Preposto sicurezza impresa	[redacted]
Preposto sicurezza subappalto	[redacted]
Note dell'impresa-Interferenze	
Recapito	[redacted]
Sintesi attività 2	

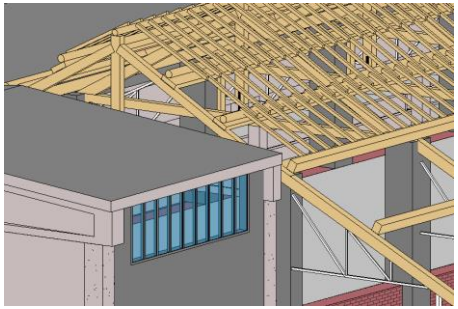
Scavi - Settimana 51				
Area in lavorazione	MQ	Addetti totali sull'area	Sintesi attività di scavo	Impianti/mezzi/attrezzature
1/A	24603 m²	5	Scavo di scotico	2 escavatori - 3 dumper
3	59367 m²	18	Scavo canale tratto 10 - Scavo fondazione ASV B2- Scavo di scotico sbancamento	8 escavatori - 8 dumper - 1 ruspa
4	43397 m²	6	Scavo fondazione - Scavo fondazione cabina MT	2 Escavatori - 4 dumper
5/A	49411 m²	7	Scavo fondazione spalle ponti e zattere canali tratti 5 e 6	2 Escavatori - 2 ruspe - 2 rulli
6/A	23130 m²	4	Scavo fondazioni spalle ponti da traliccio direzione da Ovest	Escavatore - 2 dumper
6/B	64232 m²	4	Scavo fondazioni spalle ponti da traliccio direzione da Ovest	Escavatore - 2 dumper
9/C	48596 m²	13	Scavo fondazioni spalle ponti da traliccio direzione da Ovest - Scavi di sbancamento	5 Escavatore - 2 dumper - 1 pulmino - 3 mezzi d'opera

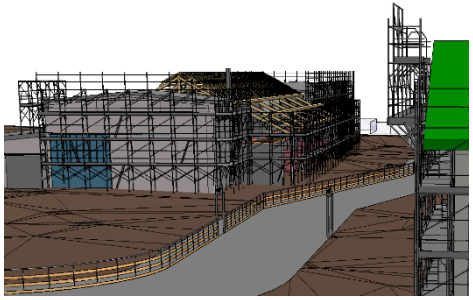
A Sub-Construction Site

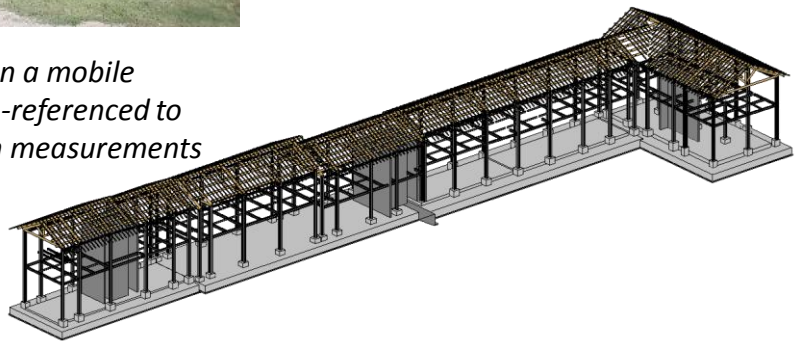


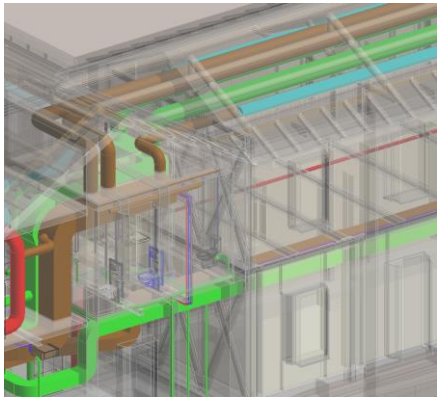
Faro Focus 3D terrestrial laser scanner (TLS) on a mobile vehicle in the Stop&Go mode. Scans were geo-referenced to be semi-automatically aligned by total station measurements

The Inventory Model was geo-referenced according to the CAD file containing the site information provided by the engineering company



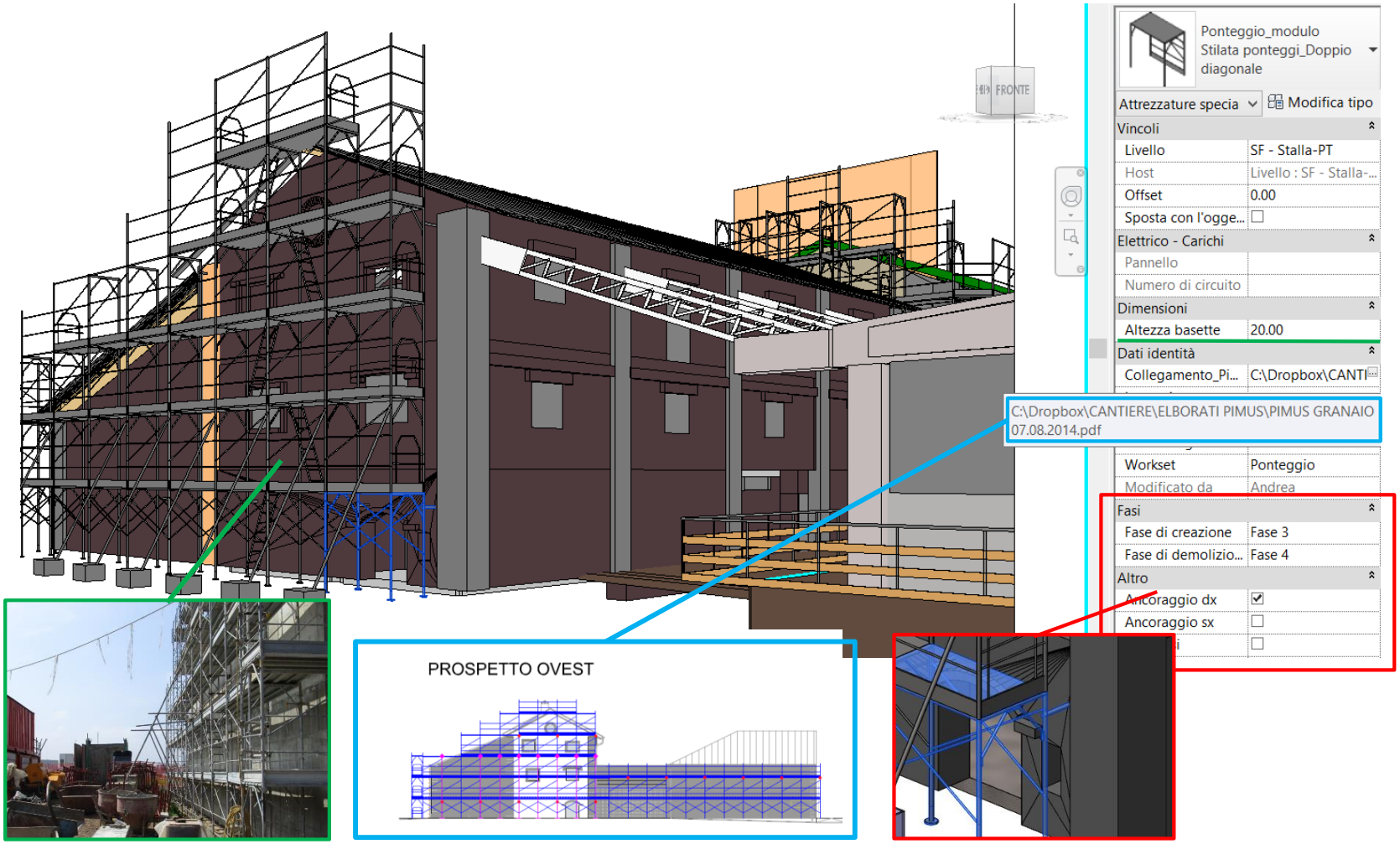






A Sub-Construction Site

Objective:** a **health** and **safety database

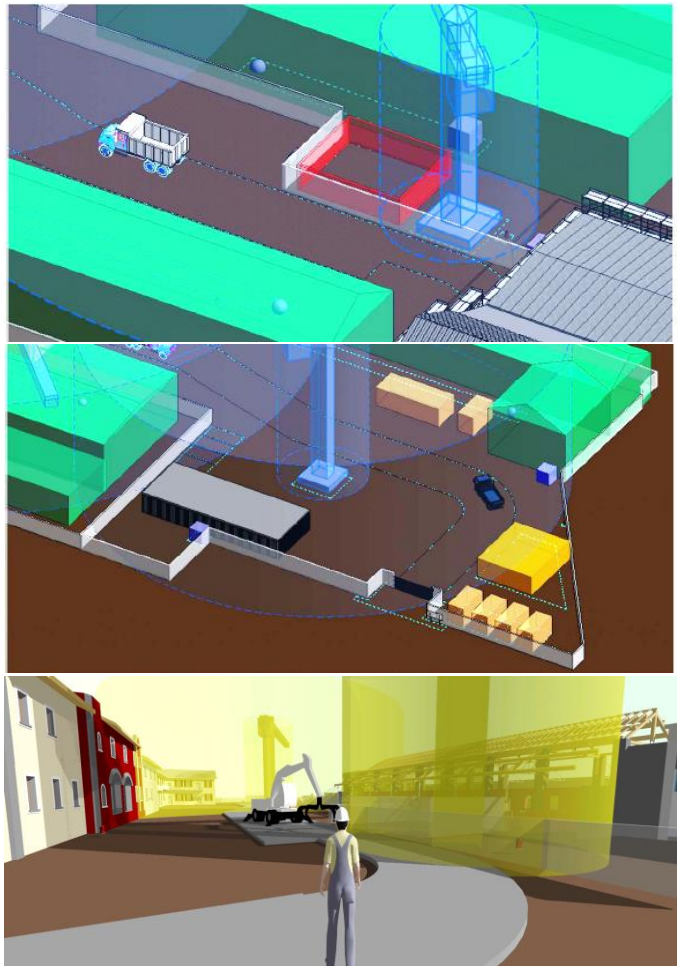


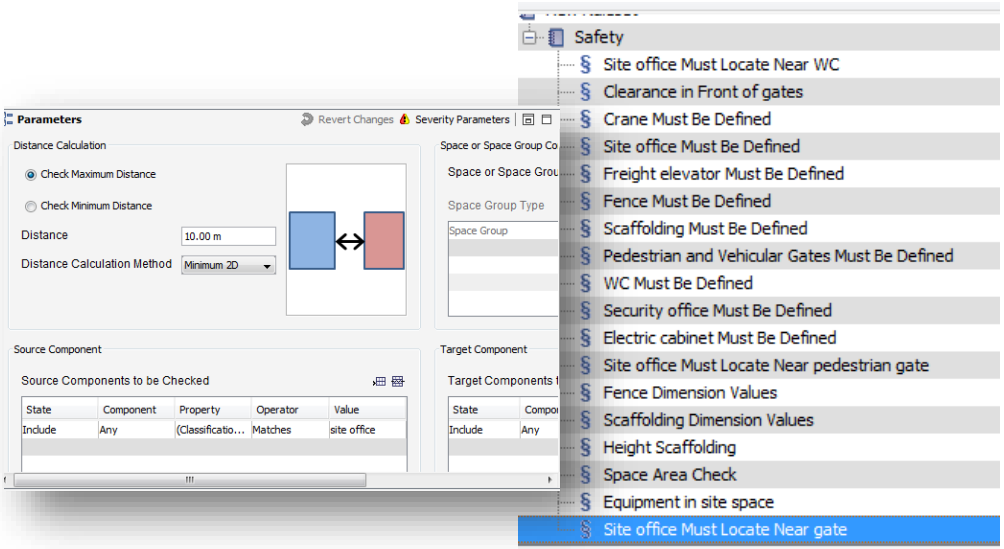
A Sub-Construction Site

Objectives: H&S BIM-based analyses

H&S ruleset

- **Presence** of safety devices and site fencing
- Check of **geometrical parameters**
- **Location** of safety equipment and other requirements of the operating space
- **Interferences** between construction spaces



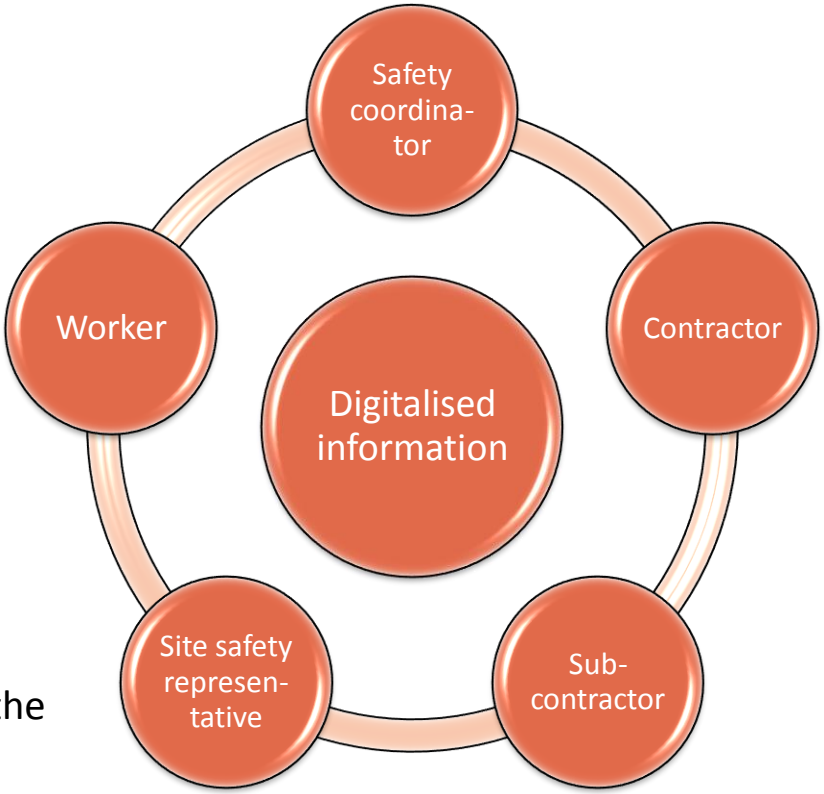


Traffic Management

Objective: *constant* ***update*** *and* ***communication*** *of changes in construction site viability*

- **Large construction site**
- **High number of sub-construction sites**

- **Coordination**
- **Communication**



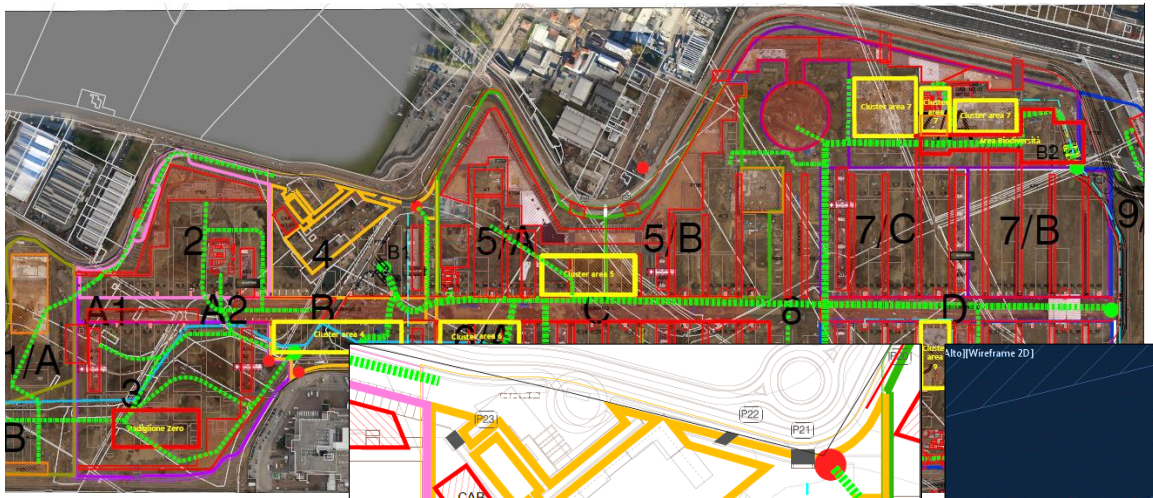
Upload an **OPEN STREET MAP** on mobile devices

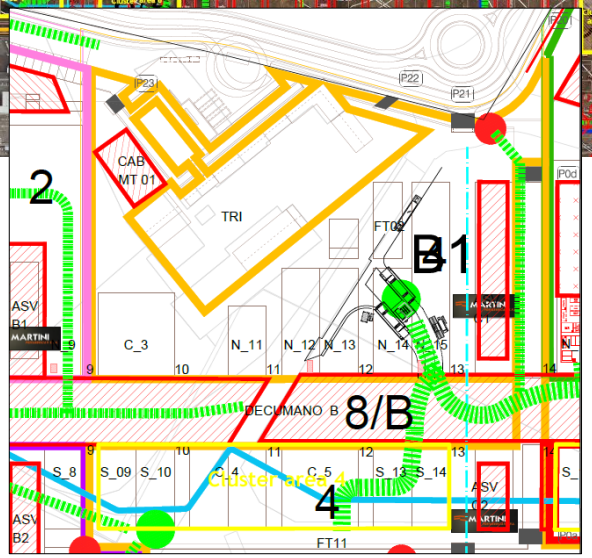
Not a new tool, but a new way of using it to support the **information flow** on site

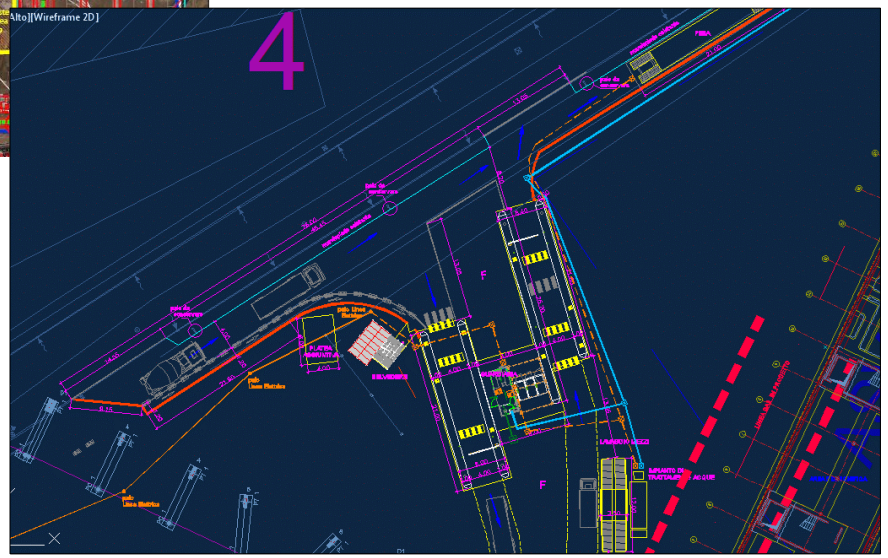
Traffic Management

traditional process

Objective: *constant* ***update*** *and* ***communication*** *of changes in construction site viability*



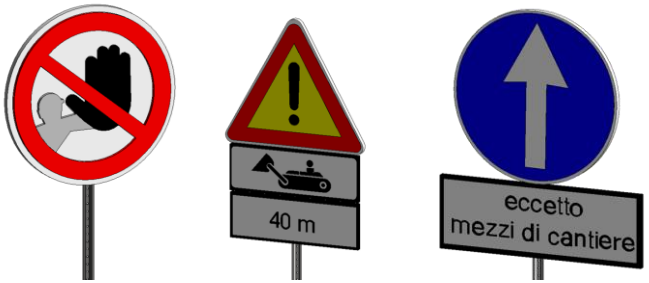


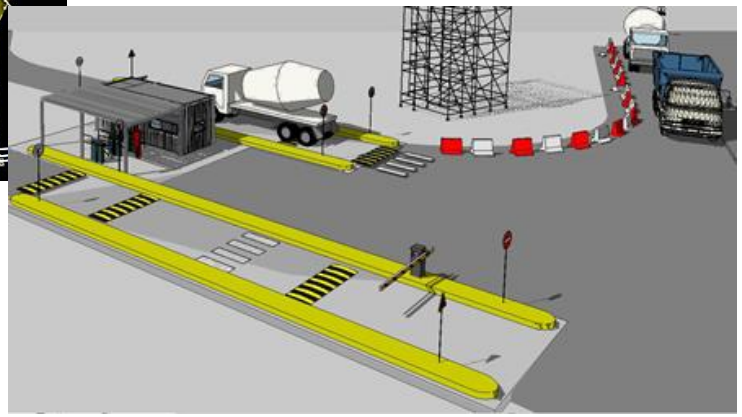


Traffic Management

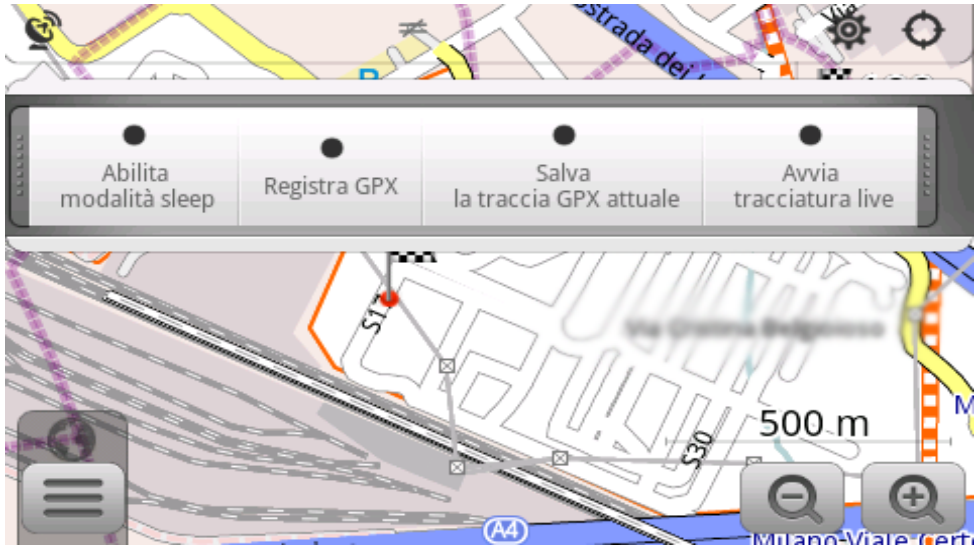
Infomation Modelling

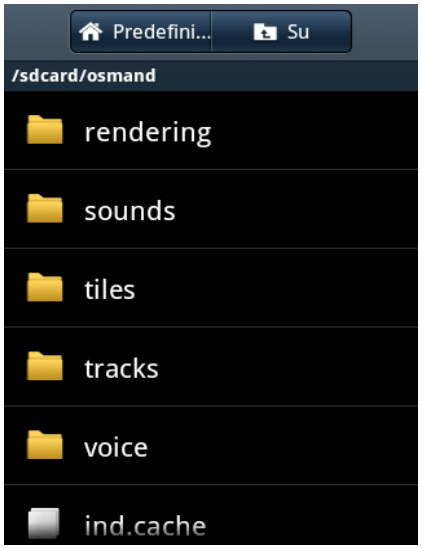
Objective: *constant* ***update*** *and* ***communication*** *of changes in construction site viability*





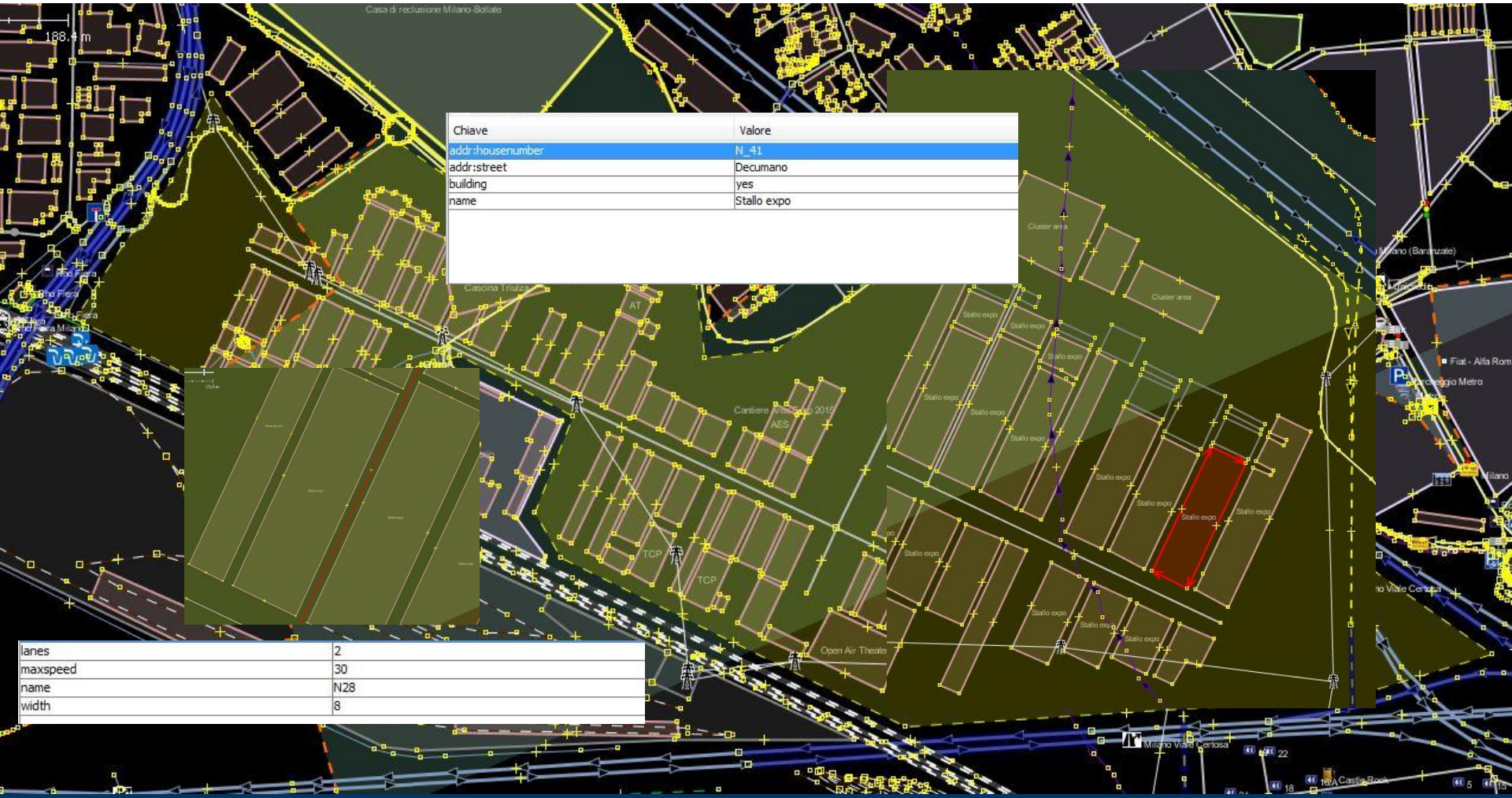
Traffic Management





Traffic Management

Implementation of parameters



Traffic Management

The OSM resulted to be integrated with the road network of the urban context

Conclusions

Resource management

- The H&S coordinator remarked some failures in the information coming from the main contractor and asked for an improved **data flow** within the construction site
- **BIM-based analysis** of safety plans

Traffic management

- **Update and share** information about viability on site

Future works

- Use of **sensors** for a real-time data flow of the information recorded on site (ie. Information about workers and vehicles going through the access gates)
- Direct link from **Infra BIM authoring tools** and the editor of OSM
- Use of **traffic analyses tools** to analyse the impact of the construction site on urban traffic
- Development of an **app** to collect different construction analyses. It would be possible to have information about resource management and at the same time about traffic management and regulations to apply in case of emergences

Thank you

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