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The dissemination of the culture of safety: Innovative experiences from important infrastructures and construction sites

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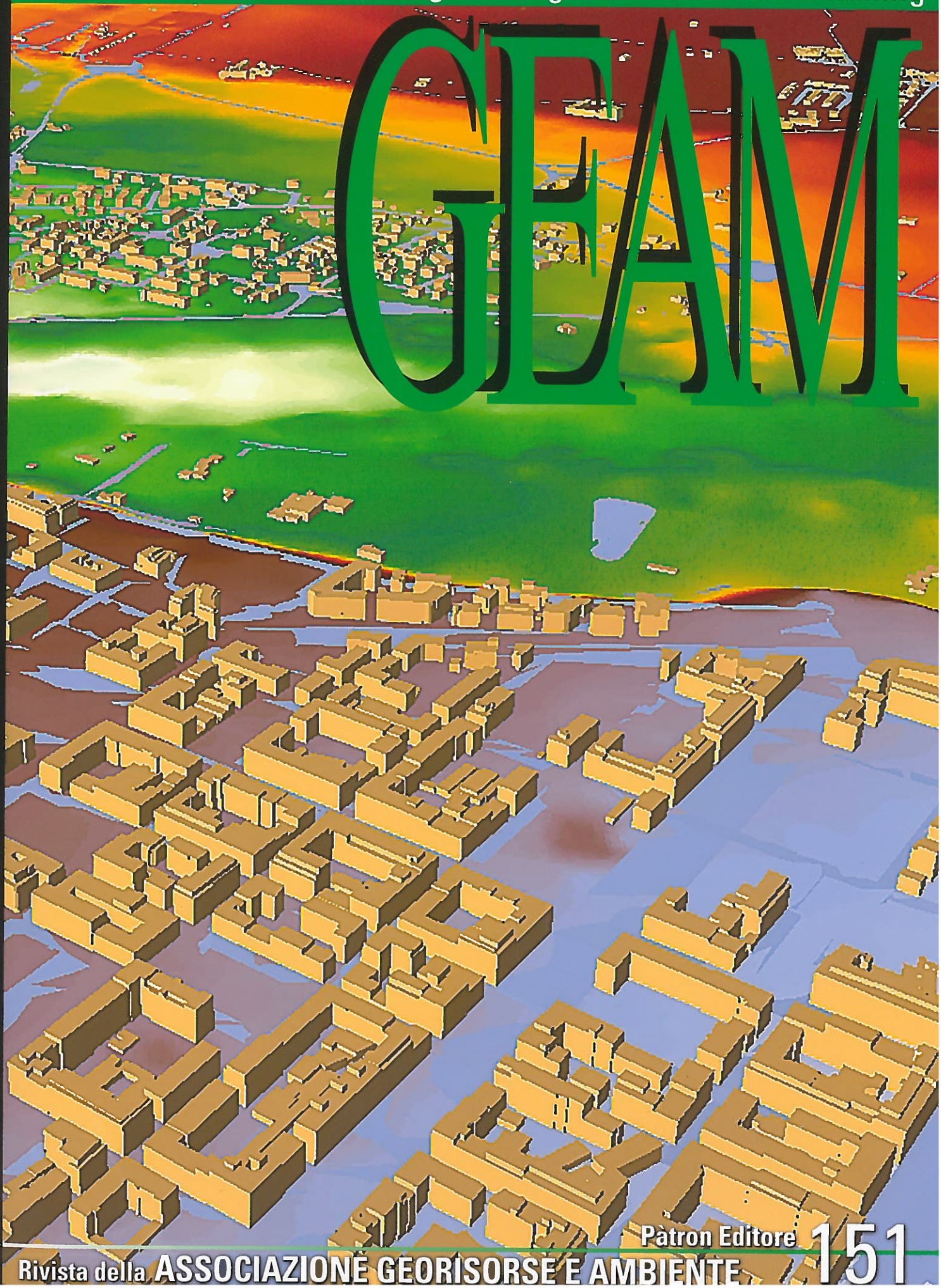
GEAM



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e-mail: geam@polito.it – www.geam.org

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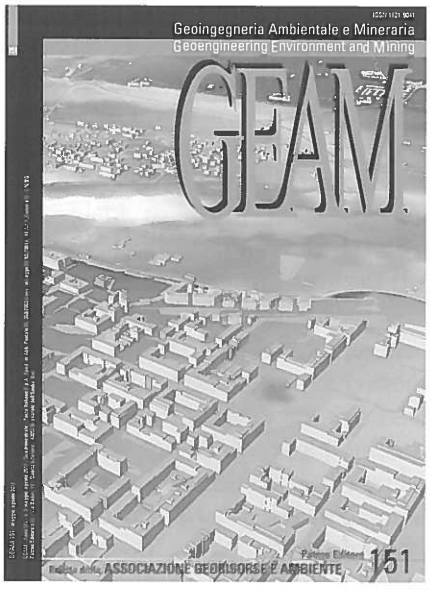

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The dissemination of the Culture of Safety: innovative experiences from important infrastructures and construction sites

Elisabetta De Cillis*
Paolo Fargione*
Luisa Maida*

* DIATI, Dip. Ingegneria Ambiente, Territorio e Infrastrutture, Politecnico di Torino, Italia

The Culture of Safety is the enduring value and prioritization of worker and public safety by each member of each group and in every level of an organization *(Von Thaden and Gibbons, 2008).*
First, the Authors provide some considerations on the roles, tasks and responsibilities of the subjects involved, and reiterate the importance of an approach involving a strong motivation for the figures with real decision-making power.
Taken into account what emerged in the International Meeting "the basic role of the clients of great infrastructural operations in the promotion of the Culture of Safety: management and communication strategies, contractual aspects, case histories and best practices", SiTI, Turin, Politecnico, May 12th 2017, *the Authors discuss – coherent to the original structured classification of the various aspects of the Culture of Safety into specifically designed sub-categories – the critical Occupational and Community S&H issues, and the responses of the clients.*
Keywords: *dissemination of the culture of safety, OS&H in temporary and mobile construction sites, International OS&H meeting, OS&H clients' experience, OS&H Management, OS&H communication strategies, dissemination of Culture of Safety*

La disseminazione della cultura della sicurezza: esperienze innovative maturate nell'impostazione e realizzazione di grandi cantieri ed opere infrastrutturali. *La Cultura della Sicurezza* è "Il valore permanente e il livello di priorità da assegnare alla sicurezza dei lavoratori e dei terzi da parte di ciascun membro in ciascun gruppo a tutti i livelli di un'organizzazione" *(Von Thaden and Gibbons, 2008).*
Vengono espresse alcune considerazioni su ruoli, compiti e responsabilità dei soggetti coinvolti, e ribadita la assoluta importanza di un approccio che motivi le figure con reali poteri decisionali.
Prendendo spunto da quanto emerso in occasione dell'Incontro Internazionale "La Committenza di grandi opere quale essenziale promotore della Cultura di Sicurezza e Salute del lavoro: strategie di gestione e comunicazione, aspetti contrattuali, buone prassi ed esperienze" *organizzata da SiTI presso il Politecnico di Torino il 12 maggio 2017, si discutono, adottando come riferimento logico la classificazione strutturata dei vari aspetti della Cultura della Sicurezza in sottocategorie omogenee messa a punto dagli Autori, le criticità rilevate sul campo e le risposte che le Committenze hanno saputo introdurre.*
Parole chiave: *disseminazione della cultura della sicurezza, OS&H nei cantieri temporanei e mobili, Incontri internazionali su OS&H, esperienze di OS&H delle grandi committenze, gestione della OS&H, strategie di comunicazione degli aspetti di OS&H, disseminazione della cultura della sicurezza*

1. Foreword

According to the main results of an EU survey in many Countries, Italy included, Occupational Safety and Health – OS&H professionals operate in a context lacking of a widespread Culture of Safety, and not in tune with the multidisciplinary research results that would be essential to understand in depth the special OS&H criticalities of modern activities – in particular temporary and mobile construction sites – and to identify the suitable countermeasures (*Maida and Patrucco, 2017*).

The International Meeting "*the basic role of the clients of great infrastructural operations in the promotion of the Culture of Safety: management and communication strategies, contractual aspects, case histories and best practices*" (Turin, Politecnico, May, 12th, 2017) organized by Higher Institute on Territorial Systems for Innovation – SiTI, with the cooperation of the research team *of The General Safety Issues and Goals in Turin Universities – TGSIGTU*, and of Geoingegneria Ambientale e Mineraria – GEAM, was an important opportunity of debate between "insiders" on the approaches and experiences on S&H in relevant infrastructures, focusing on the excellences, with obvious return of dissemination of the Culture of Safety.

The meeting, supported by Tunnel Euralpin Lyon Turin – TELT, was planned to share virtuous experiences on completed or ongoing situations gained by important clients (see fig. 1), and became a real chance to collect firsthand information and spread the results, the innovations and the original approaches to other clients and contractors, qualified designers and OS&H practitioners and experts. Far from being an una tantum occasion, the meeting was intended to be the first of a series, aimed at mutual exchange of information on the possible improvements of Occupational and Community S&H.

The aim of the Authors of the present paper – far from a mere report/summary on the speakers' interventions – is to provide a critical analysis of the main results of the Meeting in terms of effective contribution to the dissemination of the Culture of Safety, in particular on technical and managerial approaches adopted by each

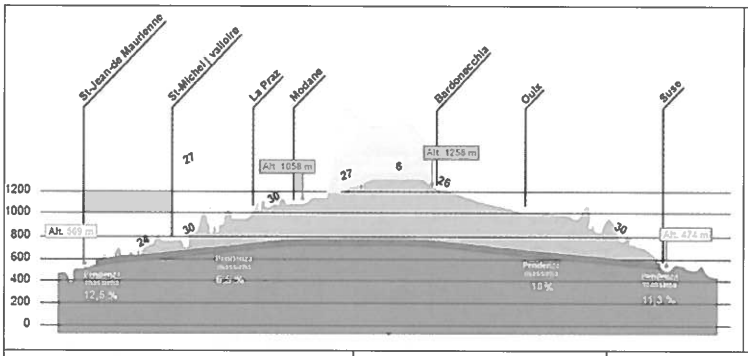
invited client, highlighting the original innovations and the results of the discussion. According to this approach, the organization of the Authors' observations in the following is coherent with the result of their critical effort to classify and organize the different sub-topics of the Culture of Safety, as proposed in *De Cillis et al. 2017.*, GEAM stesso numero).

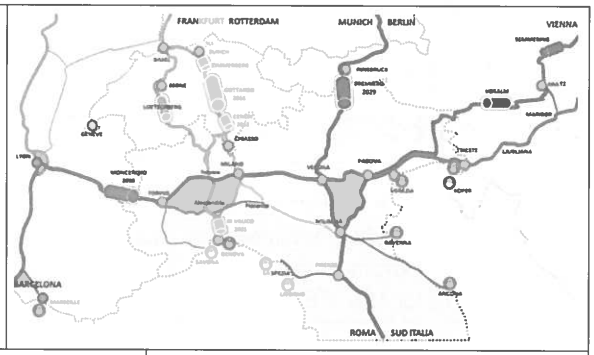
Fig. 1. The relevant infrastructures discussed in the International Meeting.
Le grandi infrastrutture prese in considerazione nel Meeting Internazionale.

2. The Case Histories discussed in the International Meeting

Infrastructures do not result only in mere figures regarding kilometers of tunnels, bridges, money spent, workers involved..., but they have an intended use aimed at the improvement/ replacement of existing systems, or at the introduction of new sites interesting. Thanks to the experiences considered in the Meeting, we had the chance to see key works, of interest not only of the Countries hosting them, but, more often, responding to an international need within the European community. The following tables 1÷7 summarize the main information about the infrastructures discussed.

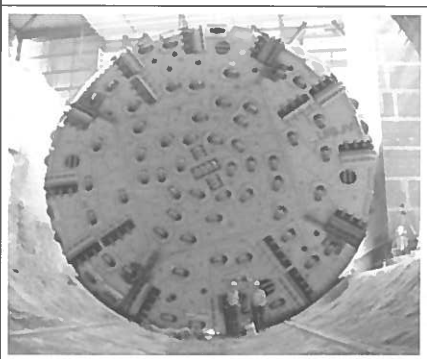
Tab. 1. Lyon-Turin Base Tunnel.
Galleria di base Lione-Torino.





Tunnels	Moncenisio	Frejus
Investments €	8.6 10^6 €	n.a.
Workers involved	n.a.	n.a.
Year of completion	2029	1871
Length	57.5 km	13,64 km
Travel time required	1h 47min	3 h 43 min
m above sea level	474-569 m	1,190-1,335 m
Slope of the path	6.5-12.5‰	27.5-30‰
Trains max length	750 m	550 m
Locomotives	1	3
Convoys Weight	1,600 t	Max 650 t
Freight train speed	Max 100-120 km / h	
Passengers train speed	Max 220 km / h	

TUNNEL EURALPIN LYON TURIN
Mediterranean
Trans-European
Network Corridor



Tab. 2. Milan-Verona railway.
Linea ferroviaria Milano-Verona.

cepav due
consorzio eni per l'Alta Velocità

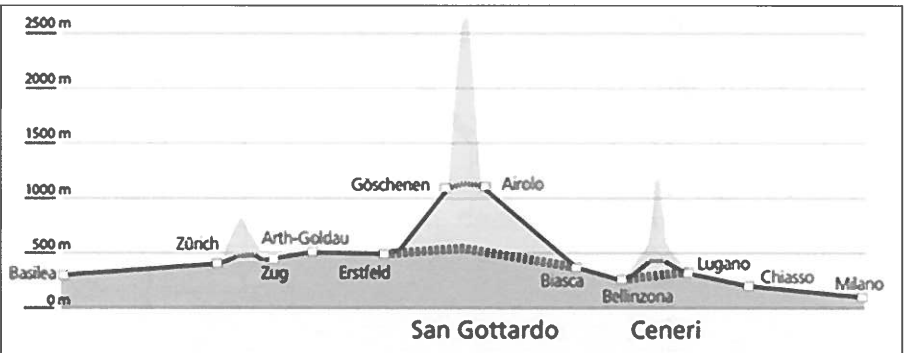
New High Speed/High Capacity Railway Milan Verona – Functional Lot Treviglio – Brescia

Mediterranean Trans-European Network Corridor which will link southwestern countries to Eastern Europe, the Mediterranean Corridor is a privileged itinerary for both Asia and Europe (from Spain to Ukraine)	
Investments €	2 10^9 €
Workers Involved	More than 5,000 – 4,5 10^6 h worked
Year of completion	2016 – in 5 years
Length	51 km
High speed increased connection/day	1 / day to Rome/Naples
Passengers train speed	200 km / h
Time required	16 min less than before

Tab. 3. Rhine-Alpine Core Network Corridor.
Corridoio Rhine-Alpine.

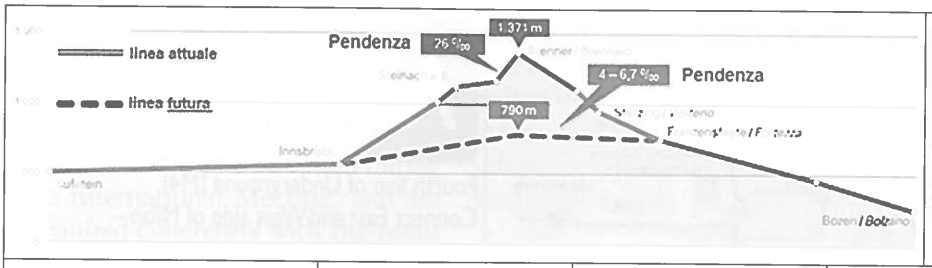
AlpTransit Gotthard San Gottardo

Rhine-Alpine Core Network Corridor, connecting the North Sea Port of Rotterdam to the Mediterranean basin in Genoa, crossing a strong economic area whose accounts for 16% of EU GDP.



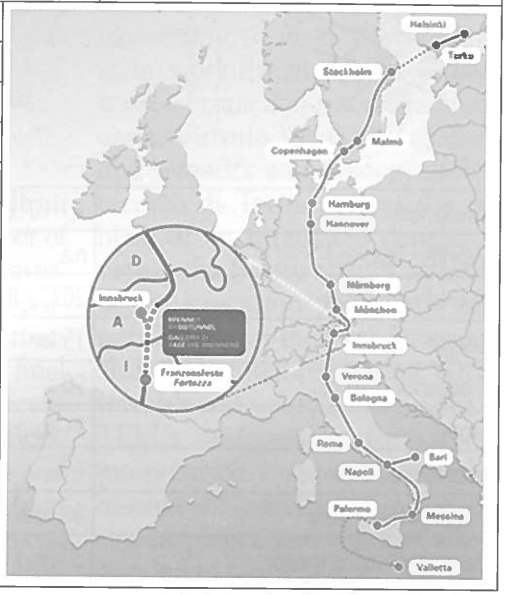
Tunnels	Gotthard	Ceneri	Previous
Investments €	3,3 10^9 €		n.a.
Length	57 km	15.4 km	15 km
Workers involved	1.800		
Year of completion	2016	2019	1882
Maximum depth:	2.300 m	800 m	n.a.
m above sea level	550		1,150
Slope of the path	12.5 ‰		n.a.
Freight trains/day	250-260	390 total	290
Passengers trains/day	50 to 80		
Convoys Weight	4,000 t		2,000 t
Passengers train speed	200 km / h	Notes: less locomotives, less personnel, less electricity.	
Freight train speed	100 km / h		

Tab. 4. Scandinavian-Mediterranean Core Network Corridor.
Corridoio Scandinavia-Mediterraneo.

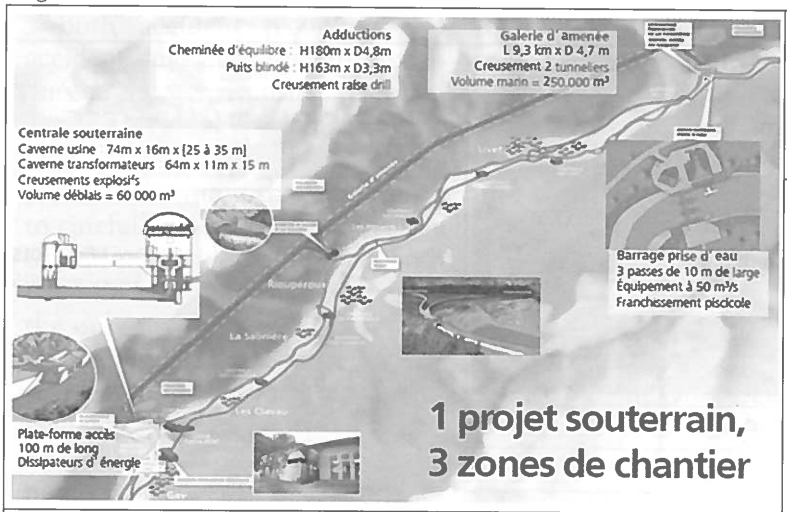


Scandinavian-Mediterranean Core Network Corridor

Tunnel	Brenner	Previous
Investments €	3 10^9 €	n.a.
Workers involved	n.a.	n.a.
Year of completion	2025	1867
Length	55 km	75 km
Travel Time	35 min	1 h 45 min'
m above sea level	790	1,371
Slope of the path	4 – 6.7‰.	26‰.
Total trains/day	400	290
Trains' length	750 m	450 m
Locomotives	1	2-3
Convoys Weight	1,600 t	1,200 t
Freight train speed	100 km / h	Notes: less personnel less electricity
Passengers train speed	200 km / h	



Tab. 5. Global project Romanche – Gavet.
Progetto Romanche-Gavet.

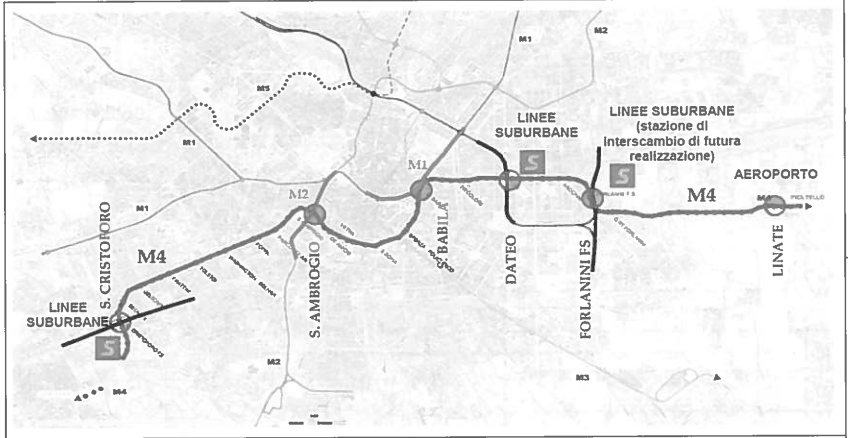


Investments €	n.a.
Workers involved	n.a.
Year of completion	2022
Power – Production increase	10 MW – 155 GWH vs previous sitiation (*)
Length	10 km
Structure	2 groups
	1 Cave
Notes: (*) need of a city of about 70,000 inhabitants	

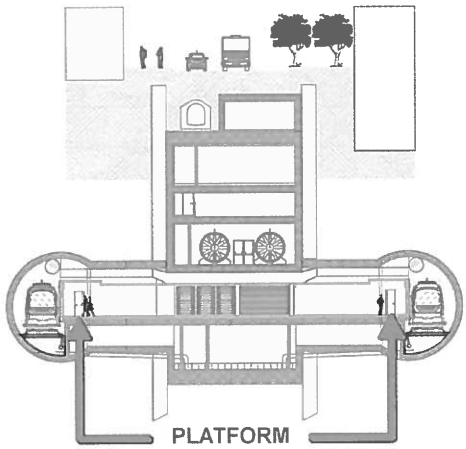
EDF

Romanche Gavet – EDF is replacing six existing centuries-old power stations with a more powerful underground powerhouse

Tab. 6. Fourth line Milan Underground (M4).
Linea 4 Metropolitana Milanese.

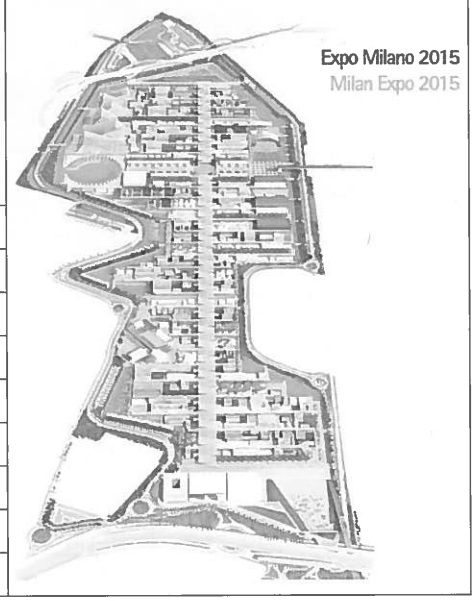


Fourth line of Underground (M4).
Connect East and West side of Milan – straight to the airport.



Investments €	1,7 10^9 €
Workers involved	n.a.
Year of completion	2022 (88 months duration)
Length	15 km
Frequency of a train	90 s
Stops	21 stops
Interconnections	6
Passengers per year	86 million
Passengers trains speed	80 km / h
Notes: less traffic of surface vehicles	

Tab. 7. EXPO Milan.
EXPO Milano.



Investments €	2,2 10^9 €, 3,2 10^9 €
Enterprises	233 Coordinate Subjects
Site Surface	1,100.000 m^2
Average workers in the yard	November/April 2014: 3,362
Max. workers in the yard	April 25th, 2015: 9,147
Year of completion	2015
Time required	6 months
Total visitors	22,2 10^6
€ from visitors	421,3 10^6 €

Fonte: *Il Sole 24ore.*

3. Some considerations on the topics discussed during the Meeting

The following considerations cover the main topics discussed during the International Meeting, and are organized coherently with the result of the Authors' critical effort to classify and organize the different sub-topics of the Culture of Safety (De Cillis *et al.*, 2017 stesso numero GEAM).

3.1&2. Value of the Culture of Safety dissemination (in compliance with the OS&H Regulations and Standards), and Occupational and Community S&H criticalities

These topics are stressed at first in the keynote "Motivazioni e obiettivi dell'Incontro Internazionale – Reasons and ground of the International Meeting " (*Sorlini and Patrucco, 2017*), together with the common aspects characterizing the Safety / Quality approach.

Both accident recording and accident data management are discussed by AlpTransit, MM and Expo. The speakers summarize the reports on injuries occurred in the yards, underlining the importance to carefully understand data before to plan corrective measures. In both the MM and the AlpTransit sites, the only number of accidents is of no use, if no information about presence in the site attendance is available: great works are characterized by continuous variability in the number of workers, due to the simultaneous presence of a number of contractors during the various execution phases. At the same time, the severity of the consequences should be considered, to sort hierarchically the Risky processes, and immediately intervene where necessary.

Dr. E. De Cillis (PhD student – Management, Production and Design, subtheme OS&H, Politecnico di Torino) stresses the criticality of temporary and mobile construction sites, and, hence, the importance of a continuous action of dissemination of the Culture of Safety: the International Meeting can be considered a rare initiative, decidedly worthy of sequels.

3.3. The need of specific competences in techniques, technologies and OS&H, and the role of decision makers

Professor Romano Borchiellini, President of SiTI and Vice Rector of Politecnico di Torino, in his introductory speech highlights the importance of great works and infrastructures not only considering their final intended use, but also as real technical and technological challenges, and a moment of development and evolution of the whole national system during the years, and across all phases, from the design to the execution. All the great works represent the answer to social and economic needs: goods to move around Europe increase day by day, and road transport could not satisfy the need for many reasons, among them related traffic, environmental pollution, hazard factors connected to intrinsic and extrinsic variables, etc.

A glance to the data from Bankitalia, Italian Statistical Institute – ISTAT and Eurostat shows that in the lapse 1980 – 2010, economic resources in Public investment in Italy was 2.6% of the Gross Domestic Product – GDP. In 2008 Italy invested in infrastructures €18,9 billion (beginning of crisis), in 2015 € 12,2 billion, in 2016 € 13,47 billion and in 2017 € 16,8 billion (forecasted). To confirm that statement, we can compare those investments, for example in 2015, with the amount of public and private contribution invested in Research & Developments: € 22,9 billion (€ 8,9 billion from public contribution). Great works, always demanding to overcome the technical limits and introduce innovations, and involving substantial investments in Research & Developments, can then be an important occasion of cooperation between clients and research institutions[1].

It is moreover important to consider that in a Prevention through Design – PtD approach, every intervention is a good forward-looking investment to make the whole system working smoothly avoiding waste of time and resources. In this optic, Vittorio Verda, full professor of Energetics and Ecology at Politecnico di Torino, raises the problem of an integrated design, covering the Safety fittings necessary in the execution phase, and their possible use for the final destination also. As highlighted by eng. Sorlini (Health and Safety Expert – TELT), TELT's designers projected some intervention to ensure the highest reachable OS&H level in the execution phase, and suitable also to respond to future use.

3.4&5. Culture of Safety at all levels, and Goals to reach in terms of basic knowledge/ competence of workers, and other actors

In the case of tunneling operations, the need to minimize the risks

[1] Authors' note: Safety is a *scientific* system of organized and systematic knowledge production, i.e. the unity of *actors* (research groups on techniques, technologies and OS&H topics) that conduct *researches*, and, through complex *structures* (journals, papers, books, meetings, ...), spread the gained knowledge at different levels to create an *educational system* (Aven, T., 2014): as discussed in De Cillis *et al.* 2017 (accepted as oral presentation for the International Conference WOS 17), Politecnico di Torino, thanks to its widespread technical – technological expertise, integrated with confirmed OS&H competences, can then be a prestigious reference Institution.

from the very beginning of the design process is of paramount importance. All the invited clients agree about the idea that Safety cannot be developed in a compartmentalized approach, and pasted on an already complete project, but it has to match, phase by phase, all the process steps, from the design to the emergency management. Thus it is necessary that every pratictioners involved in the work is familiar with the basics of OS&H.

In this optic, all the clients expose their own approach: AlpTransit involved a special team of external engineers, experts in OS&H, and the project was then submitted to a group of certified verifiers. Brenner Basis Tunnel – BBT and TELT, due to the length of the tunnels, decided to afford a geognostic exploration to improve the know step by step of the characteristics of the rock formations, to refine the design. Designers, of course, had to consider also practical aspects: the deep intercepted fossil water, the amount of muck to manage, the supply materials for the work progression, etc., and, to avoid to increase the traffic load of public roads connecting to the tunnel, they decided to drive geognostic tunnels to investigate the composition of the soil, and to face all the problems above mentioned, minimizing the possible negative consequences.

It is obvious that not every practitioner is required to be OS&H expert, but one of the pivotal aspects necessary to ameliorate the Safety in these situation is that workers develop knowledge, skills and competences coherent to their expertise level and decision making power.

3.6. *Find target*

The considered infrastructures differ at first for the geographic area where they have been designed and realized or programmed. Every case had to face different problems and different challenges: regulations are different not only for the typologies of infrastructures, but they also depend from the Country where the realized, or, this being the case in Italy, also from Regional rules. It is necessary to carefully consider these aspects, in particular in infrastructures connecting two Countries: AlpTransit for the Gotthard (IT-CH), of BBT for the Brenner Base Tunnel (IT-AU) and TELT (IT-FR). For example, Switzerland has obviously no obligation to transpose the 92/57/EEC Directive; the Sud-Tirol region has different supervisor's bodies compared to other Italian regions, etc. In these cases, all the Official bodies have to coexist, and the only possible – and safe – solution is to compy the strictest rules of both the Countries, reaching a situation of compliance, independent of both the exact position where the yard is located, and the progress of the operations.

3.7. *Subjects and organizations involved*

For all the infrastructures, the client deals with Public Administration, so that works have to undergone specific control commissions that confirm the suitability of the selected contractors. The contractors can have different organization charts, internal associations, business relations, numbers of clients or sub-contractors, etc., but, in every case, it is evident the need and the importance of simplification[2]. Simple Systems are – in general – easier to control and monitor, but not only: it be also easier to manage an educational system if we have a clear distribution of roles, without any confusion about duties and responsibilities in OS&H matters.

All the great works presented during the Meeting faced the problem of interferences: managers identified the coexistence of more than one contractor operating in different fields at the same time and in a limited space. It is important to fix these criticalities from the design phase, using all the tools useful to avoid incompatible operations overlaps.

In many cases, the structure of organization is essential to understand the possible scenarios: a compact organization is surely easier to manage by top managers, but there are some reasons that can force the clients to split out the execution phase between many smaller contractors. As is often the case, there could be a gap between the client's Safety performance and the contractors' Safety performance; for example, in some cases, client's reports underline that the companies working with contractors occasionally experience unforeseen Safety problems.

In the case of EXPO, the project was really complex, with limited time to complete the opera in which many contractors, with different background culture, company culture, and attitude regarding OS&H issues were working together. The problems raised in such a scenario where connected to the internal interferences: to solve the situation, the managers realized that it was necessary to create a climate of communication and cooperation and, before the opening of EXPO, they totalized the surprising number of 994 meetings and round-tables. Project leaders managed tasks and plans, but for Safety, behavioral issues were important: their own role in giving the good example and addressing OS&H issues was fundamental in creating a high-level Safety consciousness. MM decided to raise standards of Safety not only for their own employees, but also for workers of the companies working for them. Improving the

[2] *Never increase, beyond what is necessary, the number of entities required to explain anything, William of Ockham, Summa logicae* (1323)

Safety performance of contractors has been one of the Occupational and Community S&H challenges and priorities, and a relevant part of their strategy.

3.8. *Overview of best practices: Specific population*

Promoters planned and organized the International Meeting with the goal to underline the importance to afford the Safety issues from the very first design phase, in a PtD approach, to avoid unwanted events.

Despite that, it is always necessary to consider possible scenarios of high risk or deviations before to begin works of this magnitude. In each intervention, a particular attention was focused on the problem of emergencies: almost all the infrastructures analyzed, as already discussed in previous points, have common characteristics: underground-works, many contractors involved, interference problems, etc.. The speakers explained how they designed detailed plans of emergency in which all bodies involved would intervene quickly and simultaneously. The most common tool used, and suitable to ensure good results, is a simulation movie: it is useful for outsiders to understand the entity of a possible accident, and for insiders, to better understand the procedures to follow in case of emergency.

In long tunnels, the access to the excavation face, where we can suppose the presence of higher risk processes, depends from the underground layout, the distance to cover, the promptness of intervention, and the available Emergency organization and equipment.

All the Speakers explained and agreed that the procedures and the respect of specific regulations were at the basis of the emergency management, but in the perspective to reach an excellent effectiveness, interventions have to be immediately enforced. There are units working h 24, placed at the entrance of the yards, set up for emergency management: from equipped control-rooms, operators monitor and manage the site process and the Safety and Security facilities: Control of site and tunnel access, switching on and off the ventilation, management of electrical and lighting systems, management of the traffic-lights system for the activation of escape routes, etc.. Meeting points and support organization for Fire and Security internal teams, Fire Fighters teams; Health Care people, etc. should moreover be available.

3.9. *Dissemination of the Culture of Safety in a quality approach*

Changes are, as in a continuous spiral, results of new knowledge and applied intelligence, and, at the same time, starting points and bases to develop new theories and applied researches, so that the theoretical result increases can be directly transferred into practice.

Eng. M. Vigone (coordinator for Safety and Health matters at the project execution stage) discussed these aspects with reference to the San Paolo skyscraper (Torino), opened in the 2015. During the operations a number of important contractors were contemporarily present in the yard, and the work was completed without any relevant OS&H problem; however, managers had to face Security problems: the yard, rising in downtown, was occupied more than once, and the managers had to intervene to guarantee the Safety of workers and population. The TELT's geognostic tunnel is facing the same complex situation, due to the uninterrupted presence of multiple police/army bodies, allocated at the yard to protect it from people contesting the infrastructure.

The Authors underline the carefulness everybody put to comply with the Regulations. Nevertheless, to ensure a high OS&H level, it is necessary but not sufficient to strictly obey the laws: all the speakers confirmed that the whole system should be managed in a Quality approach. In complex cases, like those analyzed, the variables are so many that it is impossible to control everything without a systematic approach, essential to face the multiform and complex problems which can arise.

3.10. *Not only information, formation and training, but promotion*

According Arch. Virano's opinion, in every virtuous Management it becomes of pivotal importance to set ambitious goals to improve the previous situation. Taking such ambitious goals can be risky, because nobody is sure to reach them, but it is an essential step to see tangible results: it helps in modifying machinery and equipment, and even in introducing small innovations that, if put all together into a symbolic chain, will substantially increase the overall quality level of the whole scenario.

In this optic, the coordination of many small and medium contactors is of course more difficult but, in some cases, clients decided to privilege the territorial wellbeing including local companies in the whole system. Furthermore, Arch. Virano highlighted the chance of infrastructures not only to reach a ZERO impact, but also to have a *positive* environmental impact: positive benefits derive from the final outcome, and great works can lead to situations better than the original ones, in particular thanks to their aesthetic characteristics. A clear example is the Romance-Gavet yard, which will bring an

improvement on the energy production, and a considerable betterment of the surrounding environment, bringing all the plants underground.

In the Brennero experience, managers introduced permanent facilities for inhabitants of the neighboring cities: the 24 h/d, 7/7 d/w open medical care should have been necessary in any case for the yards' workers, but they make it available also for the population. This decision was adopted since, in a perfect scenario of no work related accidents, it would have been always "useless".

Clients have a special role and responsibility as promoters of Good Practices on Safety: in the case of TELT, the work has been in the eye of the storm and, from the beginning of the geognostic tunnel, is facing a media overexposure. This implied particular attention, that went beyond what a client must normally face: at the beginning, this was experienced as a problem, but *every cloud has a silver lining*, so managers of TELT, assuming that the situation would have not changed, decided to aim at excellence in every sector, and to exploit the spotlight to show it.

Conclusion

The International Meeting "*the basic role of the clients of great infrastructural operations in the promotion of the Culture of Safety: management and communication strategies, contractual aspects, case histories and best practices*" was an important occasion of debate on the approaches and experiences on OS&H in relevant infrastructures, and confirmed the importance of the involvement of figures with real decision-making power.

The Meeting was organized by SiTI, with the cooperation of the research team of TGSIGTU – a formalized research cooperation Politecnico – Università di Torino-, of GEAM, and the TELT support, and held in Turin, at Politecnico, on May, 12th, 2017, as the first of a series aimed at mutual exchange of information and experiences on the improvement of Occupational and Community S&H.

Thanks to the high experience of speakers and audience, we can consider the Meeting a good opportunity within the general target of dissemination of the Culture of Safety.

Authors provide a critical analysis, coherent with the result of their effort to classify and organize the different sub-topics of the Culture of Safety, on the main results in terms of technical and managerial approaches of every intervened client.

A lot can be done with tangible positive results, although a long way ahead remains, especially when we shift the focus from large yards to the small ones, where *paper-based Safety* is often the only available.

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