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CIVIL LITIGATION AND DISPUTE RESOLUTION DURING URBAN TUNNEL CONSTRUCTION CAUSED BY PROPRIETY DAMAGE

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Tunnel construction has to interact with many complex variables, both in the design phase and in the construction phase, especially in urban areas with high population density. Thus, building a new metro line inevitably involves disputes. Even if companies have appropriate guarantees provided in the contract, the initiation of a claim normally involves a dispute, which can be resolved, through confrontation of the parties, or it can incur court proceedings. During the construction of Milan's new subway line, Metro Blu, a great deal of effort was devoted to the management of damage complaints, induced mainly during the excavation phases and beyond. Thanks to the effort and commitment of numerous insurance companies, which supported the contractors, damage claims were collected and managed, almost always in conjunction with construction. Some disputes have been settled; others have resulted in court disputes. Although the most frequent claims have been for damage to the existing building (fractures and deformations), some disputes have involved claims for damages in relation to property rights and compensation for property expropriation. The authors expose two cases history of recurring disputes involving the construction of the new subway line, with the aim of reflecting on the patterns of large-scale litigation.

Keywords: Urban excavation, Insurance, Claims, Settlements, Expropriation.

1 TUNNELLING CONSTRUCTION IN URBAN SITE

In the construction of a new metro line, the presence of an urban environment with high population density and high real estate value is an influential factor in the design and management phases of tunnel construction. It becomes an influential factor in the management of disputes (Ratay 2000). Although new technologies, such as the use of Tunnelling Boring Machines (TBMs), make it easier to overcome complex technical issues, such as excavation depth, excavation of complex geotechnical structures, consolidation of inhomogeneous soils, the presence of groundwater, including surface water, and excavation speed while still ensuring a high degree of safety of the work and the operators, it is necessary to take into account the disturbance to the built urban fabric, both in terms of damage to existing buildings and in terms of occupation of the areas required both for site preparation, for temporary periods, and for the installation of artifacts (stations, outfalls and entrances) on a permanent basis (Burland *et al.* 2001).

When the urban site is permanently modified, the change in property values can be a parameter to evaluate the economic effects of a tunnelling infrastructure. The realization of this type of infrastructures, in fact, can have significant impacts on the different components of a

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territory (environmental, social and economic). Among the effects on the territory the change in the value of real estate is one of the most obvious and perceived by residents (Del Pico 2023).

With reference to the new subway in Milan (Italy) the impacts and potential changes induced by the construction of the infrastructure in central and peripheral has been analyzed to evaluate the impacts in damage refund.

2 A NEW SUBWAY LINE IN MILAN

During the construction of the new subway line in Milan (Italy), the authors have been appointed Judge's expert in civil litigation brought by owners variously damaged by the subway construction works. The disputes involved property injuries, either for temporary or permanent occupation of private areas or for damages induced by subsidence during and shortly after the excavation phases. For all disputes, contractors intervened with their own insurance coverage.

In general, about 1,000 claims were counted, of which 50% were resolved by private negotiations and reimbursement of an economic award for damages or for occupation or expropriation, or restoration to damaged structures; the remaining 40% were resolved by out-of-court settlements. About 10 percent were the subject of preventive technical assessment, a form of judicial technical ascertainment conducted on an emergency basis with conciliatory purposes. Few, on the other hand, were disputes for which civil lawsuits were filed.

Milan's new subway line, now nearing completion, M4 or "Blue Line" will connect the city center with the east (Forlanini district and Linate Airport) and the west (Lorenteggio district and San Cristoforo Station), integrating the urban transport network with a new sustainable mobility solution (Fig. 1). The line will have about 15 km of extension, 21 stations and 30 line constructions (constructions not accessible to the public, placed along the line between stations, housing technical rooms, ventilation systems, emergency exits and emergency access for firefighters). A flow of 86 million passengers per year is planned through the use of 47 bi-directional vehicles consisting of four interchanges. Six interchange points with other existing lines are planned. The vehicles run through two single-track 2-track line tunnels: excavation diameter 6.50 m (outer sections) excavation diameter 9.15 m (middle section). A peak hour operating frequency of 90 seconds, a minimum frequency of 75 seconds and a maximum speed of 80 km/h are expected (M4 2023).

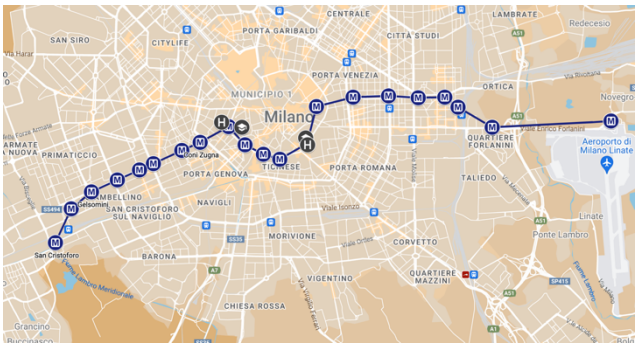

Fig. 1. Metroblu line (M4 2023).

The M4 Line is constructed entirely by "blind hole" underground excavation using TBMs, except for the excavations for the construction of stations and underground utilities, which are "open pit".

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Beginning with the preliminary design, before proceeding with excavations for the construction of a metro, preliminary investigations were carried out to collect data on the nature of the subsoil, the condition of buildings and monuments, and in general on the feasibility of the work, which will then be used to draw up the final design. At this stage, a state witness report was prepared for each building within the subsidence area to describe the state of visible cracking. The expropriation and occupation plan were prepared, too, to notify the owners of the public utility of the construction site for both temporary and permanent occupation.

Once the design was approved and the fencing of the areas housing the construction sites was developed and all preliminary activities were completed, construction of the diaphragms along the perimeter of the stations and line constructions began, and then excavation of the stations began (Fig. 2). TBMs (tunnel boring machines or mechanized moles) excavated the tunnels and covered their walls entirely underground, moving at a depth of around 25-30 meters reducing the risk of the stability of buildings.



Fig. 2. View on March 2022 of a station excavation. Inside this excavation the TBM has been inserted, to dig the tunnelling lines.

2.1 Damage Complaints Induced During the Excavation Phases and Beyond

Despite the high construction density and despite the ageing of buildings in the excavation subsidence belt, especially in the historic city center, no collapse of existing buildings occurred during Metroblu construction.

Almost all of the damage complained of involved minor or negligible crack states, for which the owners requested recognition of all the crack states found.

In these cases, the dispute was easily resolved by comparing the state witness prepared before the excavation works with the current state. In all these cases, the damage was interpreted in the context of a foreseeable risk of minor, repairable damage, for which the authors quantified the costs of remedial work. The insurance companies took note of the proposed quantifications and supported the settlement between the contractors the damaged owners.

2.2 Property Rights and Compensation for Property Expropriation

Once the project was approved, the Municipality of Milan awarded a tender to an association of contractors, to set up a joint venture company to be entrusted with the concession to build and operate the Metroblu Line. The contractor's association formed a company, named M4, together with the municipality, which signed the concession agreement for the construction and operation of the new subway. Among the services covered by the concession is also the management of the expropriation procedures of subjugation and occupation as well as the preparatory activities on the properties affected by the construction of the work, to be carried out on behalf of the granting

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municipality pursuant to a Regional Law, with delegated authority to exercise expropriation powers.

Considering the Italian Law on Expropriation (2015) the M4 Company managed all expropriation procedures, identifying all areas to be expropriated or temporarily occupied, in relation to the approved project. A technical committee was formed to determine the compensation for occupation and expropriation, according to the criteria defined by the law in force in Italy for expropriations. Most of these activities ended with the formalization of occupation or expropriation decrees and the payment of the indemnities calculated by the commission to the owners.

In about 20 percent of cases, appeals aimed at negotiating the indemnities were initiated. Only in a few were the disputes not settled and civil suits had to be brought by resorting to the Court. Generally, civil litigation occurred when the owner demanded not only the statutory indemnity, but also a reduction in the value of the remaining property.

3 DISPUTES FOR PROPERTY EXPROPRIATION

The case of a claim for damages brought by a property, following the construction of an exit staircase from a subway station, within a private parking lot is analyzed.

The expropriation had resulted in a reduction in the surface area of the parking lot, but also a reduction in the brightness and views of the properties on the ground and second floors, following the construction of the exit staircase.

The authors provided a procedure that, on the one hand, quantified the loss of value resulting from the loss of surface area and the reduction in property value factors (loss of brightness or views as a result of the construction of the staircase), but on the other hand, quantified the increase in value acquired by the property as a result of the construction of the subway line. In particular, the analysis of the sector studies showed that the increase induced by the construction of another subway line a few years earlier (Lilac Metro) had ranged from a minimum value in the suburbs of 2.1 percent, with values in the outlying areas ranging from 2.1 percent to 5.3 percent, to maximum values of up to 22 percent, recorded in the downtown districts. In the area under review, moreover, the analysis of actual purchases and sales allowed for a comparison of prices recorded in 2019 and 2021 (before and after the construction of the metro station). This comparison showed a real increase of 2 percent as a result of the completed.

4 DAMAGE IN A MULTI-PROPRIETY STRUCTURE

During the excavation of the tunnels with TBMs, in one building were recorded progressive settlements, which initially reached maximum values of 13 mm, while in the following three months mobilized increasing values up to 30 mm, and then stabilized at maximum values of 35 mm (Fig. 3). Inside the building, crack states had been detected in the same period as the subsidence and in any case different from those already detected in the state witness of the phase prior to the excavations. The owners of the building, believing the analysis proposed by the construction companies to be inadequate, appealed to the court, calling into question all parties involved in the design and execution of the work.

The authors were asked to verify whether the building required safety works. A study was developed to assess the static safety of the structures. The geometry was reconstructed with the help of the original architectural design and targeted on-site surveys. The physical and mechanical properties of the materials were determined with a survey campaign developed with the agreement of all parties.

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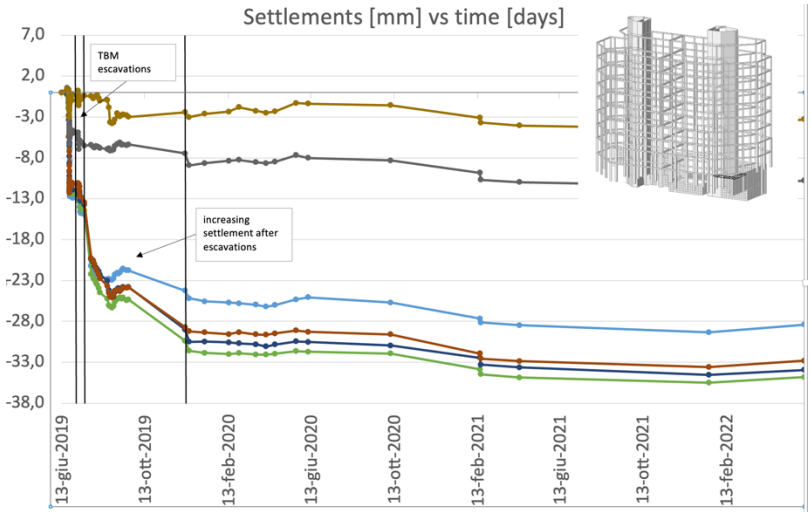

Fig. 3. Building Settlements measured during and after the TBM excavation.

A structure certificate was available for the building, which was built in the 1960s. The structure is in reinforced concrete frames, except for the perimeter walls. The size of pillars is variable in height. The concrete wall thickness is of 20 cm and the slabs are made of concrete of thickness equal to 23+4cm.

The strength values of the materials were obtained from the diagnostic campaign, shared in the investigation phase with the parties (Table 1 and Table 2).

Verifications were conducted with reference to ultimate limit state, considering the actions and combinations provided by the Italian Law on Technical Standard Construction (2018) in force, in the absence of settlements, and verifications applying the detected settlements.

Table 1. Concrete properties.

f_{cm}	23.92MPa
E_c (Young module)	29GPa
ν (Poisson coefficient)	0.20
γ (specific weight)	25kN/m^3

Table 2 – Reinforcement bar steel properties.

f_{ym}	373.0MPa
E_{cm} (Young module)	200GPa
ν (Poisson coefficient)	0.30
γ (density)	78.5kN/m^3

It was verified that the settlements do not result in additional stresses that would affect the static safety of the building. The maximum increase in stresses is recorded at the ground floor piers with an increase in the section utilization rate of 1.2% (Fig. 4).

The analysis was linear static and used constraint schemes consistent with the design practice of the time, which envisaged columns subject to axial action only and beams and floors designed as continuous beams, considering at most a congruence moment at the end, however ignoring the monolithic frame behavior of the structure. This assumption leads, for weakly reinforced

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structures such as the one under consideration, to a scheme that is nonetheless balanced and a consequent verification that is always in favor of safety.

Even if the numerical simulation does not allow the exact stress distribution in the structure to be determined, determined only by a nonlinear analysis, since the safety verifications turned out to be abundantly satisfied, and since there was no damage picture on the structural elements that would suggest situations of incipient crisis, it was considered that carrying out further investigations, with inevitable inconvenience for the tenants and significant costs, and carrying out far more complex numerical analyses, could be avoided.

The analysis made it possible to rule out the need for consolidation work on the structures and to identify both the liability profiles of the parties involved in the dispute and the costs of restoration.

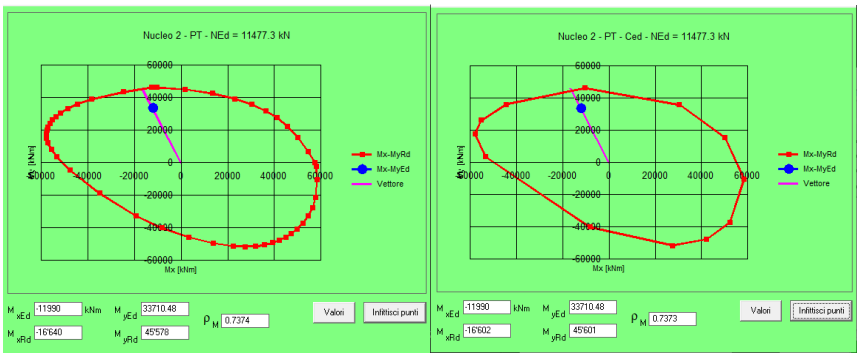

Fig. 4. Eccentrics assail force diagram of the staircase core, on the left before the settlement, on the right after the settlements inducted by the excavation.

5 CONCLUSIONS

The construction of urban infrastructure, such as a subway, inevitably involves interactions with private property and, therefore, disputes. In resource planning, it is necessary to prepare appropriate contracts to ensure adequate insurance coverage. The presence of insurance coverage, together with proper planning of each phase of work preparation and execution, favors the resolution of those inevitable disputes that arose during the construction of a new subway line (whether due to the occupation of private areas or the mobilization of damage states after the excavation phases). In fact, insurance coverage can quickly reimburse claims for damages by a rapid negotiation or alternative dispute resolution criteria. Civil litigation rates remain low, generally when claims for damages are not included in insurance coverage or involve parties other than contractors.

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