PAPER • **OPEN ACCESS**

Building landscape. A new road infrastructure as an occasion for a multidisciplinary approach to a landscape project

To cite this article: Michele Ugolini *et al* 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **960** 032103

IOP Conf. Series: Materials Science and Engineering **960** (2020) 032103 doi:10.1088/1757-899X/960/3/032103

Building landscape. A new road infrastructure as an occasion for a multidisciplinary approach to a landscape project

Michele Ugolini, Stefania Varvaro, Francesca Ripamonti, Caterina Gallizioli

Politecnico di Milano, DAStU - via Edoardo Bonardi, 3, 20133 Milan, Italy

michele.ugolini@polimi.it

Abstract. This work presents an analytical study founded on the assumption that the design of a new infrastructure (not only road-infrastructure) is primarily the transformation of a portion of landscape (natural or anthropic). This endeavor is undertaken with a methodological approach that is able to avoid resulting in a project that is just specialized in one aspect. This goal is reached through the definition of a new road infrastructure, respecting technical and legal requirements, within a residual logic that has to both mitigate the impact on the landscape and the environmental system of which it will be part. The study involves a group of researchers from Politecnico di Milano called to support the different parts of the project of a road infrastructure in the area north of Milano - Como province. Therefore, the project should assume specific and aware intentions aimed at transforming the environment and the landscape itself. The environmental aspects involved are many: ecological (vegetational, forestry, wildlife biodiversity), hydraulic (rainwater, irrigation, surface water and groundwater), agronomic (farm and cultivation system), acoustic and air quality. Many are also the needs of the landscape: conservation and land protection (architectonical and spatial part to enhance, point of view to define), fruition and tourism (paths and rest areas), and an architectural design (contextual section, new assets for greenery). The study represents an opportunity to work in a multidisciplinary context able to involve a contribution of different knowledges, but also to develop a multi-scalar project that deals with a large territory in which the new road is the core, in its specific condition of linear infrastructure, capable of linking far places and of defining margins, materials and rainwater collection system. The dimensions of a road, in the specification of a section able to vary adapting to context - not only according to legal, technical and functional reasons but also guided by visual relations, protection and enhancements triggered by the project - are the most interesting aspects of multi-scalar design. This process resolves itself in an exploratory progression of the territory at many scales. It presumes to consider the road as the possibility of a mutual design process that works on a large and small scale: a sort of elastic line between the roadside and the landscape dimension. “restarting from landscape means overall having the awareness that acting of the territory is like entering in history that others helped build before us” (Pinter 2003). Roads become a readable and indissoluble part of the landscape itself. Mostly vanguard and development promoters, they represent the land palinsesto with which it is possible to interact. The landscape re-writes itself through a net of connections that changes and transforms itself in time. If only some of them could get a chance to be redone through a museum-like logic (for example road Timmelsjoch), the new project has the duty of considering itself as a multidisciplinary experimentation. The challenge of designing this road was to conceive it as a system with the dual complex role that a highly trafficked linear infrastructure has: dividing different parts of the territory and also connecting and integrating the context it crosses

1. Introduction

A road, as has happened to many roads that we call historical, is a fundamental part of the landscape or of what we call context and which is usually interpretable in its stratification of signs over time. Indeed, many times they represent its historical motive for change. If we think on the ancient Roman roads, starting from via Emilia to Salaria, they formed the matrix for the development of the neighboring territories for over two thousand years, although their original forms are no longer recognizable as they are continuously updated over the centuries by the people who they served. No longer recognizable and indistinguishable today from any other driveway, except for some milestone still located on the roadside. The premise for the project consists precisely in the historical reading of the reference context starting from the maps of the Teresian land register (1721) to trace those characteristics of permanence and trace of the territory relevant elements that can become guiding tools in choosing the path for the new road.

2. The reasons for a multidisciplinary approach and the role of the architectural project

Too often a purely functionalist approach has been applied to infrastructures, which is highlighted in an exclusively technical-specialist perspective, as if the only respect for the rules and the necessary correspondence to good technical textbook practices were sufficient to make their works consistently designed with the territory and the environment in which they are inserted. Losing sight that they are an integral part of the context in which they settle, not only from a functional point of view, but also from a landscape and environmental point of view.

"[…] we have frequently happened to deal with various forms of questions that escape any immediate identification of architecture with the solution of the problem, such as landscaping, engineering, specific morphologic value and transformation of great infrastructures, land planning and open spaces. It is an investigation on both the consistency and extension of our discipline's territorial margins, as well as on any possible contribution to its deepening that may proceed from the fact of turning the architectural solution of these very problems into a central question." [1] Gregotti expresses the need to acquire other knowledge that can deepen the project and at the same time put at the service the specificity of the architectural design to qualitatively systematize the multiple aspects that converge in the space construction at the different scales, from the territorial to the scale of the building which is most commonly intended as architecture.

The reasons for proposing an active multidisciplinarity are not just courtly in the cultural debate, which more than ever in the last twenty years, reflects the urgent need to offer effective responses to the insane building policies of the past years, but these reasons also lie in the methodological framework of the presentation of an infrastructure project that urbanistically and administratively requires from the professional. "A plethora of rules presently subjects a project to a preventative verification of environmental impacts and its integration into the landscape context. Notwithstanding a legislative frame work aiming for extensive protection, reality discloses a scenario marred by patent critical aspects and inadequacies when it comes to safeguarding and defending the landscape." [2] The real crux is to define how the project should take care of managing, interrelating and summarizing the contributions of the various disciplines that are rightly called upon to provide opinions and verifications.

"The road today is a crucial *place* for a reflection on the city and on the territory: a fundamentally ambiguous artifact and space, intended at the same time to perform very precise functions, usually interpreted in terms of fluid mechanics, and very vague, […] destined to play clear, in terms of connecting, and not so clear roles, in terms of redistribution of wealth, the road requires a return to overall visions that explore again, crossing numerous layers of reflection, vast territories and long times. […] What dominates the representation is a *banal* hydraulic image, usually used in the two inflections, organic and alluvial, to reduce and enhance the role of the road, reduce it to a single purpose and enhance its importance: it is a matter of channeling flows, disposing of, evacuate, circulate, avoid the formation

of traffic jams, from which (infrastructures) you would like to remove hiding and concealing any fouling, any different purpose, such as stopping, staying, turning back and looking at." [3]

The design of a road needs, Secchi still writes, to again find its "semantic depth", becoming a constitutive and distinctive element of planning a territory. Removing the project from functional specialties and bringing it back to the center of the process with the role of directing and coordinating the necessary disciplinary contributions is a prerequisite so that it can be said that an infrastructure builds a landscape.

3. The road ad a break and as a connecting element

The project of a new linear infrastructure, which is a road with intense traffic, classically operates a break between different parts of the territory: interrupting pre-existing road routes, both vehicular and cycle-pedestrian, rather than agro-farm or paths, many times historic. Organized plots of agricultural fields are often interrupted, the result of centuries of soil organizations by man to make the territory more productive. Ecological continuities are interrupted that connect parts of distant territories, breaking the possibility for many animals to continue moving between different areas, locking them in increasingly narrow enclaves. The natural and artificial water systems are separated, together with precious and valuable landscapes and environments.

On the other hand, a new road infrastructure is also an opportunity to connect places previously not connected to each other or to improve the conditions of connections by making them more appropriate to support today's vehicular traffic by balancing and reducing pollution. The environmental landscape objective, specifically in this case, was to reason the road as the opportunity to reconnect the elements of the landscape and at the same time to conceive it as a positively integral and qualifying part of the landscape itself.

4. The project and the main features of the insertion context of the new infrastructure

The project for the road connecting to the Lomazzo north junction of the A9 motorway represents a variant of the route for the towns of Cadorago and Lomazzo which tries to respond to the traffic and congestion problems of the two towns today particularly affected by the heavy impact of urban crossing, both in terms of pollution, both in terms of noise and danger. Functionally, the goal is to collect the traffic on the road leaving the highway in Lomazzo, together with that one comes from the south along the provincial road n. 30, while further north is to intercept the vehicular traffic exiting at the Fino Mornasco tollbooth which it moves south. In particular, the consolidated urban system of Cadorago is characterized by narrow streets, a continuous road curtain and, in some sections, by the lack of sidewalks. Over the years, the vehicle passage has significantly increased and has created situations of congestion and pollution that are no longer sustainable. The new ring road planned plans an alternative route which considerably simplifies the load of the current Provincial Road 30 in the stretch corresponding to the settlements of Cadorago. This means that the new road would have a positive reflection not only in the immediate surroundings and in relation to the terminal nodes of which it is substantiated, but would also absorb part of the load of a road such as the Statale dei Giovi which represents a strategic territorial connection with the city of Milan, transferring a wide-ranging analytical-contextual dimension into the project.

Determinant in the definition of the project is the presence of the crowded A9 motorway (Milan Como Chiasso) characterized by a high level that detaches it from the altitude of the countryside and which cuts linearly the territory west of Cadorago running in a north south direction. Just as the settlements of Caslino al Piano and Cadorago are decisive, marginalizing the east side of the area where the new road axis must be inserted.

Therefore the main impact in reading the place is given by the highway, both in terms of noise and pollution, both in general visual perception and landscape reading as well as in the separation and division of the territory. Another decisive element for the project is the orographic shape of the soil. It is mostly flat, starting from the south and becomes steep in the northern area in correspondence with the Lura valley, where the river bed is around tens meters down compared to the flat country surface, as well as rotated in the northwest / southeast direction.

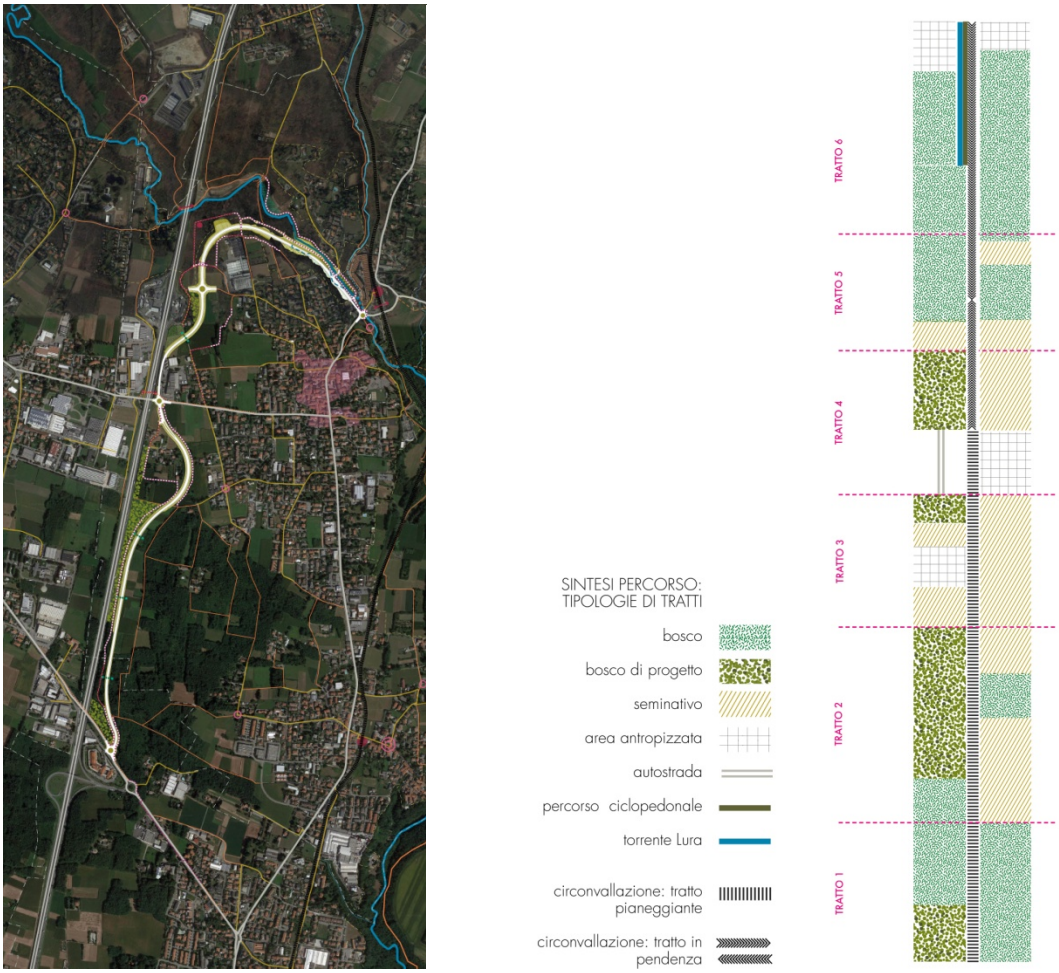

Figure 1. Left: satellite image of the context with the insertion of the new infrastructure [4]. Right: diagram of the infrastructure divided into 6 segments with the element of the context it crosses: existing woods, designed woods, agricultural land, urban area, cycle path, Lura stream, infrastructure (flat stretch), infrastructure (slopping stretch).

5. The track

Inserting a linear infrastructure such as a road in a territory with its own specific environmental and landscape values requires a precise and careful choice of the route. In reality today, in a country such as Italy, so heavily populated, the places where new infrastructures become essential are often the most urbanized and inhabited sites. This always makes their insertion in the territory very difficult, many times forcing their track to convulsive trends to find the minimum space necessary for their passage to avoid inhabited areas, individual buildings, areas of difficult crossing and sometimes areas of particular value or protection. The choice of the route is also an essential element for the inclusion of the infrastructure in the landscape, on the one hand, to minimize its impact, on the other to redesign it. In this case, the route has been set up, in the flat part of the area, as close as possible and parallel to the

highway to reduce the cut made in the area. Instead, wide curves were drawn to avoid the houses of the Fasciano locality and the Lario Est motorway service station and then return to alignment with the motorway axis. A particular element of the track is the interaction with the Lura park and its lowered valley which leads the track to make a great curve towards the east following the course of the river and to descend along the steep side of the valley from the maximum altitude of 330 m to the minimum of 290 m on the sea level. (figure 1)

Another important element, relating to the project positioning of the new road on the right bank of the Lura torrent, is to guarantee in the future the possibility of restoring the confluence of the Livescia torrent into the Lura torrent, which today is still tumbled below the area of courtyard of the former Bombix factory. Different positioning of the road would have blocked this possibility, compromising an important environmental and landscape objective contained in the Territorial Planning map of the municipality of Cadorago. The result is an impact on the Lura stream which requires a movement of the riverbed in the corresponding section while guaranteeing the least qualitative and quantitative alteration of the environment in terms of natural, ecological resources and overall landscape system.

6. Elements of environmental sustainability for landscape enhancement. Multidisciplinary contributions converge in the design of the road layout and its sections

The direct approach to the project of the road infrastructure has manifested itself in a double relationship: through a general reflection that would lead to a rethinking of all the elements that make up a road, and how these elements, in addition to carrying out their main functional purpose, interacted with the surrounding area, eventually becoming tools at the service of the enhancement of the landscape. Therefore, in compliance with current regulations, the usual catalog of components that usually compose a road infrastructure has not been drawn, but alternative forms have been identified to guarantee the necessary protection for vehicles in transit. As regards the impact of the infrastructure in the context, in the face of a constant section-type with regard to its driveway width, it was considered appropriate to structure it in such a way that it was able to accommodate and react to the different configurations of the landscape surrounding and to the suggestions it induces, acquiring elements of definition and security studied ad hoc. The longitudinal development constitutes the main and most evident character of any vehicular infrastructure, an aspect considered essential, from the landscape point of view, in the design of the road. For this reason, in the design approach pursued, specific attention has been paid to all the elements that follow its long unfolding in the territory, first of all, the edges that draw it for kilometers but which are better definable through the control of the cross section of the road itself. It is in this sense that the project is configured as transcalar, due to the constant transition of scale to which it is subjected, which becomes a verification of the need/ability to interpret the long dimension of the landscape and the minute one of man. (figure 2, 3)

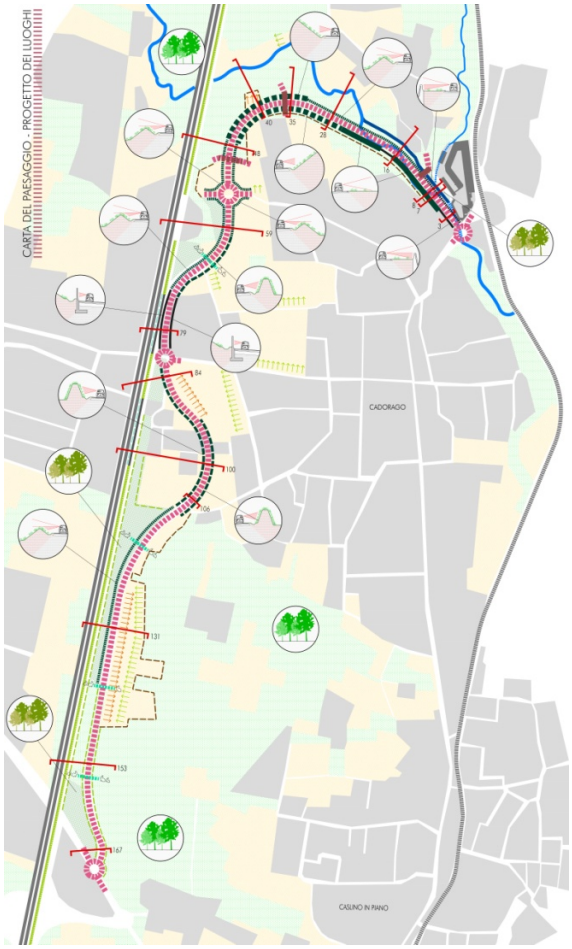

Figure 2. Diagram of the project with a summary of the elements of environmental sustainability for a landscape enhancement

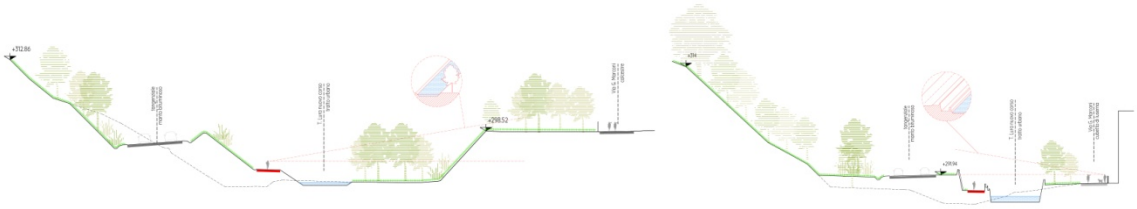

Figure 3. Sections of the road: landscape and the different point of view drawn

6.1 Territory morphology and new soft mobility

An important theme for the project was the reconnection of the existing routes, both in terms of routes serving the farms, to give continuity of access to agricultural land where it was interrupted by the introduction of the road, and to seize the opportunity to connect in a single new continuous system, paths, farm roads and fragments of existing cycle paths., The real goal is to combine soft and sustainable mobility with the entire road section. Through a system vision, a second infrastructure, cycle-pedestrian, a so-called green infrastructure was added to the project for the new driveway. [5]

A light and ecological mobility that compensates for the heavier one by defining a balanced relationship between the two infrastructures. In other words, gentle mobility has been ensured, which although crossing the same stretch of territory as the new road, does not simply become the shadow of

the latter, its weak derivative, physically closely flanked, with the inevitable consequence of having to suffer directly all the negative impact in terms of noise and pollution. The new light infrastructure, in fact, distances itself from the driveway, recovering existing farm roads and creating new cycle-pedestrian sections on its own, acquiring specific functional independence and autonomy of the track, becoming, also and above all, an opportunity to read the landscape, giving the possibility to live directly the open environment in contact with woods, cultivated fields and the course of the Lura torrent. In its enlarged territorial dimension, this route is part of the Eurovelo 5 route, from London to Brindisi, which follows a good part of the ancient Via Francigena. (figure 4)

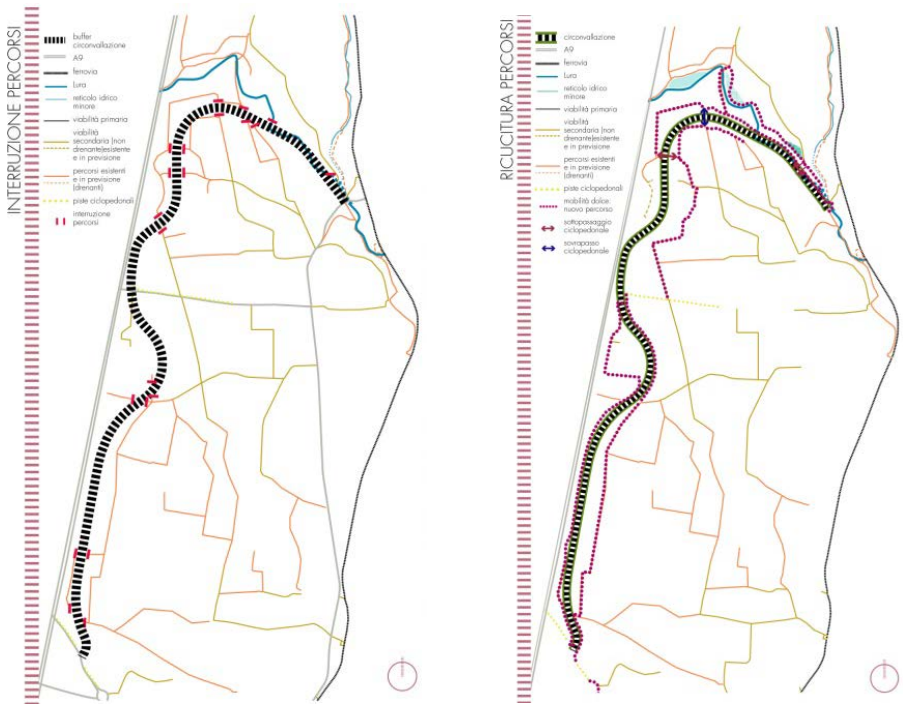

Figure 4. Left: disruptions created by the new infrastructure. Right: re-linking of existing connection through the project.

6.2 Guardrail elimination

The infrastructure has been designed with an active user in mind, who runs it safely without feeling 'bottled' in a sort of open-air tunnel, as are now many roads, completely closed by triple-wave guardrails that enclose them on both sides. Always equal to themselves, such as to become obsessively monotonous with the risk of losing attention to the driver who runs them. On the contrary, by using the soil movements to draw the ground, it was decided not to isolate the driver from the surrounding world: his vision was oriented to keep his perception active, keeping constant attention towards the road ahead. "[…] We can summarize the main objectives of the configuration of the visual experience of the road. The first is to present the observer with a rich and coherent sequential form, a form that has continuity, rhythm and development and a dynamic balance. […] the third objective is to deepen the understanding that the observer has of the environment in which he finds himself " [6]

But the road is also perceived by observers who are outside it, by those who move in the area and who can see it due to orographic conditions. In this sense, most of the new roads today appear as the simple back of a world designed to be enjoyed from within the road. It is often the rear side of the guardrail that is visible linearly, sometimes for kilometers, above the road embankment. Also in this case, through the movement of the ground that structures the road embankment, or in some cases in defining the lowering in the trench, the cumbersome, as well as extremely expensive, presence of the

guardrail has been remedied. In this way it was possible, in many cases, to limit the view of the road from the outside, making an active part of the modeling of the soil and a balanced insertion into the landscape. In some cases, it also allowed hiding the view of the cars that drive it. In this way, the portion of land occupied has allowed us to outline a careful insertion into the landscape and a constantly calibrated and punctual relationship with the territories crossed by the road.

The objective pursued was that of eliminating the guardrail to re-establish, in safety, the link between the road route and the territory crossed. The dimensions (transversal and longitudinal) and the features of the guardrails are an impediment to perceiving the surrounding landscape, just as they represent the most evident element in reading the infrastructure from outside. The need for the guardrail is given by the way in which the roads are created, that is, by the difference in altitude that is established between the road embankment and the surrounding soil. When this difference exceeds one meter in height, it is normally necessary to insert protection and safety elements. Therefore, as far as possible, the project has tried to manage the difference in level between the road surface and the countryside level, keeping it lower than this measure.

The elimination of the guardrail was also pursued by reusing the excavated soil to model the ground in such a way as to structure green side protection barriers that flank the roadway where necessary, accompanying the longitudinal course of the road for kilometers and strongly changing the perception in the view from inside as from outside.

This modeling can perform other and different functions by taking, from time to time, different shapes and sizes: dunes or excavations that connect with the surrounding soil, reinforced ground to manage significant differences in height, noise barriers and, in fact, protection and road safety systems.

6.3 Reusing of agricultural land: excavations and backfill.
Among the design objectives that have been set, particularly important is the reusing of all the material excavated for the construction of the work rather than sending it to the landfill. The landscape implications of these choices are evident. It's cultivated land because the new infrastructure passes completely outside the urbanized area and does not follow existing roads. This choice allows obtaining a multiplicity of advantages: to save the high landfill costs; to cancel the heavy pollution produced by the heavy vehicles necessary to transport the material to distant landfills while avoiding overloading the traffic roads with a consequent increase in road hazard, noise and also the instability of the surface of the roads themselves. Furthermore, this choice allows having available for the realization of the project a considerable quantity of natural material, very precious: the soil. This element is useful for the construction of noise barriers to replace the commonly used impact sound-absorbing panels; useful for the design of road protection and safety systems instead of the very expensive and equally impactful guardrails. Finally, it allows modeling the ground by defining inclined surfaces, height differences, geometric lines that allow an interpretation of the orographic and geometric trend of the surrounding landscape from a design point of view. The soil, such a precious material on which it is possible to plant and which therefore allows enriching the infrastructure of greenery and plant species, in particular shrubs (as well as the lawn), also near the road. In this way, the integration of the infrastructure in the territory becomes environmentally sustainable and it concurs at the beauty of the surrounding landscape. (figure 5)

6.4 Soil movements, noise barriers and green protections
Where the situation required the use of lateral protection elements (due to the difference in height compared to the country level or for a very steep ground), in place of the traditional guardrails, earth protection elements with an asymmetrical triangular section were proposed, with a softer slope of the ground towards the road side and steeper towards the outside. This element is followed, along its entire length on both sides, by a ditch that marks the detachment between the inclined edge and the road and,

on the other side, between the countryside and the protective relief. The barrier, thus designed by modeling the ground, acts as a bank for the roadway exits of vehicles traveling on the road while the ditch collects the wheels of a vehicle containing the thrust towards the outside. In the flat parts, the barrier is positioned only on the external side of the turn. In this way, a visual opening is defined and oriented towards the surrounding landscape on the opposite side from the presence of the barrier. They are protections, but at the same time, they act as elements of margination and perceptual definition. The water drainage ditch detaches the dune from the road and specifies its section.

Noise barriers were designed with the same approach. Normal and impacting barriers made of high metal panels topped with glass with the stylized bird figure have been eliminated (such as those present along the adjacent stretch of the highway near the town of Fasciano). The use of barriers made with the soil recovered from the site excavations was chosen. Similarly, the project proposed in replacement of the guardrails side protection systems made by excavation soil. In this way, in the unfolding of the road, a continuity of architectural and landscape elements that see as the main character the recovered land and its modeling with shrubby plant above.

Armed and green escarpments, thanks to the naturalistic engineering technique, are made: escarpments three, four meters high, depending on the distance from the houses to be acoustically protected, and, steep to contain the size of their occupation of the soil.

Particular attention was paid to the points of passage between the noise barriers and the side protection dunes of the road, working on the design of the connection of the change of height and slope between the two elements: the two elements are both parts of the same modeling of the soil for landscaping purposes. (figure 5)

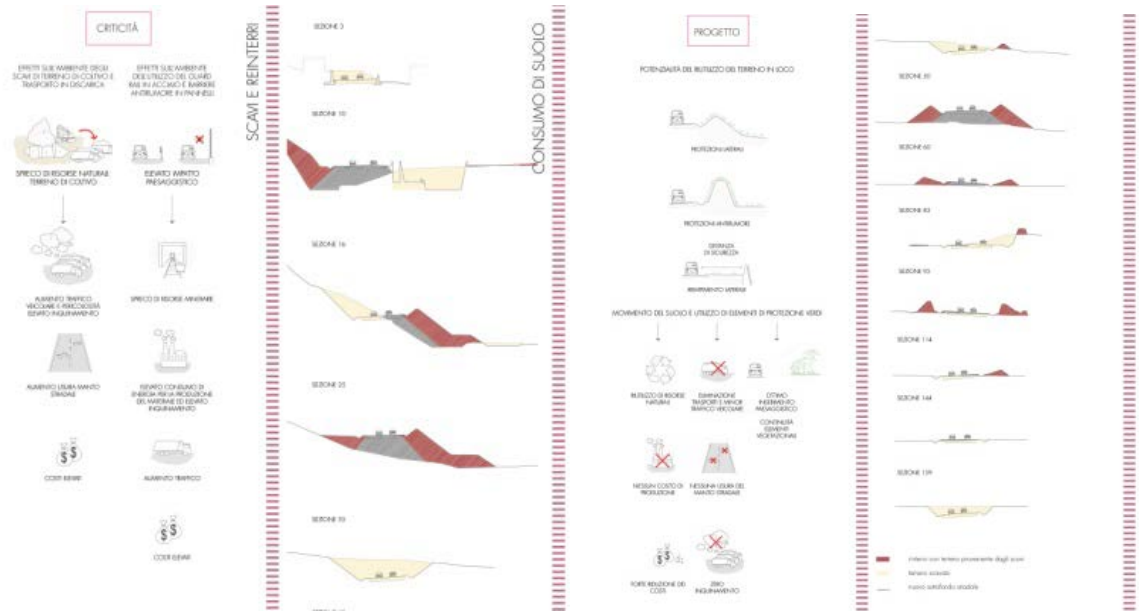

Figure 5. Environmental effects of excavation of cultivated land and landfill transport, environmental effects of the use of the steel guardrail and noise barriers. In dark red color the recycled land for the road design

6.5 Environmental and woods analysis

The issue considered to be a priority for the landscaping of the new road is the increase in forest areas. Environmentally founding the basis of the project, reforestation is expressed in the dual action of

increasing wooded areas and preserving others. The choice of the route of the infrastructure is decisive in this regard.

From a large-scale territorial reading, the presence of the PLIS Lura park of inter-municipal interest but also of other environmental systems to be protected, as well as the Territorial Coordination Plan aligned with the Regional Landscape Plan, identify a series of specificities relating to the ecological network that the project assumes and respects.

6.6 Bridges and underpasses

Within the project, it was necessary to build two different bridges: one for the cars connecting the new road and via Marconi near the Bombix area and another for the pedestrian and for fauna that crosses the road a little further upstream to connect the system of farm tracks that cross the woods in that area. Both bridges have been carefully defined in their horizontal architectural profile and coated in corten. An attempt was made to prevent these works from being treated exclusively as structural works to be prefabricated and laid substantially the same in every and different context. On the contrary, specific orographic and functional conditions have defined the bridge line.

The one for the car needs to cross not only the Lura torrent but also the new cycle and pedestrian path which flanks the torrent on the right bank side in that stretch. An asymmetry condition is defined where a support (shoulder) descends inclined up to the altitude of the water with which it comes into direct contact while the other support stops at the altitude of the cycle-pedestrian path away from the water. This asymmetric condition becomes a design element making itself explicit in the "L-shaped" figure of the bridge which highlights one shoulder in particular while the other is visually hidden by inserting it into the embankment.

The other bridge, a pedestrian and fauna walkway, is always defined by an asymmetrical figure since the ground has a different configuration on both sides, due to its strong transversal slope with respect to the longitudinal axis of the road. This design is made explicit by the dark colored painted reinforced concrete support pillar and made more evident by the rectangular section with short sides connected in a semicircle and by the highlighting of the support point of the bridge horizontal profile with respect to the pillar itself.

The underpass to the new road, necessary to give continuity to a farm track, is made with a reinforced concrete box which, however, externally presents a more inviting profile that could be defined with open wings. Even vertically, the entrance profile opens by climbing diagonally to make the access wider and it should be noted as it is coated in corten.

6.7 Roundabouts

There are two roundabouts intermediate the new road. The roundabouts normally have, with some exceptions, a design strongly characterized by their circular shape and by the strict rules of the highway code to which they are subjected. The result is that they are all substantially the same and anonymous. This produces an alienating and lost orientation effect by those who travel by car and the road, in this way, also loses its own recognition within the territory. On the contrary, some are often too characterized, not so much in their design, as in the treatment of the central part which becomes the stage for exhibitions, sometimes even bizarre.

In the project, on the contrary, we worked not so much centrally, as on the external contour, with tree-like elements that surround them and give an upward momentum to their circular planimetric shape, and with movements of the soil, which reflect those used as lateral protection of the road, giving a character of greater concentration and interiority to the space of the roundabout.

7. Conclusion

The interest of this proposal lies in representing a typical situation in which many can exist in an anthropized territory, such as the Italian one and more generally in Europe. Put aside for a moment the generic truth belonging to the project that correctly tends to take on each context in its specificity, we can, however, affirm that precisely because we are not in the presence of exceptional contextual data, we can consider this case as an example of a possible multidisciplinary replicable methodology coordination. Flanking the development of the project with university research brings in-depth resources into the constant passage of scale from the territory to the detail that represents the critical filter to build landscape in the final design of the road.

References

[1] V. Gregotti, “La strada: tracciato e manufatto”, in Casabella n.553-54, Electa, Milano 1989 (in Italian).
[2] F. Schiaffonati, Il territorio delle infrastrutture, in Techne Journal of Technolgy for Architecture and Enviroment, n.11 Firenze University Press, 2016 (in Italian).
[3] B. Secchi, “Lo spessore della strada”, in Casabella n. 553-54, Electa, Milano 1989 (in Italian).
[4] Google map, Satellite image - Cadorago-Caslino al Piano, Lombardy, Italy. Großräschen, Germany. DigitalGlobe. [Online] 2020 [Accessed 22. 03. 2020] Available at: < https://www.google.com/maps>.
[5] M. Rigillo “Green Infrastructures and Ecosystem Services in urban areas: research perspectives in environmental design” in Techne Journal of Technolgy for Architecture and Enviroment, n. 11 Firenze University Press, 2016.
[6] D. Appleyard, K. Lynch, and J. R. Myer, “The View From the Road”, Mit Press Cambridge, 1964.