"THE BUILDING OF NEW BRIDGES AND THE REBUILDING OF OLD BRIDGES DURING THE LAST TEN YEARS IN THE PROVINCE OF ALESSANDRIA"- ITALY -

Dott.Ing. Piergiuseppe A. Dezza
Chief Engineer Technical Office/Roads Direction System Provincia di Alessandria - Via Porta, 9 - 15100 Alessandria (I)

Dott. Ing. Felice Lo Destro
Manager Engineer Technical Office/Public Works-Road 1 Sector System Provincia di Alessandria - Via Porta, 9 - 15100 Alessandria (I)

Dott. Arch. Roberta Bocchino
Manager Engineer Technical Office / Public Works-Road 2 Sector System Provincia di Alessandria - Via Porta, 9 - 15100 Alessandria (I)

Dott. Ing. Massimo Robiola
major Engineer Techinical Office/Public Works Design Unit Provincia di Alessandria - Via Porta, 9 - 15100 Alessandria (I)

ABSTRACT

The Province of Alessandria is located in Piedmont Region, North-Western Italy, where the 20th Winter Olympic Games took place in February 2006.
Since October 2001, when competences on former National road network (thitherto managed by A.N.A.S. – Azienda Nazionale Autonoma Strade - National Agency for Road Management) were transferred under the legislation of Italian Provinces, the Province of Alessandria, third province of Piedmont by territorial extension, manages 2,150 Km. of extra-urban roads, composed by 1,765 km. of "historical" province roads and 380 km. of former national roads.
Several bridges are located on this extra-urban road network. 138 constructions are disseminated along the "historical" province roads, and other 225 are situated on former national roads, which makes a total of 363 constructions that the Road System Department of the Province of Alessandria must keep in efficient working conditions.

Over the last ten years the Province of Alessandria has experienced a few impressive natural disasters such as the flood of river Tanaro in 1994, the flood of river Po in 2000, the one of torrent Scrivia in 2002, as well as the earthquakes of 2000 and 2003 and quite a lot of hydrogeological unbalances.

As a consequence of those extraordinary cataclysms, new works were started along the flows of Tanaro and Scrivia, aimed at the realization of reinforced-concrete or pre-stressed reinforced concrete bridges, with span length over 100 m. and development over 500 m. In addition to it, pre-existing ancient bridges were reconstructed along river Bormida and torrent Scrivia, using innovative environmental-friendly building techniques, and preserving the aesthetical features of "historical" buildings.
A lot of brickwork arch bridges built in the first years of the 20th century need road widening today in order to fit to the new geometries of commercial traffic flow, as well as footways to provide pedestrian safety.

1. INTRODUCTION

The Province of Alessandria is a part of the Piedmont Region: it is situated in the North-Western part of Italy, in the area where the Winter Olympic Games took part in February 2006.
In the heart of the Province is located Marengo, the famous site where on June 14th 1800 Napoleone Bonaparte led one of his most important battles and sensationally won it thanks to light infantry of General Desaix.
During the Battle of Marengo Desaix, who had just joined Napoleon during the battle of Marengo, in the moment when all seemed lost, before they managed to overthrow the front line, it is said that Desaix pronounced the following sentence: “This battle is lost, but it is two o’clock and there is still time to win another one”.
Nowadays, the Province of Alessandria, as all the other Provinces of Piedmont and of many Regions in Italy, since October 2001 has been interested in the transfer of comnpetences of the ex-state road system so that, since that time onwards, the Company management responsibility extends on about 2.150 km of extraurban road, among which 1.765 Km are “historical” Provincial Roads and 380 Km are ex-State Roads. [1] (Picture n° 1)

This heritage is extremely variegated, with a a medium length of 7+128 km as regards the 248 “historical” roads and 27+150 km, so almost four times as much, as regards the 14 “transferred” roads. t
Along the extra-urban road system of the Province of Alessandria there are a lot of bridges: the managed manufactured goods are 138 along the “historical” Provincial Roads and 225 along the transferred ex- state roads, for a total of 363 structures which must be kept efficient by the Technical Office/ Roads Direction System.[2]

During the last ten years, the territory of the Province of Alessandria has been affected by some extraordinary calamitous phenomena, such as the floods of the river Tanaro and Bormida in 1994, of the river Po in 2000, of the torrent Scrivia in 2002, the seismic events in 2000 and in 2003, as well as several hydro-geological difficulties. (Photo n° 1)

As a consequence of such extraordinary natural effects, new bridges in C.A. – reinforced concrete - and C.A.P. – prestressed reinforced concrete - on the rivers Tanaro and Scrivia have been built, with lights of more than 100 metres of length and a total development superior to 500 metres.(Photo n° 2)

Moreover, old arc bridges on the river Bormida and on the torrent Scrivia have been reconstructed, taking innovative metodologies, which are nevertheless completely respective of the esthetic aspect of the “historical” manufactured goods, as well as of the surrounding environment. (Photo n° 3)

A lot of masonry arc bridges, which have been built during the first years of the twentieth century need nowadays an extension of the road plan, in order to be suitable to the new geometries of the commercial traffic, as well as the adoption of pedestrian footbridges to guarantee a safe way of people. (Photo n° 4)

Other bridges of reinforced concrete, built in the fifties, need urgent interventions of extraordinary maintenance of the scaffolding concrete and steel, which have been intensely damaged by carbonation phenomena, and degraded by the solicitation of heavy vehicles. (Photo n° 5)

A precise and up-to-date listing of bridges and viaducts, carried out by the technicians on the territory and registered by a special software by the Road Land Register, which was established in 2002 within the framework of the Road System Office of the Province of Alessandria, is granting a wide knowledge of the structural heritage on the Company and is contributing to the planning of manufactured goods maintenance in order to assure, as far as possibile, a safe way of vehicles along the managed extra-urban road system.

Picture n° 1 - The extraurban road system of the Province of Alessandria


LA STAMPA

ALESSANDRIA

E PROVINCIA

Strade e ponti, più danni che nel 2000

Dalla Provincia primo bilancio: almeno 7,5 milioni di euro

Camion bloccati

Il viadotto è caduto e si rischiano multe

Photo n° 1 – The page of the daily paper “La Stampa” of 28/11/2002 – Section of Alessandria and Province

Photo n° 2 – The new viaduct of the main road 78 “Valenza – Rivellino”

Photo n° 3 – The rebuilding of the pier of the collapsed bridge along the main road 140 “of Borbera Valley” at Arquata Scrivia

Photo n° 4 – The bridge along the main road 143 “Serravalle – Vignole”, when the works were finished

Photo n° 5 – The collapse of the edge beam girder of the bridge along the ex- state road 30 “of Bormida Valley” at Terzo d’Acqui

2. FROM NATURAL DISASTERS: THE BUILDING OF NEW BRIDGES AND THE EXTRAORDINARY RECONSTRUCTION OF OTHER WORKS OF ART – HISTORY AND INNOVATION

*2.1 *The event*

During the first decade of Novembre 1994, in particular on 4-6 November, an extraordinary meteorological phenomenon, in the form of very intense precipitation, has affected the Province of Alessandria as well as a part of Liguria and vast areas of Piedmont: between 4and 5 November 1994, there was a medium registration of falls between 180 and 220 millimetres, with peaks of 55 millimetres towards midnight at Cairo Montenotte (SV) and at Acqui Terme (AL) [3].

The diffusion of precipitations, their great amount and duration which progressively extendedto the zones of Asti and Cuneo, have determined very high coefficients of flood on 6 November 1994, as a consequence of the grave crisis of the whole hydrogeographic system of Piedmont.

Having studied the "isoiete" of the areas affected by the damaging event, when compared with the historical series of classified data, the Autorità di Bacino of the river Po has predicted for the river Tanaro, in the Province of Alessandria, a flood withdrawal time of about 200 years.

In particular, the road system of the Province of Alessandria resulted compromised as regarded 90 of the 248 roads of the public property of the time, revealing in this way its inadequacy and the antiquity of some fundamental structures.

On that subject the Administration, with the help of the State and consequently of the Piedmont Region passed an ambitious but fundamental programme of realization of three new bridges-viaducts, among which two are on the river Tanaro and have a length of 900 metres and 200 metres, respectively along the main road 78 "Valenza – Rivellino" and the main road 77 "of Felizzano"; one is on the torrent Scrivia, with a length of 560 metres, near the main road 87 "Molino de' Torti – Isola S. Antonio", as well as the extraordinary general maintenance made on the bridge of Castelnuovo Scrivia, for the main road 85 " Castelnuovo Scrivia – Alluvioni Cambiò". (Photo n° 6/7)

*2.2 * The new viaduct "Rivellino"*

The new viaduct on the Tanaro along the main road 78, which is situated on the connection axis between the city of Valenza, "the city of gold" and the toll-gates on the A7 motorway "Milan – Genoa", is used by more than 7.000 vehicles every day; the aim of its realization was to eliminate the original ground relief which constituted the road body for a length of 900 metres, as a prosecution of a bridge built in the fifties.[4]

The structure was built in C.A. e C.A.P. since March 1997 till September 1998, on light spans of 30 metres, with a current width of 9,00 metres, among which 7,00 metres are of the finished road surface and of 2 side pavements, as well as of 2 intermediate lay-by for the emergency halt of the vehicles. (Photo n° 8) (Picture n° 2)

The scaffolding, supported by circular piers of ϕ 2,50 metres which rest on piles of a large diameter ϕ 1200 millimetres with a maximum length of 28 metres is composed by girders with an "upside-down" pi greco in C.A.P., with a length of 29,80 metres, upon which there is a reinforced concrete ceiling with a thickness of 30 centimetres; the static scheme was planned with two kinetic chains of eight beams and two chains of seven beams, in order to limit the number of joints and so the maintenance interventions during the existence of the work of art.

*2.3 *The new viaduct named "Isola S.Antonio"*

Another considerable manufactured article is the jumping of the torrent , built along the main road 87, on the East-West axis between the toll-gate of Casei Gerola along the A7 in the Province of Pavia and the agricultural centre of Sale along the ex-state road 211 "Lomellina" with a length of 560 metres, as well as the access flight sto the existent road system, for a total development of 1250 metres of modern road line. [5]

The new work, opened to the vehicle traffic in October 1999 is constituted by a scaffolding in prestressed concrete with a scheme of continuous beam of fifteen spans, with a minimum light of 32,15 metres and a maximum one of 40 metres; the total width is of 9,20 metres, the road of 8 metres, the external curbs of 60 centimetres. (Photo n° 9)

More precisely, the scaffolding bridge in CAP is constituted by a series of pairs of precasted beams packaged in yard and with longitudinal and oblique joints; on the piers axes there have been placet pairs of beams of variable height from 125 to 185 centimetres, with a cantilever function, 15,70 metres long, joined to each other and with beams of a constant height 125 centimetres and of varying length. (Photo n° 10)

The foundations of each plinth have been realized with a perimetral corona of jet grounding piles ϕ > 80 centimetres and with a depth of 15 metres, as well as a bottomplug built with the same technique, in order to allow the digging of a well till about 8 metres under the country surface; this is estimated necessary to avoid foundations undermining under the ruinous and frequent shove of the torrent rising from the Ligurian Apennines.

*2.4 *The restoration of the "Castelnuovo Scrivia" bridge*

A very significant building experience, even if it was "a complete ristrutturazione of a historical and artistic nwork of art", were the works of restoration, adjustment and extraordinary maintenance of the bridge on the torrent Scrivia, in the city of Castelnuovo Scrivia, along the main road 85 "Castelnuovo Scrivia – Alluvioni Cambiò", not far from the toll-gate of the homonymous locality along the A7 motorway; because of its natural placing, this manufactured article was intensely affected by the heavy traffic.

The 13 spans bridge, supported by masonry piers and with a total length of 240 metres dates back to the XIX century, as the building was completed in 1867; the lowered arch spans are built with masonry bricks and the soaring road surface is protected by a cast iron railing, which is interrupted by semicircular parapets near the piers. [6]

The Province of Alessandria has undertaken the restructuring of the bridge involving:

* the reinforcement of the foundation ground through the building of two lines of jet grounding columns raising from the road; (Photo n° 11)

* the reinforcement of the piers, above all in the more degraded northern façade, thanks to the complete demolition of the load-bearing masonries as far as the depth of the foundations, and their following rebuilding with obstruction back with concrete.

The structural restauration was limited to the side fascia by connecting the two parts with soaring reinforced concrete ceiling in C.A., (Picture n° 3) in such a way that the transversal section is seen a san upside-down "U".

The new reinforced concrete slab therefore does not have a gap as it is limited to the original width of the bridge: for evident safety measures with regard to the use of the bridge by pedestrians and cyclists , a path has been built to the width of 1 metre on the valley side of the bridge, in a steel structure attached to the reinforced concrete ceiling by draw piecesa laid down at 2,40 metres one by one, protected by a metallic railing based on the design of the original bridge. (Photo n° 12)

The "Castelnuovo Scrivia" bridge was also the first work to be opened to the traffic after the flood, on 19.03.1998.

*2.5 * The new "Felizzano" bridge*

The forth bridge, and probably the most significant work among those carried out in order to restore the damages caused by the flood in 1994, is that on the river Tanaro, along the main road 77 near Felizzano, and so near the homonymous toll-gate on the A21 "Torino – Piacenza" motorway.

The planning, approving and financial procedure has been very difficult, as this bridge had to replace a historical manufactured article, (Photo n° 13) with a metallic caisson, built between 1883 and 1885, with five spans, a total length of 165,19 metres, with a load-bearing structure consisting of two main side girders of symmetrical double T; (Photo n° 14) these also acted as barrier and parapet and they were made of nailed joints, with a height of 2,80 metres and a wheelbase arrangement of 6,50 metres.

The "Soprintendenza delle Belle Arti" of Piedmont demanded the maintenance of the first span as a "historical memory" on Felizzano sideand the first pier in the river-bed! [7] (Picture n° 4)

The new bridge, (Photo n° 15) completely built with reinforced concrete pumped in yard, joins the banks of the Tanaro; it is supported by two piers and it opposes the old structure because of its transparence and lightness, while the old one was lower and with lots of props in the river.

In the new structure, whose works began in November 1998 and which were opened to traffic on 03.02.2001 the combination of the improvement the materials - from bricks and iron to C.A. and C.A.P.- and the refinement of building techniques is visibile in the slimming of the leaned girder, in the reduction of the prop number and dimensions, as well as in the structure purity and essentiality.

The bridge of Felizzano runs for a total length of 202 metres over three spans, among which the central one is of 100 metres and the two sides ones of 51 metres; it is constituted by a central road of 8,00 metres, by two side pavements of 1,10 metres each, for a total framework width of 10,20 metres. (Picture n° 5)

The piers are manifactured by plinths "at well" over foundation, realized by a palisade constituted by an external ring of 29 piers ϕ 100 centimetres, (Photo n° 16) with a length of 25 metres and by a central palisade constituted by 62 micropiers with a length of 10 metres; as the impost surface of the foundations is situated at 8 metres under the surface of the water, the piers of great diametre have been placed side by side to a 29 jet grounding corona with a length of 11 metres, in order to avoid infiltration phenomena.

The building of the new manufactured article was realized in embassed work from the piers, according to the "Dywidag" system, with concaves of 5 metres of development each: In this way two jumps have been carried out for a total length of 98,00 metres, among which 49,00 metres are on the abutment side and another 49,00 metres are on the central pier side, by working at couple from the pier axis.

*2.6 * The rebuilding of the bridge along Historical Road "Arquata – Vignole"*

After the flood in November 1994 and the disastrous one of the river Po in October 2000 affected the city of Casale Monferrato and the whole vast surrounding area, the memory of the last fifteen days of November 2002 is still living. Between 22 and 26, near Arquata Scrivia and close behind the A7 motorway, 261 millimetres of rain have been recorded, with a peak of 84 millimetres on 25.11.2202. [8]

The extraordinary flood of the torrent Scrivia caused, at about 11,30 a.m. of 26.11.2002, the collapse of two spans of the bridge situated along the main road 140 "of Borbera Valley", between Arquata Scrivia and Vignole Borbera. °(Photo n° 17)

In less than twenty hours in that geographic area the river registered a height of 3,50 metres at the height of the flood; this hydraulic shock caused a vertical collapse of about 1,60

metres, accompanied by a forward and lateral rotation of 3° 49' from the second pier of the manufactured article, with the consequent fracture of the foundationand collapse of the two spans which pressed on the same pier, because of a very violent phenomenon of foundation undermining at the base. (Photo n° 18)
The masonry bridge on the Scrivia, with five spans of 22,50 metres each and a total length of 142,50 metres dates back to the second decade 1900.
Anyway, the collapsed bridge showed an evident risk of global collapse, not only as regarded the two central spans, which were already irreparably compromised, but also as regarded the whole structure, because of the lack of equilibrium of the horizontal thrusts against the pier head, as the support of the "plunged" one failed: the collapse would have caused an irretrievable damage! For this reason, in July 2003 the Province of Alessandria took care of I° phase putting on safety of the structure. (Photo n° 19)
By a system of "drawing-tying up" of the pier-abutment block, using 6 smooth Dywidag bars with a diameter of 40 mm, a length of 51,60 metres and pulled in a sequence of 16 phases till to strength of 420 KN/each; in this way they isolated the central spans from the remaining ones, allowing the central spans to collapse without interfere with the other structural parts.[9]
Before the demolition of the archs, the existing abutments and piers have been reinforced by micropiers ϕ 240 millimetres which were carried out from the extrados of the reinforced concrete ceiling for a lenght of 24 metresand run through the whole thickness of the structure, as well as the building of a corona of 51 jet grouting ϕ 800 mm, pervading from the extrados of the plinths and with a lenght of 8 metres each.
The "new" pier was built in reinforced concrete and it was laid into prefabricated walls, which were already coverei in full bricks, in order to guarantee the same geometry and the same aspect of pre-existing piers; the new archs of the two rebuilt spans- realized vafter the controlled demolition of the deformed ones- were made in reinforced concrete precasted thanks to elements, which are six for every span, also used as bridge deck for upper concrete. (Photo n° 20)
The final reinforced concrete slab was built by reinforced concrete on "predalles a perdere", after removing the first phase security chains and fixing thouse decks to the bottom crubs by steel pegs plunged of 50 centimetres, in order to guarantee the resilience to the restraining effects of moving vehicles.
The new oblique section of the road system has nowadays a total width 10,30 metres along the whole structure. (Photo n° 21)
The works, begun in January 2004, were finished in July 2005: during the restoration period, the pier position and dimensions were not modified, as well as the interference of the manufactured article with the torrent below.
To conclude the "alluvional" phase, it is interesting to compare the expenses of the new structures realization as well as of the historical manufactured goods rebuilding, by analyzing the following table:

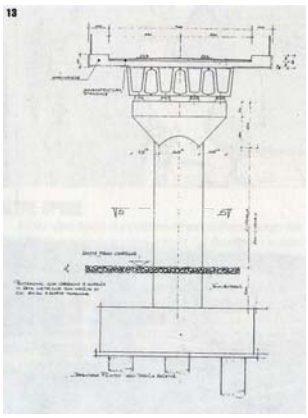
WORK	TYPOLOGY	SURFACE (mq)	EXPENSE (€) (*)	UNITARY EXPENSE (€/mq)
Viaduct “Rivellino” Historical Province road n° 78 New work	Structure in Reinforced Concrete (R.C.)- Girders in Prestressed Concrete (P.C.). a π rov 9,00	8.100	8.958.460,00	1.110,00
Viaduct “Isola S.Antonio” Historical Province road n° 87 New work	Structure in R.C. – Girders pairs in P.C. joined in yard	5.152	6.579.700,00	1.280,00
“Felizzano”Bridge Historical Province road n° 77 New work	Structure in R.C. – Caissons in P.C. carried out through embossed work from the piers	1.959,40	3.454.130,00	1.765,00
“Castelnuovo Scrivia” Bridge Historical Province road n° 85	Reinforcement 6 masonry piers and their foundations – Rebuilding of reinforced concrete ceiling in R.C. and of the section below –	1.344,00	1.867.635,00	1.390,00
“Arquata – Vignole” Bridge Rebuilding 5 spans	Reinforcement masonry piers- Demolition 1 pier and two masonry archs - Total rebuilding 1 pier and two archs in R.C. covered by bricks-	1.493,50	5.013.750,00	3.355,00

Table n° 1– The bridges of the floods 1994 - 2002
(*) The expenses of Public Works are up-to-date to 2006

Photo n° 6 – The bridge along the main road 85 “Castelnuovo Scrivia – Alluvioni Cambiò” at Castelnuovo Scrivia, damaged by the torrent Scrivia flows.

Photo n° 7 – The bridge along the main road 85 “Castelnuovo Scrivia – Alluvioni Cambiò” at Castelnuovo Scrivia – The restoration works of the road system.

Photo n° 8 – The finished Viaduct “Rivellino”

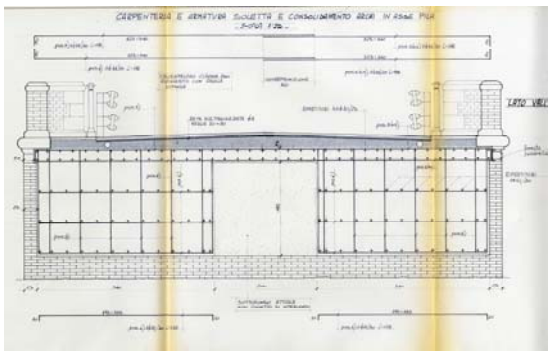


Picture n° 2 – Type section and details of the new Viaduct on the river Tanaro of the main road 78

Photo n° 9 – The new bridge along the main road 87 – Static test made on 23/10/1999, in concomitance with the flood of the torrent Scrivia

Photo n° 10 – The new viaduct along the main road 87 – Launching of the viaduct last span

Photo n° 11 – Plinths and piers reinforcement of the bridge along the main road 85 “Castelnuovo Scrivia – Alluvioni Cambiò”

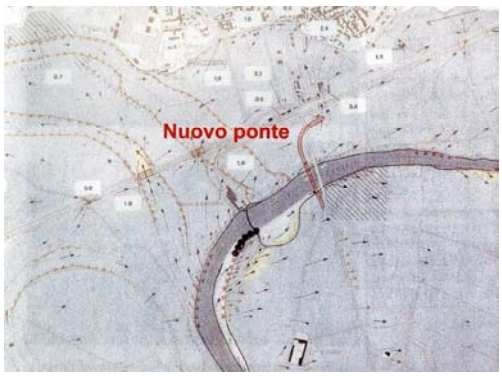


Picture n° 3 – The new road section - carpentry and scaffolding of the bridge along the main road 85 “Castelnuovo Scrivia – Alluvioni Cambiò”

Photo n° 12 – The restored bridge, with its footbridge, in Castelnuovo Scrivia.

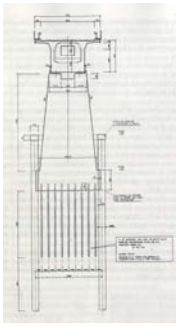
Photo n° 13 – Beam concave of the new bridge on the Tanaro along the main road 77

Photo n° 14 – Sight of the original bridge of Felizzano.



Picture n° 4 – Plan of the area of Felizzano, with the flood surface reached by the Tanaro and the placing of the new bridge on the main road 77.

Photo n° 15 – The new bridge of Felizzano, with a view of the old structure in the background



Picture n° 5 – Type section of the new bridge “Felizzano”

Photo n° 16 – Foundations “at well” of the piers of the new bridge along the main road 77

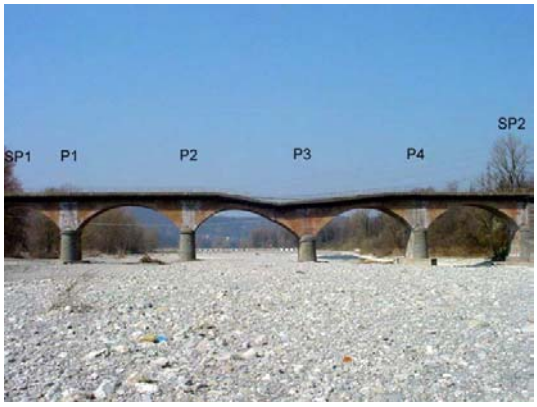


Photo n° 17 – Longitudinal sight of the collapsed bridge

Photo n° 28 – Particolar plastic hinge upon an arch

Photo n° 19 – Sight of the chains for I° phase putting on safety.

Photo n° 20 – Precasted semi-archs placed in yard.

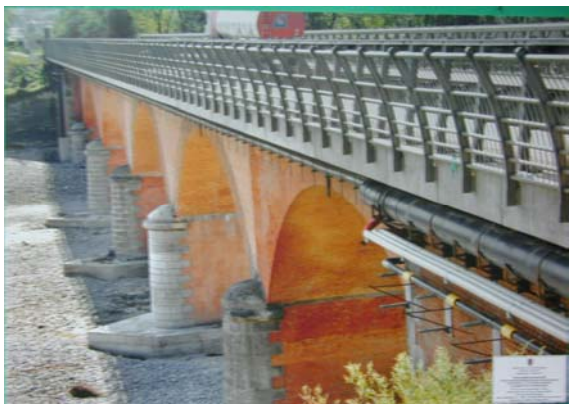


Photo n° 21 – The finished work on the torrent Scrivia between Arquata Scrivia and Vignole Borbera

3. THE HEAVY ROAD TRAFFIC AND THE EXISTENT HERITAGE: OBLIGED RESTORATION AND NECESSARY MODERNIZATION OF THE "HISTORICAL" MANUFACTURED GOODS

*3.1 * The extraordinary maintenance*

The veihicular traffic, is constanty incredsing, this falt is registered by the Province of Alessandria's "Road Lan Register Office" on a sample of 13 roads of the extra-urban road system. In particular from the ending of 2003, the "Road Lan Register Office" installed fixed traffic positions under the road's paving with a periodic dowlnload of the data by a dedicated software.

Besides the heavy vehicles, very often moving at great speed along roads and manufactured goods that are not geometrically and structurally adequate, together with the corrosive effect of the water coming from the road, which is full of aggressive matters – as the defrosting salts used during the winter- contribute to damage the condition of the manufactured goods reinforced concrete ceiling, generally built in C.A., as well as the piers, making the restauration interventions more urgent.

Unfortunately, it is frequent to observe the critical situation of nthe road system bridge widening, which was realized during the seventies, above all on the pre-existent masonry manufactured goods. On this subject, for example, the Province of Alessandria has recently carried out a considerable intervention of extraordinary maintenance of a structure along the ex-state road 30 "of Bormida Valley" near Acqui Terme. (Photo n° 22)

The bridge was carefully examined in October 2002, thus revealing the general degradation of beams, pavements, girder prop-piers; the foundation level of the bridge, tasted also in 2005 with drillings from the head-piers, has not been, yet it'snt, a problem. (Photo n° 23)

The damaged section of the manufactured artiche, that is the first span on the mountain side which was constantly monitored, was closet top the vehicular and pedestrian traffic from November 2002 to 10.04.2005; on that day, without any premonitory omen and probably because of the sudden changes of winter, which certainly increased the difficult evolution, as well as the sudden thermal rise and fall of the period, the weak ties between that section and the adjacent structures failed and the girders collapsed into the river below. (Photo n° 24)

After considering the existence of various damages- among which a longitudinal one running through all the spans- between the pre-existent arch structure and the beams in R.C., and the oblique ones on the piers axes, as well as after explorative researches in situ, the absence of an adequate oblique link between the original manufactured article and the beams put later on appeared evident. So, after considering the probable instability of the beams of all the spans, it appeared necessary to avoid, during the restauration planning phase[10], the interventions which affected the embossed structure and to carry out, when the bridge is closed to traffic, the solution of a “chain” transversal connection of the laid down beams following the tipologhical model shown below: (Picture n° 6)
Later, a new prestressed concrete beam, with a form similar to those already existing in situ, and later precasted slabs and iron bars were put down for the final pumping of the concrete of th first span, already stregthened. (Photo n° 25)
At the end, the maintenance of the existent and damaged beams was carried out according to the following executive plan. (Picture n° 7) (Photo n° 26)

The intervention expense was of € 370.000,00, the works have been carried out from May 2006 to the end of July 2006, with an unitary incidence of €/mq. 245,00- value up-to-date to 2006.

*3.2 * The functional adaptation*
Another executive plan, which is more and more important for the Public Administration is the functional adaptation of the existent bridges band viaducts, in order to develop their availability as regards the safety of the vehicular and pedestrian movement.
This is the case of the bridge of Serravalle Scrivia, along the Historical Road n° 143 “Serravalle – Vignole” (Photo n° 27) where, between March 2002 and November 2002, and so just before the disastrous event happened on the other manufactured article few kilometres above, the Province of Alessandria carried out a footbridge as well as other interventions for the structure modernization.[11]

The bridge located at Serravalle Scrivia, with its present-day four masonry archs on the torrent Scrivia and some little archs at the entrance of the city dates back to 1834. In that year, after an extraordinary flood of the river, the last archs were raised for a total length of 150 metres.
After considering the road medium length of 5,26 metres- which is hardly sufficient to allow the contemporaneous way of two vehicles- the infrastructure flow limit of 10 ton, the presence of two pavementswith a width of 65 centimetres which are protected, as the road, by metallic railings only, in 2001 the building of a footbridge in C.A. on the embossed valley of the bridge appeared absolutely necessary. The aim was to allow a safe connection of the inhabitants of Lastrico Hamlet to the centre of the town, by widening the rolling surface of the cehicles and marking it through metallic guardrails- which are realized in conformità with the new technical regulations and hidden on the outside under polished paltes and a copper dripstone. (Picture n° 8)

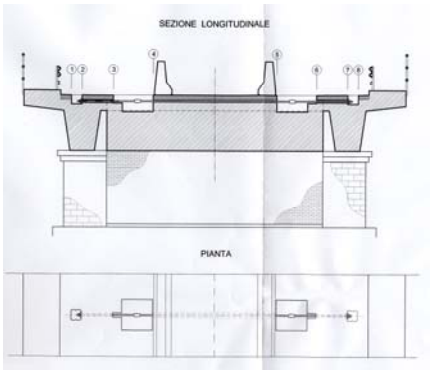
The work, which also involved a widening of the road to 5,50 metres, for a total reinforced concrete ceiling of 8,10 metres was naturally carried out phase after phase in order to guarantee the traffic of light vehicles with an alternated running, as well as the replacement of various lines of subservices
The counterbalance girder, built in C.A. within the arch bridge body, was particularly solid and reached a dimension of centimetres 80 * centimetres 100; the new flow limit of the bridge, which is verified with the loadings of second category, was fixed to 25 tons and so of very superior to the original value. (Photo n° 28)

The total expense for the intervention of functional adaptation of the significant “historical” manufactured artiche amounts to € 405.000,00 – the value is up-to-date to 2006 – with an unitary incidence of €/mq 335,00.

Photo n° 22 – General sight of the bridge on the river Bormida, along the ex-state roa 30, at Terzo d’Acqui

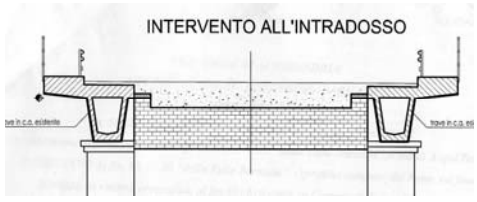
Photo n° 23 – Degradation condition of the bridge along the ex-state road 30 at Terzo, at the beginning of 2000

Photo n° 24 – Collapse of the first beam – mountain side of the bridge along the ex-State Road n° 30 at Terzo, near Acqui Terme.



Pictures n° 6 – “Chain” reinforcement of the beams of the bridge at Terzo, along the ex-State Road n° 30

Photo n° 25 – Iron bars placed on the new reinforced concrete slab near the first restored span of the bridge of Terzo, along the ex-State Road n° 30



Processings on the existent girders

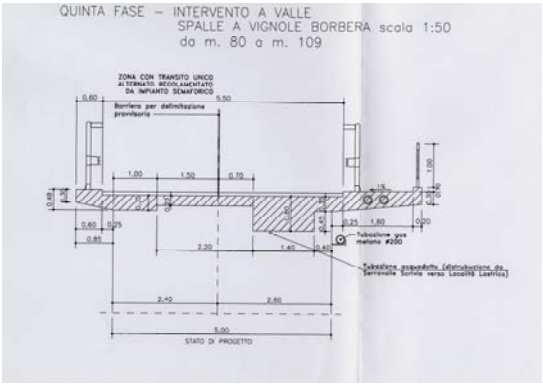
1- Reviving of scaffolding intrados through sand-blasting or hydro sand-blasting with water under pressure by using siliceous sand
2- Removal of damaged reinforced concrete:
- till 2 centimetres on the whole intrados
- till 4 centimetres in the most degraded areas
3- Restructuring of existing scaffolding instruments for the preparation of new jets
4- Pre-treatment of the concrete surfaces with watery solution of acrylic-vynilic resins
5- Restoration of the original section through concrete of high durability, by using expansiv

Protective treatment through materials made of concrete leganti, which have been modified by epossidic synthetic polymers

Picture n° 7 – Some phases of the restoration intervention of the concrete and of the damaged iron bars of the bridge along the ex-State Road n° 30 / Terzo

Photo n° 26 – Sightsof the bridge of Terzo, along the ex-State Road n° 30, when the works were finished

Photo n° 27 – Sight of the “original” road system of the bridge on the Scriva, along the main road 143



Picture n° 8 – Plan transverse section of the bridge on the Scrivia / main road 143

Photo n° 28 – General sight of the bridge on the Scrivia and of its footbridge / main road 143

4. THE MONITORING CONDITION OF THE ART OF WORKS, NOWADAYS AND A LOOK TO THE FUTURE.

*4.1 * The Road Land Register*

The Road Land Register, even if it is expected by the Article 13 of the New Road Code– D.Lgs. n° 285/1992, was founded by the Province of Alessandria in 2002, in consequence of the promulgation of the Ministerial Decree 01.06.2001. [12]

This prescriptive provision established that the census of data and and information, as it is intended for the intervention management and planning by the Companies running the road system, constitutes a data bank for the SIS – Road Informative System -; for this reason, the finding of useful notes must be geographical referenced together with the basic elements constituting the road line (axes, bends, road junctions).

The Road Land Register of the Province of Alessandria aims to create a reference data bank for the Company’s road system which can be shared from every other public structure operating on the territory, as it is compiled a language, that is to say with a method that the Ministerial Decree 01.06.2006 made univocal.

The acquired information, which were later implemented by the Road Land Register Office by the special software concern:

- the traffic monitoring
- the accidents on the road system
- the works of art
- the Concessions, and so the management of accesses and road signs.

Regarding the bridges, as it is the subject of the Memory, the Technical Office/Road System Management of the Province of Alessandria started in 2003, in a methodical and scientific way, the stability control of the road works of art; it surveyed all the manufactured goods with a length superior or equal to 10 metres along the “historical” main roads and the bridges of all dimensions along the ex-state transferred roads.
Thanks to the control activity of the stability conditions of the works of art, it appeared how the surveying technicians’ signalling has already “obliged” to carry out some urgent inteventions, warranting in this way a superior security level as regards the roads of the Province.

4.2 The future
Within the Province of Alessandria there is a great infrastructural effort in the field of Public Works, regarding either the road system, or the housing.
In particular nowadays seven new stretches of road are being built for an amount of more than 98 million of euros and all of them are already approved by the specific Conferences of Services.
Similarly near Marengo, along the road axis of the ex-state road n° 10 “Padana Inferiore” where every day about 45.000 vehicles moving in and out from Alessandria a new axis of new stretch of road is being planning. The latter, which will cost more than 65 millions of euros, will have its most significant example in the new bridge on the river Bormida, a building of steel and concrete, with a total light of 260,00 metres. [13] (Photo n° 29)

Photo n° 29 –Plan of the new bridge on the river Bormida, along the new stretch of road to the city of Alessandria.

5. CONCLUSIONS

We have put in evidence the great quantity of work that the Province od Alessandria carried out on the “historical” roads of its competence and on those transferred by the superintendent of public property.
The new works of art built in the areas affected by the floods, as well as the “extraordinary maintenances” carried out, prove the commitment profuse on the territory in order to improve the connections between the various localities which are connected by a road system of 2.170 kilometres.

The works carried out on the bridges and on the buildings in general are completely respectful of the surrounding environment.
A new moder methodology to know the infrastructural heritage is that derived from the Road Land Register Office which, after being established by the Ministerial Decree D.M.01.06.2001, became executive in the Province and was endowed with a structured Office from 2002.
The methodological survey of the manufactured goods, besides allowing a continuous check of the data recorded on the road graph, is already allowing a more adequate identification of the interventions in terms of priority compared with the road infrastructures revaluation as regards functional aspects and safety. All this is realized with the complete respect nfor natural resources and socio-economic development of the territorial area of insertion. Moreover, from this activity derives a more detailed compilation of Three-Year Programme Public Works and of the Annual List, to which the Public Administrations managing the infrastructures must be liable.
There are great ideas for the next future, together with an ambitious financial plan for building 7 new stretches of road near the critical junctions, that are connected together and first level existent road system. There is also a hope: the building of a new bridge on the river Bormida, allowing the “flight” of the vehicles from Marengo to Alessandria.
All these aspects represent the “structural-building” summary of the Province of Alessandria: a particular thanks to whole staff of Technical Office, which continues to be the object of positive discussion, and people working in the field of Public Works know how this is important and very difficult to reach.

BIBLIOGRAPHY

[1] Ing. P.A. Dezza – Ufficio Tecnico della Provincia di Alessandria
“La costruzione di nuovi ponti e la ricostruzione di ponti antichi negli ultimi dieci anni della Provincia di Alessandria: attività di cantiere ed interazione con il Catasto Strade” – Napoli, 4-7 Ottobre 2006 - XXV Convegno Nazionale Stradale - Associazione Mondiale della Strada - Comitato Nazionale Italiano – Comitato tecnico C.4.4 “Ponti Stradali e connesse strutture”

[2] Ing. P.A. Dezza / Arch. R .Bocchino / Ing. A. Clemente / Ing. M. Robiola – Ufficio Tecnico della Provincia di Alessandria
“Interventi vari per il miglioramento del livello di sicurezza su strade extraurbane di grande traffico in provincia di Alessandria” – Le Strade, 1-2/2005

[3] Ing. P.A. Dezza – Ufficio Tecnico della Provincia di Alessandria
“Ricostruzione delle strade in provincia di Alessandria a seguito dell’alluvione del 1994” – Le Strade, 12/1998

[4] Studio Tecnico Progetti e Ambiente / Ing. Giovanni Di Guglielmo – Alessandria

“Progetto Esecutivo per nuovo viadotto sul fiume Tanaro, lungo la SP 78 “Valenza – Rivellino”

[5] Studio Tecnico Gaia & Rivera – Alessandria / Sintecna S.p.A. – Torino
“Progetto Esecutivo per nuovo viadotto sul torrente Scrivia lungo la SP 87 “Molino dei Torti – Isola S. Antonio”

[6] Studio Tecnico Progetti e Ambiente / Ing. Giovanni Di Guglielmo – Alessandria
“Progetto Esecutivo per i lavori di ripristino, adeguamento e manutenzione straordinaria del ponte sul torrente Scrivia in Comune di Castelnuovo Scrivia lungo la SP 85 “Castelnuovo Scrivia – Alluvioni Cambiò”

[7] Studio Tecnico Azeta – Bello e Devecchi – Tortona (AL)
“Progetto Esecutivo per un nuovo ponte sul fiume Tanaro lungo la Sp 77 “di Felizzano”

[8] R.Chierici / Ing. P.A. Dezza / Ing. G. Sciutto / Ing. G. Estienne / - Ufficio Tecnico della Provincia di Alessandria
“Dove la storia sposa l’innovazione” – Quarry & Construction, 8/2005

[9] Sintecna S.p.A. / Torino
“La progettazione esecutiva dei lavori di ripristino funzionale del ponte sul torrente Scrivia a servizio della SP 140 “della Val Borbera”

[10] Studio Corona s.r.l. Civil Engineering / Torino
“Progetto Esecutivo per la manutenzione straordinaria delle strutture del ponte lungo la ex S.S. 30 “di Valle Bormida” in Comune di Spigno M.to”

[11] Ing. P.A. Dezza / Ing. G. Sciutto - Ufficio Tecnico della Provincia di Alessandria
“Progetto Esecutivo per la realizzazione di una passerella pedonale in corrispondenza del ponte sul torrente Scrivia in Serravalle Scrivia ed ulteriori lavori di ammodernamento della struttura lungo la SP 143 “Serravalle – Vignole”

[12] Ing. P.A. Dezza / Arch. P. Morroi - Ufficio Tecnico della Provincia di Alessandria
“Dalla ristrutturazione di un ponte gravemente lesionato al catasto delle Strade” – con la collaborazione dell’Ordine degli Ingegneri di Alessandria, 11/2004

[13.1] Ing. M. Robiola / Ing. A Clemente - Ufficio Tecnico della Provincia di Alessandria
“Progetto Preliminare della Variante di Alessandria lungo la ex S.S. 10 ”Padana Inferiore” – i° Lotto “, 10/2005

[13.2] IGEAS Engineering – Torino / International Bridges Consulting – Roma / Progest s.r.l. – Vicenza
“Progetto Preliminare della Variante di accesso ad Alessandria lungo la ex S.S. 10 “Padana Inferiore” – II° Lotto, 10/2005