Methodology for classifying road yards and reliability of areas near them

Prof. engineer Giulio Maternini
Associate professor of Transport engineering, Department of civil engineering of the University of Studies of Brescia

Dr. engineer Silvia Foini
Expert on technique and economy of transport engineering, Department of civil engineering of the University of Studies of Brescia

Synopsis

The opening and the exercise of a yard are activity, that would have to be subject to the respect of a series of procedures and implementations, assets and liabilities, finalized to the safeguard of which, for varies reasons, can interfere, also episodically or for a short time, on the activity of the yard. For such reason it has been attempted to indicate some elements and lines guides for the companies working in the road sector, currently not subject to some directive or regulations, for the reduction of the environmental impacts produced from the participations that interest the street, with the purpose to introduce *"Environmental Regulations for Road Yards",* than address the choices of the enterprises on the modalities of organization of the street yard and development of the works, and opens the road to an eventual environmental certification. In order to define a methodology for a classification of the yards we have analyzed some possible impacts on the atmosphere without dealing the possible variations on the planning of the traffic in presence of the street yard and, consequently, without to make one appraisal of the costs which had to the eventual congestion of the traffic. This because the planning of the traffic and the external costs which had a congestion do not influence on the methodology proposed for the classification of the yards. The analysis has been carried out distinguishing the yards situates in urban environment from those in rural environment and considering works of brief duration (to the maximum 48 hours), and works of longer duration (advanced to the 48 hours). In this way it has been attempted to supply a methodology of classification of the street yards (reassumed in an blocks procedure), so that it can be adopted from all those who operate in the street field, characterizing some lines guides for the application of the " *Environmental Regulation for Road Yards* ", than all the operating enterprises in the street field would have to respect, characterizing all those elements and sagacities useful to concur a better control of the problematic ones acclimatize them and a criterion of appraisal of the main impacts (check-lists). In end the Capitolato insertion in special of contract of the two new regarding articles these lines has been proposed guides. The job has been carried out considering the Italian situation and the relative rules, however the defined methodology of job can be applied to various truths, adapting the different normative aspects .

Methodology for classifying road yards and reliability of areas near them

The presence of a road yard, which is a normal condition and not an exception in urban and rural environments, causes a disturbance to road circulation and problems of safety, especially for weak road users (the elderly, children, the visually impaired, those with motor difficulties, etc[1].). Consequently, the opening and working of a yard are activities that should be subject to respecting a series of active and passive procedures and obligations aimed at protecting the safety of those who, for various reasons, may interfere, even occasionally or for a brief period of time, with the activity of the yard by passing nearby on foot or in vehicles.

The general measures to be adopted aimed at reducing the local dangers caused by the yard and consequently improve the safety and flow of the traffic are established by the "Highway Code" legislative decree of 30 April 1992, n.285).

However, to reduce risks, it is necessary to assess other important aspects related to road yards, such as: the need to make all of the economic, commercial and administrative activities in the area offering services coexist with the work, which it is always preferable not to interrupt and continue to make easily accessible; possible direct and induced impacts: increase in traffic on the road infrastructure for approaching and accessing the yard, dirtying the territory surrounding the yard area, visual intrusion and deterioration of the landscape, noise and vibrations.

All of these aspects must necessarily be taken into consideration in order to improve the environmental conditions[2] of the places surrounding the point, where the work of the contracting firm is being carried out and reduce the dangers involved when crossing (for drivers, pedestrians and cyclists) the area next to the road yard.

Nonetheless, road work contracting firms are still not subject to any directive or regulation, which make it possible to improve the environmental conditions in the area next to the yard. Therefore, it is necessary to provide companies working in the road sector with directives to reduce the environmental impact caused by interventions on road foundations with the aim of introducing an *Environmental Regulation for Road Yards* that directs companies' choices towards methods of organising the road yard and carrying out work.

In order to be able to define a methodology to classify the yards, a few possible impacts on the environment were analysed regarding the occupation of public land, visual intrusion, crossing the work area safely and the mechanical effects of these activities, such as excessive noise and vibrations on the territory, without dealing with the possible variations on the planning of the traffic in the presence of a road yard.

In order to provide a classification methodology for road yards that should be adopted by everyone working in the road sector, an analysis was made of the effects of the different impacts and possible interventions, distinguishing yards situated in an urban environment from yards situated in a rural environment, and considering work interventions of both a brief duration, which, according to the "Technical standard regarding temporary"[3] road signs, last for a maximum of 48 hours (represented by work involving road signs, cleaning, pruning the greenery, topographical surveying and cadastral work and interventions to repair unforeseen faults), and work of a longer duration, in other words work that is constantly maintained in a certain place for over 48 hours (involving all work to create, maintain and repair underground road systems, rebuilding of the wearing surface and interventions to upgrade street furniture).

A few guidelines have been identified to define a classification methodology of the different road yards, which all companies working in the road sector should respect, identifying the aspects and steps that are useful for allowing better control of environmental problems and an assessment criterion of the main impacts, which can be identified as:

- noise impact;

---

[1] The Highway Code, L.D. n° 285 of 30/04/1992, states in art. 3 paragraph 53 bis: "Weak road user: pedestrians, disabled persons in wheelchairs, cyclists and anyone who deserves particular protection from the dangers resulting from traffic on the roads".

[2] In recent years various directives and regulations have been enacted to protect the environment and environmental values, such as the ISO 14001 regulation, which aims to provide all organisations with the basics of an efficient system for environmental management and regulation (CE) n. 761/2001 of the European Parliament and Council of 19 March 2001 on the voluntary participation of organisations in a Community system for eco-management and audit (EMAS), which industrial firms can join to assess the impact and improve the environmental efficiency of their own production activities.

[3] Official Journal n.226 of 26-9-2002- Special supplement.

- atmospheric pollution;
- impact on the landscape;
- vibrations.

SOME ASPECTS ON SAFETY IN AREAS NEAR ROAD YARDS[4]

In most cases, the presence of a road yard reduces the level of safety in the part of the road concerned, whose value depends on various factors. This means that managing road yards it is necessary to consider various aspects, which are not related to the nature or specificness of the work, but which determine the setting up of operative methods and procedures concerning the safety of the yard.
In order to impose certain action to reduce the local danger caused by the yard and consequently minimise risks, it is necessary to carry out a *safety analysis,* considering the effects that the yard activities may have on the surrounding roads and relative components of traffic. Such analysis should help to identify the risk factors for traffic tackling the problem from the user's point of view, trying to investigate the ways where the road space is felt, interpreted and used by the various users, who use it in different ways.
The main analysed risk factors are as follows.

- **The regulation of traffic in the presence of road yards**: people executing the work must set up the yard and carry out the work creating as little obstruction as possible to the road to avoid creating excessive hindrance and avoid, only where absolutely necessary, closing the road, with consequent deviations of traffic onto alternative routes that are not always convenient and easy to signpost. If the road is not to be closed, it is necessary to try to keep the flow constant in safe conditions by adopting all measures and steps deemed necessary for this purpose.
- **Safety of pedestrians and cyclists:** on the side of the yard, where weak users (pedestrians and cyclists) can pass, it is necessary to create a boundary using barriers, railings or boundary markers that are red or orange and stably fixed, made of material, net, or other special measures to protect the safety of pedestrians and cyclists passing the yard. The devices used to mark the boundary must be signalled with fixed red lighting that is kept on from dusk to dawn, with refracting devices set at suitable intervals along the perimeter where there is the traffic. If possible, pedestrian and cycle paths must be kept full width in the area of the work yard. In the event of narrowing for yards set up for long periods of time, it is essential not to go below the following minimum dimensions taken from the German provisions [5] since no mention is made of these measures in the Italian provisions:

Minimum widths for pedestrian and cycle paths in the presence of road yards taken from the German provisions	
Pedestrian paths	1,0 m
Paths for bicycles with no vehicle traffic in the opposite direction	0,8 m
Mixed pedestrian and cycle paths	1,6 m

With regard to manholes and all types of doors (drains or road grids for collecting rain water and wells to access underground pipes, etc.), if these are left open, even for a short period of time, they must be completely surrounded by barriers or simple barriers joined in a square, if they are on the carriageway, on verges or pavements.

- **Car parks and lay-bys***:* it is necessary to consider aspects such as the location and visibility of the entrances and exits to and from the car parks in relation to the yard and assess possible interference from vehicles manoeuvring in the car park in relation to the regular flow of traffic in the work area; it is also always necessary to allow access for residents' vehicles and emergency vehicles.
- **Access to activities in the yard area:** when road work is being carried out, it is particularly important to keep accesses to buildings visible and easy to reach, and especially, to services in the area in question. The reduced visibility of an entrance to a residential building is more acceptable than for a shop, an office,

[4] The subject of temporary signalling of road yards and their boundary marking is not discussed, because reference is made to the *Technical standard relating to road signs, differentiated by road category, to be adopted for temporary signalling,* published in the Special Supplement of the Official Journal of 26-9-2002.
[5] *Richtlinien fur die Sicherung von Arbeitsstellen an Straben (RSA)*, *Bundesministerium fur Verkehr*, August 1995.

an industry, a school or a health structure. One way of keeping public activities usable is to place informative panels immediately near the structure to indicate its presence using suitable wording and illustrations so it may be used immediately.

CLASSIFICATION OF ROAD YARDS

The proposed classification of road yards was created by identifying a suitable zoning of the area considering the road type and entity of the impact caused by a road yard. In order to carry out this zoning, it was also necessary to consider the functional class of the road where the yard is situate, as well as the environmental and urban characteristics of the work area, paying particular attention to its functional, geometrical and traffic characteristics, to the accesses, to the authorised users and to the regulation for stopping and pedestrian traffic.
To make this classification it was also necessary to consider all of the problems and inconveniences that a yard may cause to road users (pedestrians, cyclists and car drivers), residents and those employed in the neighbouring areas, assessing the damage that the work may cause the neighbouring buildings, of an historic value or other typology, and assessing the impact on the landscape and on the atmosphere.
In all yard areas the safety of the traffic must always be guaranteed, both day and night and in all weather conditions; noise and vibrations caused by operating machines, atmospheric dust caused during digging, filling and asphalting should not cause excessive discomfort to those who live and work in buildings near the road yard, moreover, all production activities that are being carried out in buildings near the road work area must not be limited in any way.
The organisation of a yard area should also not have any impact on the landscape, for this reason it is necessary to try to fit the yard into the context in question, without causing any major visual impact, trying to disguise it.
Naturally, all of the above points must always be assessed during the course of road work, but they take on a different importance depending on the context into which the yard needs to be fitted. For example, a yard set up along a local road must be organised differently, depending on whether it is in a residential, industrial or tertiary area. Similarly, a yard situated in a certain area, with certain functional characteristics must be managed with different criteria depending on whether it is on a local urban, interzonal, district, collector or through road.

Environmental classification of yards on urban roads

Therefore, in order to define the criteria for classifying road yards it was necessary to consider the typology of the area in which they are situated.
A road yard can be shared in:

- **sensitive areas** (areas for rest and entertainment, school and health areas and places of historic, cultural and environmental importance, in other words areas in “area A” in compliance with the L.D. n.1444/68), with reference apart for what is included in “class I” of the Presidential Decree of the Council of Ministers of 14-11-1997, in other words the probable presence of categories of weak users (children, the elderly,…). With regard to the effects of vibrations on man, these areas correspond to the *critical areas* in Tables 2.2 and 2.3 in enclosure B of the above stated Decree, which defines the limit level of overall accelerations considered according to the frequency of the vibrations; in the case where the levels of the vibrations in question exceed the limits set for this area (71 dB for axes x and y, 74 dB for axis z), the vibrations are objectively a disturbance for individuals who are exposed.
  Since there can only be old buildings in these sensitive areas with one or more floors, for public, industrial or residential use, built with traditional criteria, and old buildings of historic value, or modern buildings and structures for public, industrial or residential use with one or more floors, or both categories of buildings, the problems regarding noise pollution and vibrations take on a different importance depending on the particular case;
- **residential areas**, with reference to what is included in “class II” and in “class III” of the P.D.C.M. of 14-11-1997; these areas correspond to the *houses* in Tables 2.2 and 2.3 of enclosure B of the above stated Decree. The limit levels of the overall accelerations are defined on the basis of two time bands and the Cartesian axes: from 10 pm to 7 am, the disturbance threshold of the vibrations is equivalent to 74 dB for the x and y axes, and to 77 dB for the z axis, whilst from 7am to 10 pm, the limit is set at 77 dB for the x and y axes, and at 80 dB for the z axis;
- **“mixed” type areas,** characterised by “intense human activity”, with reference to what is included in “class IV” indicated by the P.D. C.M of 14-11-1997, in other words areas with a considerable presence and mixture of commercial activities, offices, services, housing, etc.. This area corresponds to the *offices* in Tables 3.2 and 3.3 of the above stated Decree, which corresponds to a limit of overall accelerations of vibrations equal to 83 dB for the x and y axes and to 86 dB for the z axis;
- **Productive areas** (warehouses, artisan workshops,…) in “area D” of the L.D. n.1444/68 or in “class V” and in “class VI” of the P.D.C.M of 14-11-1997. These areas are equivalent to the *factories* present in

Tables 3.2 and 3.3 of the above stated Decree, for which a limit level of overall accelerations of vibrations is set equal to 89 dB for the x and y axes and to 92 dB for the z axis.

It is clear from the descriptions that have been made that the considerations regarding the effects that the vibrations might have on the different types of buildings mainly concern the sensitive areas, since, in most cases, it is in these areas that there are buildings of an historic nature, as well as recent constructions.
The following *Environmental classification of urban road yards* has been made with reference to the functional classification of urban roads and to the different areas described above:

Class of the yards	Definition
1 u	*Yards on fast urban through roads and through roads in a production and tertiary area.*
2.1 u	*Yards on urban collector and district roads in a sensitive area.*
2.2 u	*Yards on urban collector and district roads in a mixed area.*
3.1 u	*Yard on urban interzonal roads in a sensitive area.*
3.2 u	*Yards on urban interzonal roads in a mixed area.*
4.1 u	*Yards on local urban roads in a sensitive area.*
4.2 u	*Yards on local urban roads in a production area.*
4.3 u	*Yards on local urban roads in a residential area, in other words yards on "residential roads".*

Table 1 – Environmental classification of urban road yards.

The predicted environmental classes identified have different characteristics and particular features, which require specific attention and precautions when organising a road yard, even if the basic principles of safety and protection of road users and people who frequent the area affected by the road work lie at the root of all categories, in which it is possible to separate the road network and portions of communal area.
Consequently, all of the classes require the yard to be organised with specific methods, depending on the characteristics, which distinguish them.

- ***Class 1 u: yards on fast urban through roads and through roads in a production and tertiary area***

Yards situated on through and distribution roads that serve for exchanges between the urban and rural area, with long or medium distance vehicle flows, with a legal speed limit (with exception) of 70 km/h. Generally, the yards that belong to this class are situated near commercial areas, administrative areas or production areas (artisan and industrial).

- ***Class 2.1 u: yards on urban collector and district roads in a sensitive area***

Yards situated on roads that connect neighbouring districts or sectors in a sensitive area, that is in an area characterised by the presence of schools and health structures (hospitals, medical institutions,…) and by places and buildings of significant historic, cultural and environmental value, where silence, the protection of visitors to the area and the protection of ancient buildings are of primary importance; moreover, in these areas, the environmental impact of road work must be reduced as much as possible, as well as atmospheric pollution.
The arteries on which these yards are set consist of one or more lanes per direction of travel, pavements and possibly a route reserved for collective public transport. Vehicles can only stop in areas or side belts that have specific manoeuvre lanes outside the carriageway. The maximum speed limit does not exceed 50 km/h.

- ***Class 2.2 u: yards on urban collector and district roads in a mixed area***

Yards situated on urban collector and district roads in zones comprising areas characterised by commercial and tertiary activity and services for the district and homes, often coexisting.

- ***Class 3.1 u: yards on urban interzonal roads in a sensitive area***

Yards situated on roads, which access buildings and sociological services for the district in sensitive type areas, that is, in an area characterised by the presence of schools and health structures (hospitals, medical institutions…) and by places and buildings of significant historic, cultural and environmental value, where silence, the protection of visitors to the area and the protection of ancient buildings are of primary

importance; moreover, the environmental impact of road work in these areas must be as limited as possible, together with atmospheric pollution.

- ***Class 3.2 u: yards on urban interzonal roads in a mixed area***

Yards situated on interzonal city roads serving mixed type areas characterised by the coexistence of commercial and tertiary activities and services for the district and homes.

- ***Class 4.1 u: yards on local urban roads in a sensitive area***

Yards situated on roads directly serving buildings used for initial or final journeys by pedestrians and motor vehicles in a sensitive area, that is, in the presence of school institutes, hospitals, medical institutions, and historical buildings or in residential areas built some time ago.

- ***Class 4.2 u: yards on local urban roads in a production area***

Yards situated on local urban roads directly serving buildings in production areas, in other words, industrial and artisan buildings for depositing, storage, transport and visible trade.

- ***Class 4.3 u: yards on local urban roads in a residential area, in other words, yards on "residential roads"***

Yards situated on residential roads, as indicated in article 3 of the *New traffic regulations*, established with an ordinance of the Mayor in an inhabited and residential type area. In these areas particular rules of conduct are in force to protect pedestrians and the environment; they are marked by a special start sign, a stop sign and a panel reporting the traffic conditions in force.

Environmental classes of yards on rural roads

As we know, rural roads are classified according to their functional, technical and structural characteristics into the following types:

A. Motorways;
B. Main rural roads;
C. Secondary rural roads;
F. Local rural roads.

Since the presence of a road yard along A and B type roads should not cause serious impacts, because the areas nearby are not usually schools and health structures or places of historic, cultural and environmental importance and they do not have large residential areas and are not characterised by intense human activity, it was not considered appropriate to regard them in the classification, since the problem is solely limited to managing the traffic.

With regard to yards situated on secondary and local rural roads, the zoning illustrated in the previous paragraph no longer applies. Although it is sometimes possible to find places of historic, cultural and environmental importance, and warehouses, industries and homes near these typologies of roads, their presence was not considered sufficient to be able to classify the areas considered into sensitive, residential or production areas. Consequently, the presence of one single general typology of area was considered and defined as a *mixed type area with fewer than 25 buildings,* which considers the presence of services, houses, historic buildings, etc.… in a limited number.

Consequently, there are only two classes into which yards on rural roads can be divided:

Class of the yards	Definition
1 e	*Yards on rural secondary roads in a mixed area with fewer than 25 buildings.*
2 e	*Yards on rural local roads in a mixed area with fewer than 25 buildings.*

Table 2- environmental classification of yards on rural roads.

To organise a road yard in relation to one of the two identified environmental classes after considering the functional characteristics of the roads examined, it is necessary to pay particular attention to controlling the traffic, trying to keep the flow constant in conditions of safety, and avoid queues forming and causing excessive inconvenience to drivers. Moreover, it is necessary to assess the environmental and acoustic impact and vibrations caused by the road work in this area too, although in most cases, the possible damage caused by the various impacts in rural areas is less compared to the damage that may occur in urban areas.

BLOCK PROCEDURE FOR CLASSIFICATION

In order to highlight the main steps to be carried out and the relative normative instruments to be used to reach an environmental classification of road yards presented in the previous paragraphs, it seemed fitting to make a block procedure to use as a convenient and effective instrument for analysing a yard situated on a certain road and in its relative area.

The starting point of this block procedure corresponds to the functional classification of the road on which the yard in question is situated, in order to be able to distinguish an urban road from a rural one, specifying its typology.
This classification satisfies the needs to standardise the infrastructural characteristics and standard of practicability of the different typologies of roads throughout the whole national territory and favours "typifying" the roads from a point of view of traffic safety, which is why it constitutes a first basic element of "legibility" of the road space.
The functional classification of the road on which the yard in question is situated can be obtained from the *Urban traffic plan* (UTP), if the road belongs to the urban category, and from the Rural road network traffic plan (RRTP) if a rural road is being examined.
If no UTPs or RRTPs are available, it is necessary to classify the roads by considering the urban road network divided into "main urban network" and "local urban network", as shown in the ministerial directives.
The first is made up of different typologies of roads:

- *Urban motorways,* for long distance journeys and rural and urban exchanges;
- *Urban through roads,* that serve to deviate the through traffic of the more densely inhabited areas;
- *district urban roads* that connect the various urban sectors.

The local urban network solely consists of *local urban roads* directly serving buildings.
The distinction between main urban network and local urban network satisfies the need to distinguish between roads that serve to satisfy the needs of vehicle traffic and roads that directly serve buildings.
Since the existing roads rarely satisfy the infrastructural requirements indicated in article 2 of the New traffic regulations, in order to make the functional classification of the existing roads possible, the ministerial directives propose the introduction of three more intermediate functional classes, which are added to those foreseen by the New traffic regulations[6]:

- *fast urban through roads,* with intermediary functions for the urban motorways and urban through roads;
- *urban collector roads,* with intermediary functions for the urban through roads and urban district roads;
- *interzonal urban roads,* with intermediary functions for the urban district roads and local urban roads.

After identifying the typology of the urban road where the yard in question is situated, it is necessary to consult the General Town Planning Scheme and *Services Card,* which allow residential areas, industrial-artisan areas and agricultural areas to be identified to be able to carry out zoning of the area in question on a town planning level. In fact, the General Town Planning Scheme is the main urban and rural territorial planning instrument; it identifies the typology for each area and provides qualitative indications on what can be done and what cannot be done and quantitative indications on how much can be built using the building parameters. Qualitative distinctions can also be made for each area.
In order to obtain acoustic zoning, which represents an effective instrument for planning urban development to prevent acoustic degradation and restore damaged areas, it is necessary to assess the acoustic zoning plan of the area in question, which should have been drawn up in accordance with the P.D. C.M. of 1-3-1991, *"Limits of exposure to noise in residential areas and in the outside environment"*.
With regard to the effects on man of vibrations produced when carrying out road work, it is necessary to consult Tables 3.2 and 3.3, taken from the UNI 9614 legislation, by means of which it is possible to differentiate the different typologies of areas on the basis of the values and levels of overall accelerations of vibrations considered bearable by man.
Finally, it is necessary to attempt to classify the area in question in relation to the effects of the vibrations on the buildings. In order to do this, it is necessary to check (using the General Town Planning Scheme, the services card and surveys), whether, in the area in question, there are old buildings with one or more floors built according to traditional criteria, and/or old buildings of an historic value, for this it is appropriate to carry out road work keeping the vibrations produced under control, trying not to exceed the levels beyond which the buildings might suffer various amounts of damage; whereas, if there are only modern buildings and structures for public, industrial or residential use, with one or more floors in the area in question, the vibrations produced during the road work should not cause damage to the buildings.
After carrying out all of the described analyses thoroughly and with precision, we finally come to distinguishing the area in question on the basis of the environmental classification for yards on urban roads, as defined above, comprising eight different typologies of classes.
Whereas, considering the rural network, this is divided up into four different typologies:

- *rural motorways;*
- *main rural roads;*
- *secondary rural roads;*
- *local rural roads.*

---

[6] Busi R., Zavanella L., *Tecniche per la sicurezza in ambito urbano Volume II*: *La classificazione funzionale delle strade,* EGAF Editions SRL, Forlì, November 2002.

If the road on which the yard in question is situated is classified as one of the first typologies, it is necessary to consider the planning and management of the traffic in the area, without making any type of classification.
Whereas if the road where the yard is situated belongs to one of the last two typologies, it is necessary to check whether there is an urban settlement in the area in question (fewer than 25 buildings). If so, the distinction of the area in question is reached on the basis of the environmental classification for yards on rural roads, which only includes two different typologies of classes; otherwise it is necessary to assess the planning and management of the traffic in the area in question.
The block diagram for environmental classification of road yards is reported below showing the different steps described above.

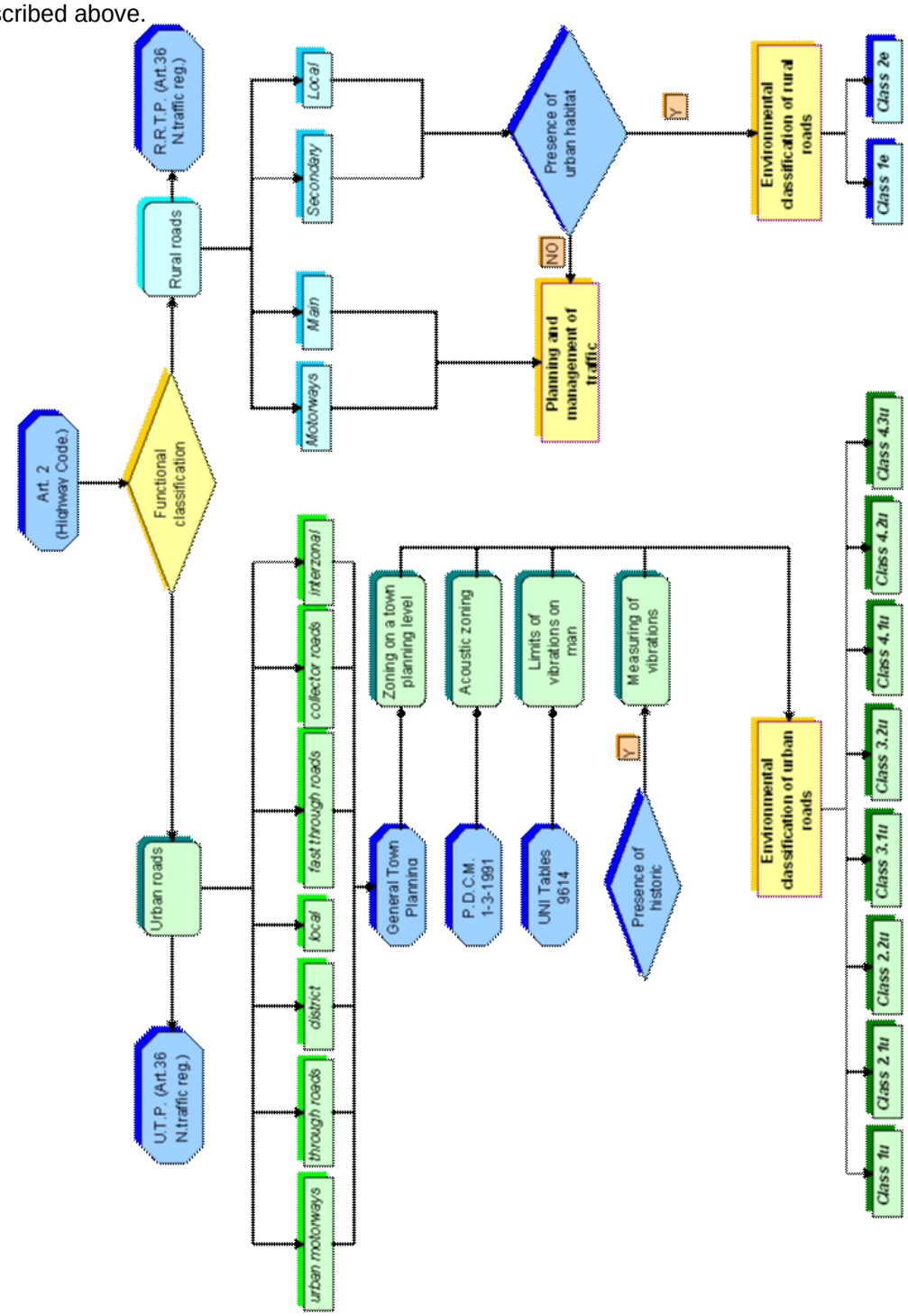

Figure 1- Block diagram for the application of the criteria for environmental classification of road yards.

CHECK-LISTS

A check-list is the simplest methodological instrument that can be used to identify the different impacts of a road yard.

Check-lists are basically “suggestions” aimed at preventing important safety related problems from being neglected; they represent the starting point for developing the overall assessment of the yard in question and formulating recommendations for potential situations of risk that are found.
The check-lists must be used as a questionnaire; a list of questions is prepared for each topic taken into consideration; the questions can be answered either affirmatively or negatively. If the answer to the question is negative, it means that in the area where the road work is being carried out, the requested state of safety has been verified for the aspect taken into consideration; if the answer is positive, it means that there is a state of danger in the area in question, which needs to be altered; in this case, it is necessary to adopt the measures relating to the check-list used; in fact, every check-list is always accompanied by various “suggestions”.
The check-lists have been created for every different level of planning.
For yards set up for long periods of time (over 48 hours) it is possible, and there is time to complete the different check-lists for the various levels of planning, starting with an assessment of the preliminary project, reaching the check and inspection phase, during which the check-lists must be used several times, at intervals, depending on the different duration of the road yard.
Whereas with yards set up for a short period of time, understood as all typologies of work and interventions lasting for a maximum of 48 hours, obviously it is not possible to use the check-lists in phases before the phase of checking the completed work; however, in these cases, it is also useful to use the check-lists prepared for this phase, even just once, to see the present environmental shortcomings and eliminate them as best as possible in a short period of time, trying to avoid any inconvenience to the various users.
The block diagrams related to the schematization of the check-lists for yards set up for long and short periods of time are reported below together with an example of a check-list.

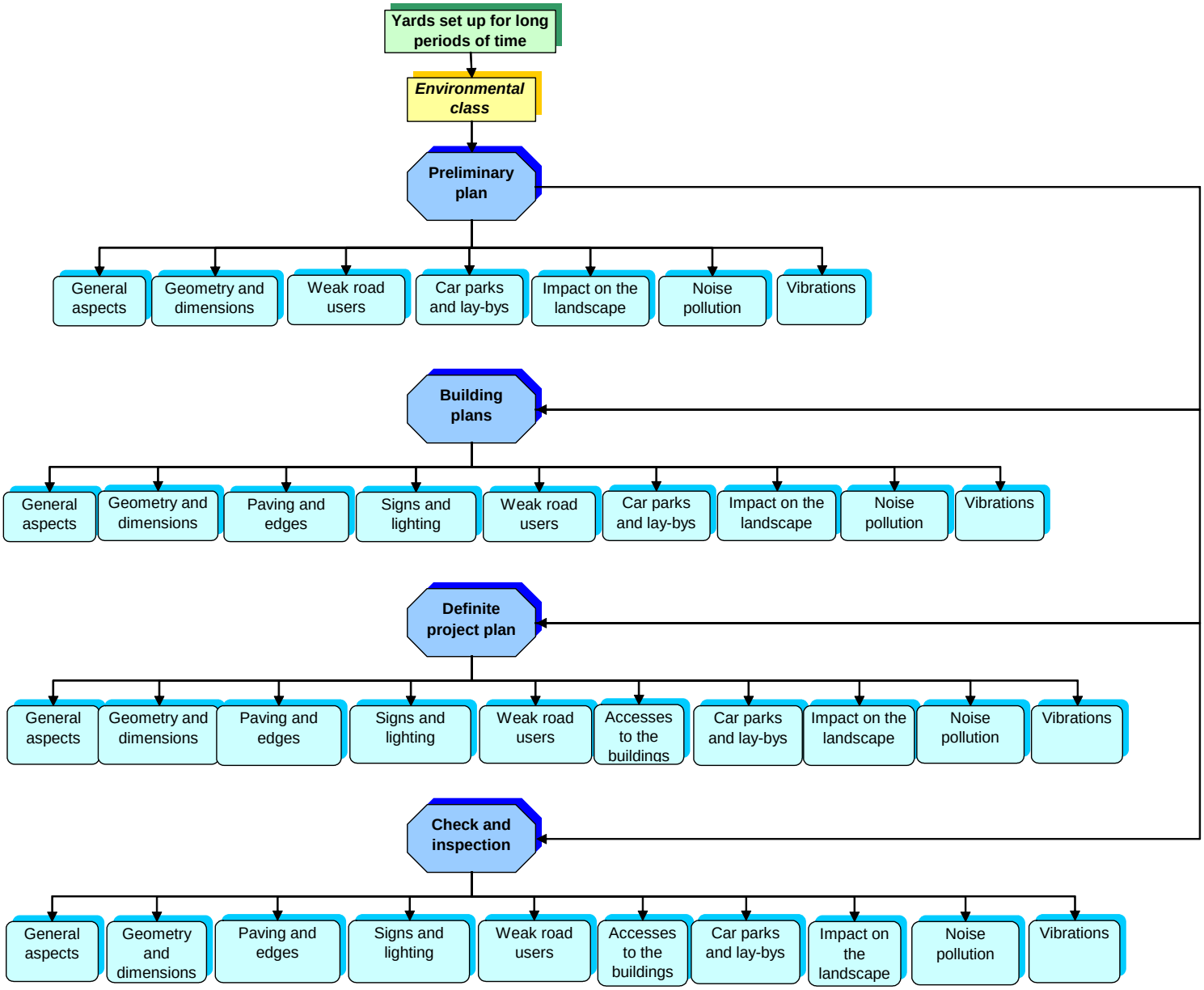

Figure 2- Block diagram related to the schematization of the check-lists for yards set up for long periods of time

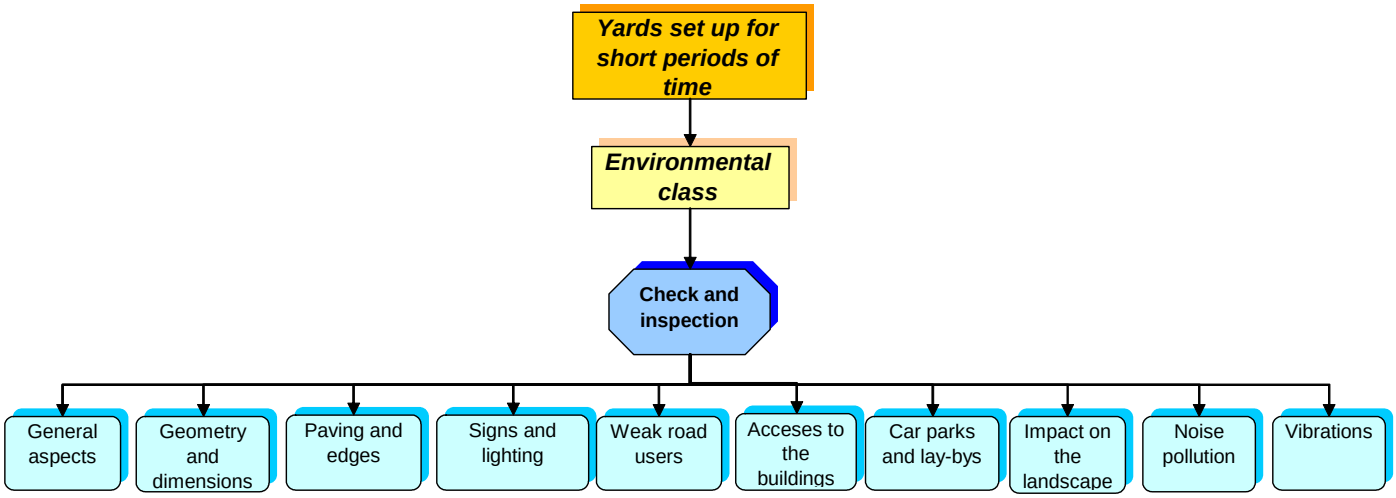

Figure 3- Block diagram related to the schematization of the check-lists for yards set up for short periods of time

Accesses to the buildings
• *Do emergency vehicles (ambulances, fire brigade fire engines, …) have difficulty gaining immediate access to the buildings near the yard and acting without problems?* *NO* *YES The immediate accesses to the buildings for doctors, firemen, and police must be guaranteed by corridors and privileged routes through the yard, which must always be free from obstacles and able to be crossed safely.*
Car parks and lay-bys
• *Is the size of the area for approaching or leaving the yard sufficient to allow vehicles to stop?* *NO* *YES It is necessary to prevent vehicles from stopping in these areas using cement barriers with slanting red and white stripes, and if this is not enough, place temporary devices to moderate the traffic, for example longitudinal misalignments or lateral carriageway narrowing.*
• *Are the pedestrian accesses to the car parks difficult and dangerous?* *NO* *YES crossings must be made, which are offset in relation to the road surface and well lit to protect pedestrians.*
Noise pollution
• *Is the disturbance caused by the yard incompatible with the needs of the road users, residents and workers in the area?* *NO* *YES If interrupting the work during the most sensitive hours or during hours of greater vehicle traffic is not enough, it is necessary to try to limit the duration of the work to a minimum.*
Vibrations
• *Are there "critical" points in the area?* *NO* □ *YES It may be useful to monitor the vibrations in these points.*

Figure 4- Example of the format of a check *list*

THE ENVIRONMENTAL REGULATION FOR ROAD YARDS IN THE SPECIAL SPECIFICATIONS

In order to remedy the current lack of limits and obligations, which contractors can use for reference when organising road yards to limit the environmental impact caused by the yard on the surrounding area and eliminate any potential dangers to users crossing the work area, it seems appropriate to propose the insertion of two new articles, marked by the numbers 42 and 43, relating to the classification methodology of road yards in the first part of the special specifications, immediately after the articles relating to the general safety regulations and safety plans.
Naturally, the numbering of the subsequent articles will consequently be modified.

Art. 42: Definition of the environmental class of the road yard
The text of article n° 42 concerning the definition of the environmental class of the road yard in question can be formulated as follows:
"Within 30 days of adjudication and nonetheless before starting work, the client is obliged to provide the contractor, in final and complete form, with the indication of the environmental class to which the adjudicated road yard belongs.
The classes which the client is obliged to consider in order to make a correct classification of the yard in question are as follows:

- ***class 1 u: yards on fast urban through roads and through roads in a production and tertiary area***

Yards situated on through and distribution roads that serve for exchanges between the urban and rural area with medium or long distance vehicle flows, with a legal speed limit (with exception) of 70 km/h. Generally, the yards that belong to this class are situated near commercial areas, administrative areas or production areas (artisan and industrial).

- ***class 2.1 u: yards on urban collector and district roads in a sensitive area***

Yards situated on roads that connect neighbouring districts or districts in a sensitive area, that is in an area characterised by the presence of schools and health structures (hospitals, medical institutions,…) and by places and buildings of significant historic, cultural and environmental value, where silence, the protection of visitors to the area and the protection of ancient buildings are of primary importance; moreover, the environmental impact of road work in these areas must be as limited as possible, together with atmospheric pollution.
The arteries on which these yards are set are made up of one or more lanes per direction of travel, pavements and a possible route reserved for collective public transport. Vehicles can only stop in areas or side belts that have specific manoeuvre lanes outside the carriageway. The maximum legal speed limit does not exceed 50 km/h.

- ***class 2.2 u: yards on urban collector and district roads in a mixed area***

These are yards situated on urban collector and district roads in zones comprising areas characterised by commercial and tertiary activities and services for the district and homes, often coexisting.

- ***class 3.1 u: yards on interzonal urban roads in a sensitive area***

Yards situated on roads, which access buildings and sociological services in the district, in sensitive type areas, that is, in an area characterised by the presence of schools and health structures (hospitals, medical institutions,…) and by places and buildings of significant historic, cultural and environmental value, where silence, the protection of visitors to the area and the protection of ancient buildings are of primary importance; moreover, the environmental impact of road work in these areas must be as limited as possible, together with atmospheric pollution.

- ***class 3.2 u: yards on interzonal urban roads in a mixed area***

These are yards situated on interzonal urban roads serving mixed type areas, characterised by the coexistence of commercial and tertiary activities and services for the district and homes.

- ***class 4.1 u: yards on local urban roads in a sensitive area***

Yards situated on roads directly serving buildings used for initial or final journeys by pedestrians and motor vehicles in a sensitive area, that is, in the presence of school institutes, hospitals, medical institutions, and historic buildings or in residential areas built some time ago.

- ***class 4.2 u: yards on local urban roads in a production area***

These are yards situated on local urban roads directly serving buildings in production areas, in other words industrial and artisan buildings for depositing, storage, transport and visible trade.

- ***class 4.3 u: yards on local urban roads in a residential area, in other words, yards on "residential roads"***

Yards situated on residential roads, as indicated in article 3 of the *New traffic regulations* established with an ordinance of the Mayor in an inhabited and residential type area. In these areas particular rules of conduct are in force to protect pedestrians and the environment; they are marked by a special start sign, a stop sign and a panel reporting the traffic conditions in force.

Art. 43: Matters to be assessed for the safety of weak users and to limit the environmental impact during the execution of the work

The text of article n° 43 relating to matters to be assessed for the safety of weak users and to limit the environmental impact can be formulated as follows:

"After the client has identified the environmental class to which the yard in question belongs, the contractor is obliged to organise the work carefully assessing various matters to limit the environmental impact of the work and guarantee all road users a high level of safety, also where there is the yard.

The aspects to be assessed are reported below; obviously they may vary, more or less evidently, depending on the environmental class to which the road belongs.

- *General aspects*

It is essential to consider the composition and volume of traffic near the yard and try to assess whether the foreseeable re-distributions of traffic onto the neighbouring roads are sufficient to reduce the level of safety.

It is necessary to analyse the weather conditions in the area that occur with a certain frequency, which may have a significant impact on the safety of users. In particular, it is necessary to check the presence of potential dangers, such as fog, snow or ice in the winter season, and the possibility of flooding or increased slipperiness on roads, when there is heavy rainfall.

It is necessary to consider the presence of factors, such as vegetation and its development in time to guarantee continued vision in time of the road area for road users.

Finally, it is necessary to consider all of those factors, which, coupled with the presence of one or more yards set close together, may prove critical to the practicability on a certain road section and in the surrounding area.

- *Geometry and dimensions*

It is necessary to ensure that the geometry and dimensions of the yard plan in the different phases is compatible with the needs of safety, always maintaining the spaces reserved for the traffic in safety for pedestrians, cyclists and motorised vehicles, also where there are clear variations in the geometric characteristics of the road due to the presence of a yard.

- *Paving and edges*

It is necessary to check whether there are areas, which present sudden shifts from an ordinary wearing surface to irregular conditions with holes in the bituminous material, which might cause problems to the traffic. It is also necessary to assess the proper functioning of hydraulic work and drains for draining meteoric water, also where there is a road yard, which, if blocked, may cause flooding and problems for the whole surrounding area.

Finally, it is necessary to check that the work and yard equipment in the area is suitably protected and inaccessible to unauthorised people to avoid causing dangers and accidents.

- *Signs and lighting*

It is necessary to ensure that all signs give drivers adequate notice and inform them of the deviations made to the route to allow them to adapt their driving to the new conditions.

The yard signs must interact with the permanent signs, in the sense that the messages of the two types of signs must not be contradictory; nor must there be physical interference, for example where the temporary signs hinder the view of the permanent signs.

- *Weak road users*

It is necessary to bear in mind the particular needs of weak road users during all of the different yard phases; to this end it is necessary to ensure that there are pedestrian crossings and cycle paths in the area where the work is being carried out to allow the yard to be crossed safely.

- *Accesses to buildings*

It is necessary to ensure that accesses to buildings are clearly visible, not blocked and easily reachable without causing queues.

- *Car parks and lay-bys*

It is necessary to set the entrances and exits to and from the car parks suitably in relation to the yard and assess any possible interference with the flow of traffic in the work area, guaranteeing the safety of pedestrians in lay-bys and car parks.

Finally, it is necessary to find new parking areas in the immediate vicinity, if the yard occupies parking spaces in areas where they are limited.

- *Impact on the landscape*

It is necessary to assess whether the organisation of the yard determines an impact of a purely visual nature, which might alter the features that characterise the landscape in question.

- *Noise pollution*

It is necessary to check that the yard activities do not cause excessive disturbance to the residents and regular visitors in the area; any acoustic discomfort caused by the work must be reduced considerably, if not completely eliminated, using the appropriate means to always try to guarantee acoustic comfort.

- *Vibrations*

It is necessary to check that the disturbance caused to people by the vibrations, which are produced, is reduced to a minimum, adopting all necessary means to this end.
It is also necessary to assess the effects of the vibrations on the buildings in the area, particular attention must be paid if the yard in question is in an area rich in historical buildings, which might suffer irreversible damage."

CONCLUSIONS

The above described work procedure was applied to some real sample cases in the city of Brescia, in this way it was possible to check the validity of the check-lists and consequently also the described work methodology.
Thanks to the experiment for example, it was possible to observe the greater effectiveness of the check-lists with a yard up and running during the execution of the work, since it is possible to assess more aspects compared with those observed on the basis of the definite project plan, because there are many variables during the execution of the work and the effects that they will have on the area relating to the project beforehand cannot be checked properly.
On the other hand, we must consider that if the check was carried out properly in the definite project plan phase, the negative aspects discovered should indeed be limited.
We must also point out the fact that these check-lists can be used both for yards set up for short periods of time (maximum 48 hours) and for yards set up for long periods of time (over 48 hours), however they are certainly far more useful in the second case, where the situation can be checked several times and consequently improved.
The application of these check-lists in these three planning levels and then at regular intervals during the work,would undoubtedly guarantee an elevated level of environmental management in yards and would surely satisfy the various road users' needs as best as possible. The most difficult part concerns spreading this useful practice to firms, which is why the inclusion of the two articles in the special specifications would indeed be an excellent way of achieving this aim.

REFERENCES

ANASTASIA E., (Settembre 2001), *Segnaletica stradale per una guida sicura*, Le Strade, La Fiaccola editrice s.r.l., Milano.
AUTOSTRADE, (1994), *Road Safety Audit*, Sydney, New South Wales, Australia.
BELLA F., (Marzo-Aprile 2001), *La valutazione ambientale strategica di piani e programmi delle infrastrutture di trasporto*, Strade e Autostrade.
BONOMO F., (Settembre 1998), *Segnaletica per la sicurezza nei cantieri stradali*, Le Strade, La Fiaccola editrice s.r.l., Milano.
BORGIA. E. a cura di, (2002), *Studi di impatto ambientale nel settore dei trasporti,* edito da: Ministero dell'Ambiente e delle tutela del territorio – Servizio Valutazione Impatto Ambientale, Roma.
BOSETTI R., (Aprile 2000), *La sicurezza nei cantieri stradali*, Le Strade, La fiaccola editrice s.r.l., Milano.
BUSI R., TIRA M., (2001), *Sicurezza dei pedoni e dei conducenti dei mezzi a due ruote,* Edizione Bios, Cosenza.
BUSI R., ZAVANELLA L. (a cura di), (Novembre 2002), *Tecniche per la sicurezza in ambito urbano Volume II , La classificazione funzionale delle strade,* EGAF edizioni SRL, Città di Castello (PG).
CIOTOLA G., MONTELLA A., (Aprile 2002), *L'indice di sicurezza globale per i cantieri stradali*, Strade e Autostrade.
CIOTOLA G., MONTELLA A., (Settembre 2002), *Una metodologia di analisi di sicurezza dei cantieri stradali*, Le Strade, La Fiaccola editrice s.r.l., Milano.
Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 *Relating to the assessment and management of environmental noise.*
FOINI S., MATERNINI G., (Ottobre 2004), *Cantieri stradali e ambiente*, Le Strade, La Fiaccola editrice s.r.l., Milano.

LO IACONO C., FIORE E., (1999), *I cantieri stradali*, Maggioli editori, Repubblica di San Marino.
MANZONI E., (Febbraio 2001), *L'organizzazione del traffico in presenza di cantieri*, Le Strade, La fiaccola editrice s.r.l., Milano.
MATERNINI G., (a cura di), (2000), *Metropoli e mobilità – Il caso di Brescia – verso un manuale per la pianificazione d'area metropolitana*, Vol. 6, Sintesi editrice, Brescia.
MATERNINI G., (Settembre 2004), *La classificazione funzionale delle strade in esercizio e la velocità operativa dei veicoli*, Le Strade, La Fiaccola editrice s.r.l., Milano.
MINISTERO DEI LAVORI PUBBLICI, Ispettorato generale per la circolazione e la sicurezza stradale, (25 Gennaio 2001), *Linee guida per le analisi di sicurezza delle strade,* Università di Napoli "Federico II", Firenze, Palermo, Roma.
MINISTERO DELLE INFRASTRUTTURE E DEI TRASPORTI, D.M. 5 Novembre 2001, *Norme funzionali e geometriche per la costruzione delle strade.*
Richtlinien fur die Sicherung von Arbeitsstellen an Straben (RSA), Bundesministerium fur Verkehr, Agosto 1995.
TIRA M., VENTURA V., (settembre 2002), *Misure per la sicurezza dei pedoni in Italia, Quaderno 2,* Edizione Bios.
UNI 9614: *Misura delle vibrazioni negli edifici e criteri di valutazione del disturbo.*
UNI 9916: *Criteri di misura e valutazione degli effetti delle vibrazioni sugli edifici.*