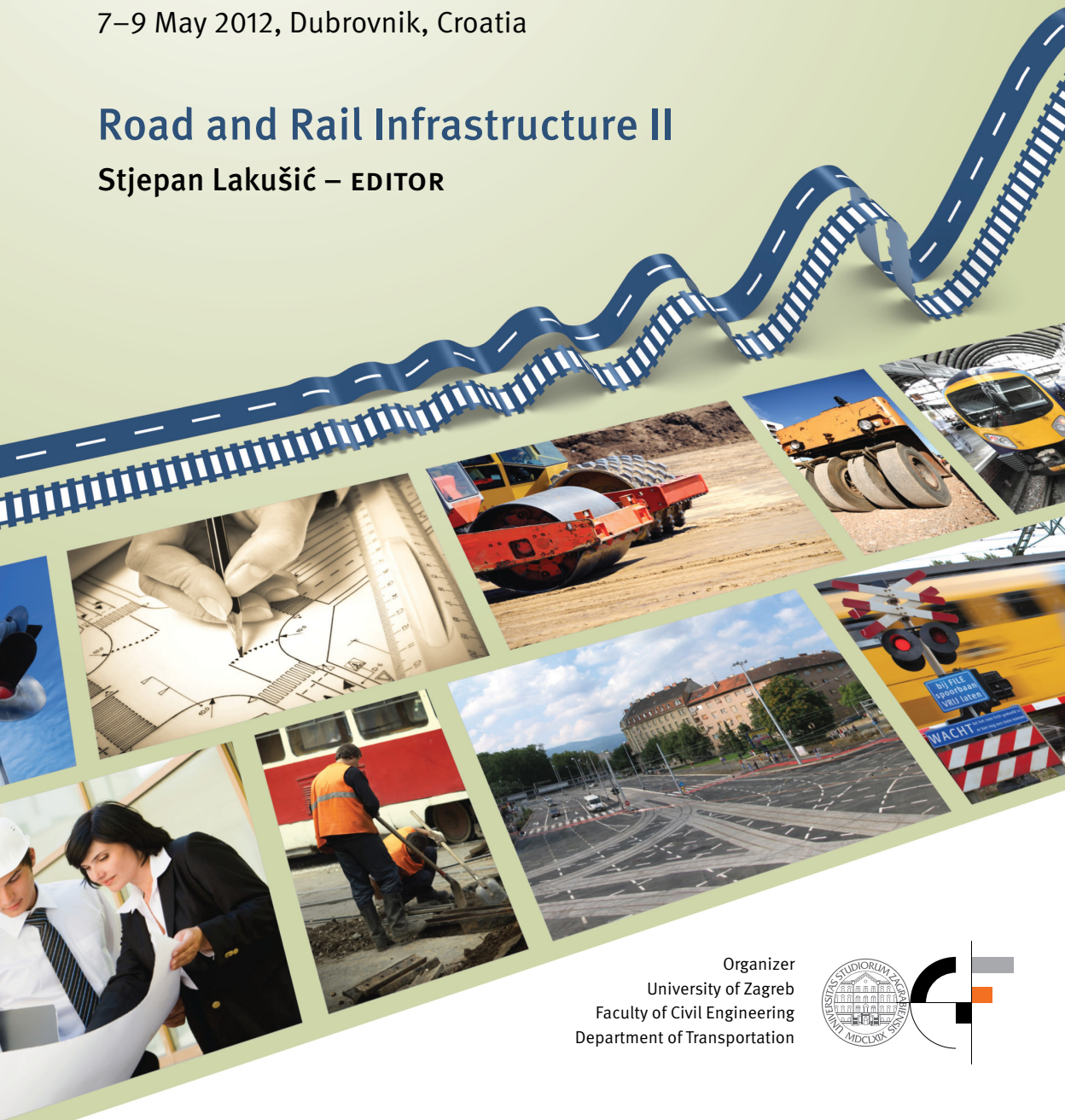
CETRA 2012

2nd International Conference on Road and Rail Infrastructure
7–9 May 2012, Dubrovnik, Croatia

Road and Rail Infrastructure II

Stjepan Lakušić – EDITOR



Organizer
University of Zagreb
Faculty of Civil Engineering
Department of Transportation

CETRA2012
2nd International Conference on Road and Rail Infrastructure
7–9 May 2012, Dubrovnik, Croatia

TITLE
Road and Rail Infrastructure II, Proceedings of the Conference CETRA 2012

EDITED BY
Stjepan Lakušić

ISBN
978-953-6272-50-1

PUBLISHED BY
Department of Transportation
Faculty of Civil Engineering
University of Zagreb
Kačićeva 26, 10000 Zagreb, Croatia

DESIGN, LAYOUT & COVER PAGE
minimum d.o.o.
Katarina Zlatec · Matej Korlaet

COPIES
600

A CIP catalogue record for this e–book is available from the National and University Library in Zagreb under 805372

Proceedings of the
2nd International Conference on Road and Rail Infrastructures – CETRA 2012
7–9 May 2012, Dubrovnik, Croatia

Road and Rail Infrastructure II

EDITOR
Stjepan Lakušić
Department of Transportation
Faculty of Civil Engineering
University of Zagreb
Zagreb, Croatia

CETRA 2012
2nd International Conference on Road and Rail Infrastructure
7–9 May 2012, Dubrovnik, Croatia

ORGANISATION

CHAIRMEN

Prof. Željko Korlaet, University of Zagreb, Faculty of Civil Engineering
Prof. Stjepan Lakušić, University of Zagreb, Faculty of Civil Engineering

ORGANIZING COMMITTEE

Prof. Stjepan Lakušić
Prof. Željko Korlaet
Prof. Vesna Dragčević
Prof. Tatjana Rukavina
Maja Ahac
Ivo Haladin
Saša Ahac
Ivica Stančerić
Josipa Domitrović

All members of CETRA 2012 Conference Organizing Committee are professors and assistants of the Department of Transportation, Faculty of Civil Engineering at University of Zagreb.

INTERNATIONAL ACADEMIC SCIENTIFIC COMMITTEE

Prof. Ronald Blab, Vienna University of Technology, Austria
Prof. Vesna Dragčević, University of Zagreb, Croatia
Prof. Nenad Gucunski, Rutgers University, USA
Prof. Željko Korlaet, University of Zagreb, Croatia
Prof. Zoran Krakutovski, University Sts. Cyril and Methodius, Rep. of Macedonia
Prof. Stjepan Lakušić, University of Zagreb, Croatia
Prof. Dirk Lauwers, Ghent University, Belgium
Prof. Giovanni Longo, University of Trieste, Italy
Prof. Janusz Madejski, Silesian University of Technology, Poland
Prof. Jan Mandula, Technical University of Kosice, Slovakia
Prof. Nencho Nenov, University of Transport in Sofia, Bulgaria
Prof. Athanassios Nikolaides, Aristotle University of Thessaloniki, Greece
Prof. Otto Plašek, Brno University of Technology, Czech Republic
Prof. Christos Pyrgidis, Aristotle University of Thessaloniki, Greece
Prof. Carmen Racanel, Technical University of Bucharest, Romania
Prof. Stefano Ricci, University of Rome, Italy
Prof. Tatjana Rukavina, University of Zagreb, Croatia
Prof. Mirjana Tomičić–Torlaković, Univiversity of Belgrade, Serbia
Prof. Brigita Salaiova, Technical University of Kosice, Slovakia
Prof. Peter Veit, Graz University of Technology, Austria
Prof. Marijan Žura, University of Ljubljana, Slovenia

CETRA 2012 7–9 May 2012, Dubrovnik, Croatia
2nd International Conference on Road and Rail Infrastructure

BENEFITS OF A MANAGED ENVIRONMENT ON A LARGE INFRASTRUCTURE PROJECT

Silvano Paolo Gritti, Andrea Amante, Armando Manes
Società di Progetto Brebemi SpA, Italia

Abstract

The new Brescia–Bergamo–Milan Motorway Connection, commonly known as Brebemi, is the new toll motorway linking the city of Brescia with Milan. The overall project will provide the completion of the new 3 lane motorway in each direction, approx. 62 km long, along with new local roads and the renovation of existing roads in the length of 35 km or so. The route involves 43 municipalities and 5 provinces and the total cost of the work is 1.6 billion euros.
The Company has decided to implement a solution to manage all documentation, at any level, connected with the Project and has chosen Bentley ProjectWise as a solution which meets all the requirements. During its implementation, an appropriate environment has been created for every work area, the file management procedures have been published and the access profiles and approval cycles have been created.
Now all of the documentation of the final and executive plan (consisting of around 60,000 technical drawings in editable and PDF format) which has been drawn up by the various external design units located all over Italy, under the coordination of the General Contractor which will also be responsible for the construction of the motorway, exist on a centralised server at the Brescia office. All procedure and authorisation documents for the project are also filed, as well as all correspondence.
The main benefits of implementing a managed environment solution include time saving in communication, controlled and accessible presentation of design and procedure documents, better standardisation of drawings and texts and the definition and implementation of linear workflows and verification.

Keywords: managed environment, Bentley ProjectWise, project design

1 Introduction

The construction of a motorway infrastructure necessarily involves the execution of many complex activities (planning, design, construction, inspection, approval and management), in which many stakeholders are involved (Grantor, Concessionaire, General Contractor, Design Teams, Public and Private Institutions, Surveillance Authorities, etc..) disseminated throughout the country, thus creating a large number of interactions and relationships which materialize in the drafting of documents in various forms (project drawings, reports, inquiries, authorizations, ordinary correspondence, etc); the number of documents can be in the range of hundreds of thousands.
Brebemi SpA, which holds the concession for the design, implementation and management of the new motorway to be built between the cities of Brescia and Milan, has addressed this issue by identifying the need to equip itself with adequate software tools enabling the effective management of all the produced documentation: Bentley ProjectWise is the software product the Company has decided to use.

2 How Brebemi fits in the infrastructural framework of Lombardy

Infrastructures and mobility management are certainly a priority for Lombardy. In this context, the new Brescia–Bergamo–Milano motorway link, known as Brebemi, is a response to the many needs of the Lombardy population, with the goal of freeing the existing road network and motorway corridor Milan–Bergamo–Brescia from traffic congestions. The new link will allow fast and safe travels on a road system that is fully integrated into the new Lombardy infrastructural system, decongesting the existing road network and the motorway corridor Milan–Bergamo–Brescia.
Brebemi will be able to attract a significant portion of the long-distance traffic that currently uses the A4, most of the short–medium distance traffic, and particularly trucks and commercial vehicles, which now congest ordinary roads all around small towns of the plain stretching between Bergamo and Brescia. Traffic forecasts show that the new motorway will be used, on average along the entire axis, by daily traffic flows of 40,000 vehicles in the first months, and by 60,000 vehicles when the motorway will be fully operational. The increased motorway capacity will free local road networks, avoiding congestions and inefficiencies. The opening to traffic of Brebemi will allow local governments to apply policies in order to control and reduce access to urban centres, especially trucks, with benefits in terms of reduced air pollution and noise, and improved quality of life for residents. The total cost of the Brebemi project is 1.6 billion euros without contributions from the Central Government. The entire budget will be financed exclusively with funds of the licensed company and by resorting to borrowing. Thus this motorway becomes an innovative project, also from a financial standpoint. Brebemi is the first Italian motorway entirely funded through the use of project finance, and it is one of the most important and complex operations currently being developed in Europe.

3 Brief description of the Project

The overall project envisages the construction of a new dual carriageway, 3 lanes each, about 62 km long; its path runs through the heart of the Pianura Padana, in the Lombardy Region, encompassing 43 municipalities and 5 provinces; along its axis there are 2 toll barriers and 6 toll stations, the main engineering works are the viaducts on Oglio (690 m), Serio (930 m) and Adda (1260 m) rivers, and the Treviglio artificial tunnel (465m in groundwater). Four service areas, a maintenance centre and an operations centre, all facilities required for management and user services, will be built along its length. The motorway will be built according to high level manufacturing standards, with equipment designed to improve users' safety and to increase the performances of individual components in order to reduce maintenance interventions during operation, with consequent reduction of road works and increased motorway safety.
Besides the construction of the motorway, the project includes 17.5 km of road connections to improve access to the cities of Brescia and Milan, and 17 km of road network to improve the local road network in the vicinity of the motorway. A general overview of the operation is shown in Figure 1.

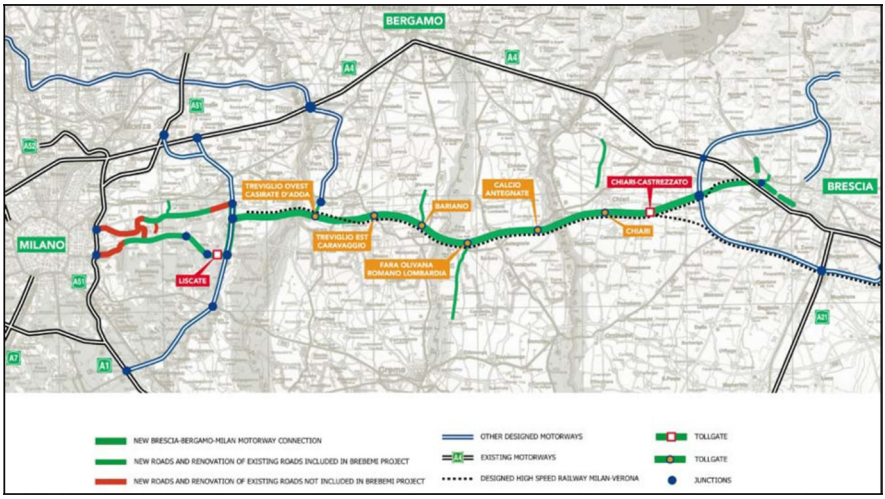


Figure 1 Brebemi highway within the Lombardy infrastructural system

Stakeholders of the project are:

- GRANTOR AGENCY: Concessioni Autostradali Lombarde SpA - CAL SpA;
- CONCESSIONAIRE: Società di Progetto Brebemi SpA, controlled by AUTOSTRADE LOMBARDE SpA;
- GENERAL CONTRACTOR: Consorzio BBM, composed of Pizzarotti SpA and CCC (Consorzio Cooperatice Costruzioni) construction companies;
- WORKS MANAGEMENT: Pegaso Ingegneria.;
- HIGH SURVEILLANCE OF CONCESSIONAIRE: Metro Engineering. (Company owned 100% by Metropolitana Milanese Spa);

Works began on July 22nd 2009 on the site of the Oglio viaduct; on January 31st 2012 the overall progress of works is at 33%, while the most complex works, Oglio, Serio and Adda viaducts are respectively at 95%, 50% and 52% completion.

4 Brebemi & Bentley ProjectWise

From the early stages of the project development, the Company has aimed at the implementation of a system capable of handling all documentation (design documents, reports, permits, construction documents, correspondence, meeting minutes of all companies of the group) in an electronic form, based in its office in Brescia. Through a local network or via Web, the system must be able to uniquely identify the current version of each document, as well as its history, including all the obligations arising under the Convention granted to the Company. All accesses must be fully controlled and tracked.

As of today, environments necessary to support all activities required to create such a large road work were created in ProjectWise; in the design phase the system handles all files related to the final project, its changes during the construction phase, and all the detailed designs (necessary for the development of special and unique elements, such as the individual segments of the 3 viaducts) in addition to the As Built drawings. Records related to expropriation of land property, management and resolution of technological interferences that had to be removed are handled and stored in ProjectWise. And, last but not least, all documents recording sites operations are processed in ProjectWise: these documents include quality management, financial reports, reporting on the progress of construction, materials for the Commission of Inspection. All uploading procedures and approval processes are standar-

dized and shared with all the parties involved at all levels of the project, from technicians working on site to the Public Authorities represented by the Grantor.
Each environment is characterized by a proper and specific data storage facility, by a specific approval cycle associated to documents, by an encoding scheme based on 32 digits which takes on different values and meanings in each environment, and by a specific access rights matrix permitting access to users' files, divided in groups.

5 Description of products & services

The system architecture includes a centralized server at the Brescia offices.
The following ProjectWise modules are installed on the server: Integration Server, the heart of the system's organization, management and sharing of data, and the Web Server for Web access.
Users access documents through the ProjectWise Explorer client, which allows access via a local Internet connection and, thanks to the Gateway Services, via the Web, or through Internet Explorer that, at first login, automatically uploads a plug-in for ProjectWise access.
External users connecting from their offices or from remote sites, can also access the system through a gateway which handles communications to the DMZ2 network within which the ProjectWise server is protected by firewalls.
Brebemi's internal users access ProjectWise directly, without going through the gateway, but always through the firewall.
External access through the Internet, is supported by a bidirectional balanced communication line at 30Mbit/s (Fiber Channel line with 4 MBit/s SHDSL backup line).
The ProjectWise system is equipped with a synchronization mechanism, named Delta File Transfer, which permits to avoid the transfer of files on the network when the local copies and the centralized copies of the documents are aligned. Thanks to this mechanism, the average demand of communication bandwidth is relatively limited when compared to the number of users and to the size of the managed documents.

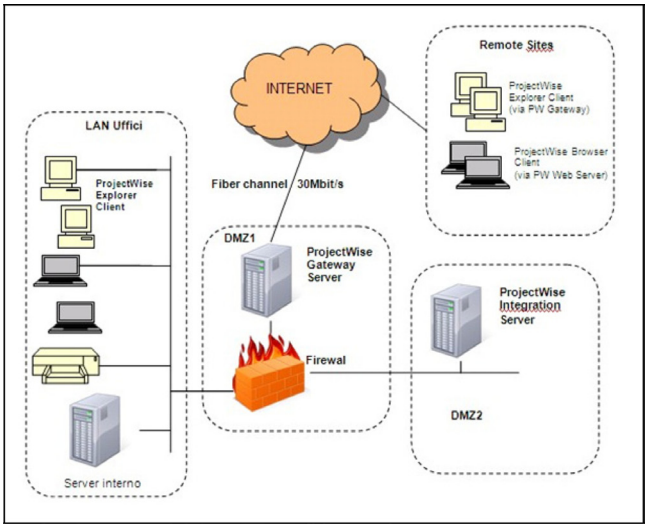


Figure 2 Graphic diagram of hardware configuration

6 Management of final design files

The final design of the new motorway link was the responsibility of BBM Consortium under a General Contractor contract of entrustment: numerous engineering companies disseminated throughout the country have contributed to the final design, all under the coordination of the BBM Consortium technical direction. The design, as a whole, includes about 1,000 engineering works, with a total of 25,000 documents: drawings, reports and spreadsheets.
The procedure to control each contractual document is governed by regulations, and it is implemented by the stakeholders of the project through a status change workflow for each document: each project document is generated by the designer in charge, approved by the Concessionaire through the Surveillance Authority, and approved by the Grantor; the final approval of the Construction Site Director validates the documents for construction, which are directly accessible from the local branches of operating sites.

6.1 Archive Structure

Drawings related to the final design are created by designers, directly in ProjectWise from their workstations; the entire motorway has been divided into lots and each lot into works. The archive structure replicates the WBS hierarchy.

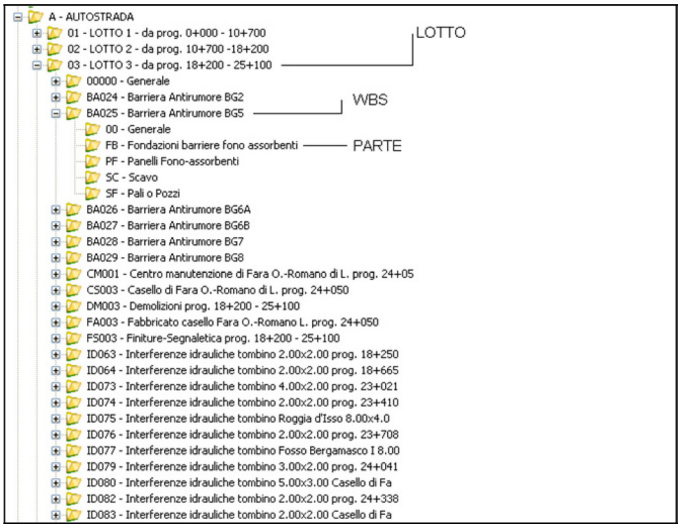


Figure 3 Final Design environment structure

6.2 Coding Scheme for the Final Design

The ProjectWise coding system automatically assigns many of the 32 digit fields of the document code, according to where the document is created in the archive, so that the designer must only define the type of document he is creating by checking the appropriate code from a drop down list, while the remaining fields are automatically assigned. The code of a final design document can have the following values and meanings:

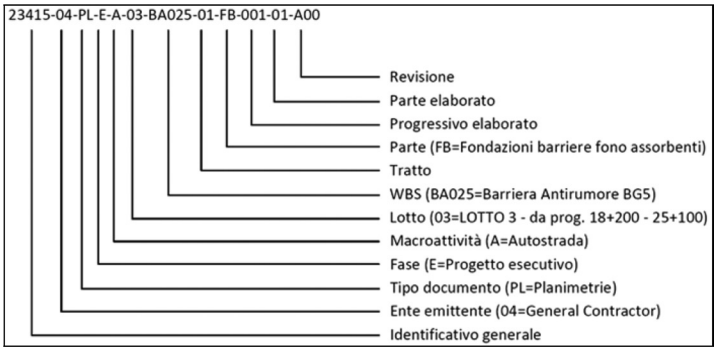


Figure 4 Coding convention for the final design

Besides the fields that make up the code, further attributes that the designer must enter when creating the document have been defined, for example the lines of the descriptive title of the document. These attributes, along with the code, are automatically written into the title block of drawings, thanks to the ProjectWise functionality which allows the linking of the ProjectWise attributes and the CAD title blocks fields.

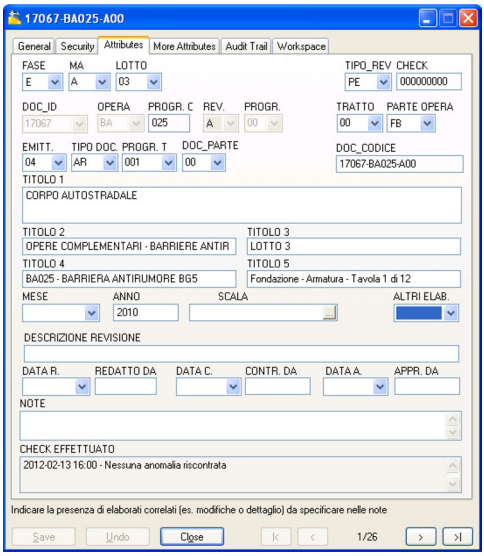


Figure 5 Entry template for attributes

6.3 Workflow and status changes

The approval workflow of documents occurs in two distinct environments which have the same file structure as previously seen. The first, called the editable environment, contains the documents in native editable format on which the first stage of the approval process is executed. The second, called the non editable environment, contains documents in PDF format on which the second stage of the approval process is executed.
In ProjectWise, access rights to documents vary according to the status that the document takes on during its approval process, so you can make sure that people who must approve the documents receive access rights only when such documents have been submitted. Con-

versely, the person who submits a document for approval, at the time of submission looses the rights to modify the document.
Until a document is in the 'in progress' status, only the Project Manager may perform a status change. When the Project Manager moves the document into the 'DA APPROVARE SDP – TO BE APPROVE BY SDP' status, he and the designers have a read-only access to the document, so that designers can no longer modify the document waiting for approval.
In this way, ProjectWise guarantees that status changes are performed only by the proper persons at the proper time.

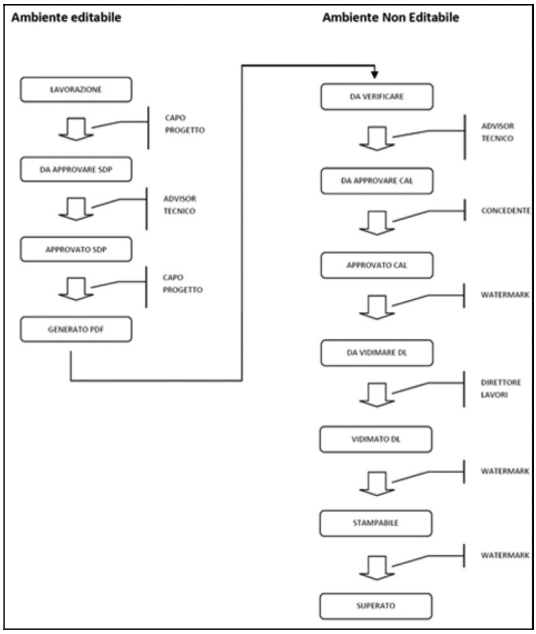


Figure 6 Approval workflow of the final design

The first part of the workflow involves the designers and the Concessionaire in an editable environment, to allow all the required modifications to the project before freezing it up and transferring it to the non editable pdf version in the non editable environment where the Grantor and the Construction Site DIrector approve and endorse the documents. Then an automatic ProjectWise procedure stamps them.
More specifically, the designer must prepare the documents in the Final Design folders using editable files and by exclusively using the following formats:

1 Drawings in DWG format;
2 X-REF file associated with drawings;
3 DOC format files.

Once a single document is complete, the design coordinator moves the document to the 'DA APPROVARE SDP - TO BE APPROVED BY SDP' status, and ProjectWise makes the document visible and ready to be checked by the High Surveillance of the Concessionarie; this status change involves the loss of designer's rights to modify the contents of the file; following all necessary checks, the Concessionaire places the document in the workflow to the APPROVATO SDP - APPROVED SDP status, and allows the High Surveillance to be in control of the document. At this point the document is frozen and transferred in the pdf format, by the designer, into the not editable environment (status GENERATED PDF); control passes on to the second part of the

approval workflow; the continuous automatic alignment of the two environments allows the transfer of the attributes (necessary for all selection and research operations) of the editable file to a non-editable file. High Surveillance verifies correspondence between the approved editable and the non editable pdf copy, and, after approval (status DA APPROVARE CAL - TO BE APPROVED BY CAL) submits the document to the Grantor by moving the document to the next status (APPROVATO CAL - APPROVED BY CAL); at this point the document is endorsed by the Director of Works and made visible to the site (status STAMPABILE - PRINTABLE).
Each status change requires the affixing of a watermark on the pdf file which records the status of the file; the stamping operation is made by a tool specifically developed by Bentley according to Brebemi's specifications.

Figure 7 Example of an approved document with watermarks

The release of a possible review of a document, as a result of a change to the project, involves the switching of the obsolete files to SUPERATO - OBSOLETE status, with automatic stamping of a well visible graphic warning on the title block of the drawing.

6.4 Use of Flat Set

The flat-Set ProjectWise tool has been conveniently used to notify documents to be approved by the various parties involved. Given the overall size of the project and the operational needs of the sites, documents approval was carried out by subdividing the detailed design documents into lots, and this has resulted in the need for certain traceability of the documents submitted for approval in each lot; this problem has been solved by resorting to flat sets.
Flat sets are a sort of virtual folders containing dynamic links to individual documents, regardless of their position in the archive. The documents are directly accessible from the set. The dynamic links allow the user to display the documents of the sets and the related attributes, with the certainty that the user is accessing the current versions of documents and attributes.

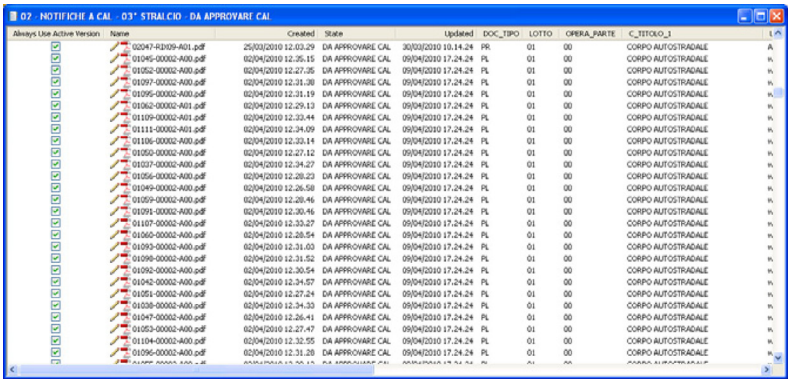


Figure 8 Example of FLAT SET

Flat sets are populated by 'drag and drop' functions and are stored in ProjectWise in a specific area reserved to notifications. Any individual approver can directly access documents in the sets, display their contents, change status, view and modify attributes, add comments, etc., during the approval phases.

7 Document management in the Construction Environment

Documents generated during the entire construction process are managed in ProjectWise. The site works documentation is uploaded into the ProjectWise Integration Server from the client workstations located in Brescia. The structure of the archive storing construction documents is organized by document type rather than by work; this is so because in the construction phase, control and approval workflows are divided into operational phases (e.g. quality documents, accounting documents, control and management documents, etc.).

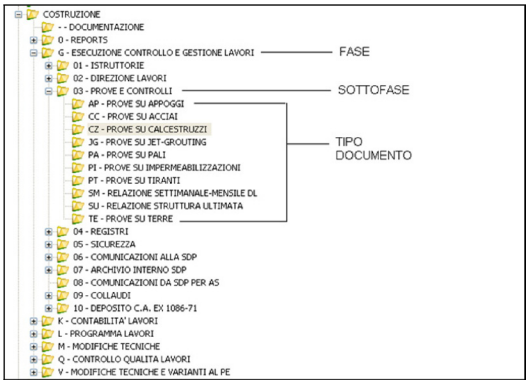


Figure 9 Construction Environmental Folders Structure

7.1 Coding Scheme for the Construction Environment

Documents encoding follow the same structure applied to the final design, breakdown of work. In this way it is possible to search construction documents by document type, by WBS, or by a combination of both. In this case, the structure of the 32-digit code follows the creation of logic shown hereunder.

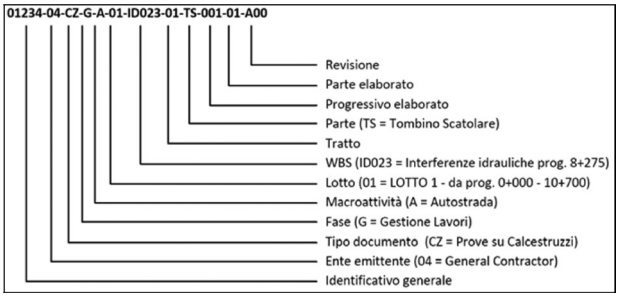


Figure 10 Documents coding scheme in the Construction Environment

7.2 Construction Environment Workflow

Documents approval workflow in the construction phase consists of three steps. When a document is uploaded into ProjectWise from site personnel, the status takes on the 'CARICATO – FILED' status. The Site Operations Manager, after checking it, can assign the 'DA APPROVARE AS - TO BE APPROVE BY AS' status. At this point the document is accessible by the Surveillance Authority who conducts due audits, approves the document and takes it to the 'APPROVATO AS – APPROVED AS' status. Finally, the Concessionaire orders the posting of the document by passing it to the 'FINAL' status and by making it visible to the concerned parties.

8 Benefits resulting from the adoption of ProjectWise

The decision to use a document management system is proving to be of utmost importance in a geographically dispersed and complex setting such as the one of the Brebemi project. These are some of main benefits which can be gained: time savings in communications among the various participants to the project; project and procedure document sharing and control; better "engineering" of the project itself in terms of graphic and text standardization; definition, implementation and generalized use of linear and shared workflows and testing procedures. Other benefits can be found in the openness of the system, which allows the data to be acquired from different environment; its configuration flexibility allows it to adapt to various data clusters and posting arising in the development of a complex project such as Brebemi. In summary, the use of ProjectWise has allowed to obtain a series of benefits, including:

- Centralize information to allow easy access by authorized users with appropriate security mechanisms;
- Structured and standardized information to simplify the performing of search, access, enquiry and rendition operations;
- Allow access from a single environment to all information in the company through an expandable modular technology;
- Provide the system administrator with flexible, customizable, adaptable tools to manage the specific information of a large and complex project;
- Provide users with a simple interface that allows to perform operations such as uploading, retrieval, consultation, modification, description and reporting of information in a familiar environment similar to Windows;
- Exploit full integration with Adobe PDF and CAD documents;
- Streamline the workflow during the entire project life cycle;
- Improve quality and efficiency in the management of static and dynamic project information;
- Increase data and company value, by implementing the chosen quality procedures;
- Trust the reliability and uniqueness of documents when converted form paper to electronic formats.