

Bergen, Norway
BNAM 2010
May 10-12

A new common tool to assess indoor noise from outdoor environmental noise sources

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During the last year a group consisting of *The Norwegian Public Roads Administration*, *Jernbaneverket*, *Avinor*, *The Norwegian Defence Estate Agency* and *The Climate and Pollution Agency* has joined forces to develop a new common data tool for management of indoor noise from road, railway and aircraft noise sources. The goal is to harmonize the processes of registering building conditions for improvement of sound insulation, and reporting for national statistics regarding noise exposure. A database system for noise in buildings is developed together with a computer application. This is intended to replace the existing tools *VSTØY* used for road traffic noise and *Støybygg* mainly used for aircraft and railroad traffic noise. The new tool is featured with full 1/3 octave spectrum capabilities and a spectral construction database from *SINTEF Building and Infrastructure*. From the start the tool is closely connected *Norstøy* which is a new national road traffic noise mapping system. Beside this, the tool will have import features adapted to other noise mapping tools like *NORTIM* and *Cadna A*. Even though the tool is developed for the major noise source owners and their consultants, it will be freely available to the public.

1 Introduction

In a modern society, controlling noise from outdoor sources has become an important issue. In Norway noise is the single environment parameter that causes the highest negative impact of the quality of life in the population. To deal with this problem, the government has issued several means. One of them is legislation that forces owners of the infrastructure to make sure that indoor noise levels in dwellings does not exceed certain limits. During the last few years this has lead to an extensive activity in the area of sound insulation improvements in buildings.

In order to ensure a certain quality throughout the variety of sound insulation projects, there has been a need for a computer system that can handle data acquisition, sound insulation computation and reporting. Several such systems have been developed and used in Norway the last decade.

The tool presented in this paper is intended to be a common tool for all involved infrastructure owners, their consultants and other experts. The main objective of the tool is to calculate indoor noise from outdoor sources, and at the same time be a database system for buildings and their sound insulation and noise situation.

The main challenge for a tool like this is to combine the span of requirements from many different user scenarios. More specifically, this will concern the span from *VSTØY* functionality to *Støybygg* features. Consequently the tool must be able to handle paramount operations and reports covering large geographical areas, and at the same time be able to give easy control of the details of specific building elements in the buildings.

This paper presents the fundamental data structure of this new tool and indicates its main features.

2 The Building Database

2.1 Data model

The new tool will include a database where the buildings are registered along with information on outdoor and indoor noise. The database is modeled according to the structure outlined in figure 1 below. This model is reflected through the entire application and its user interface. Thus it is important that any user of tool is acquainted with it.

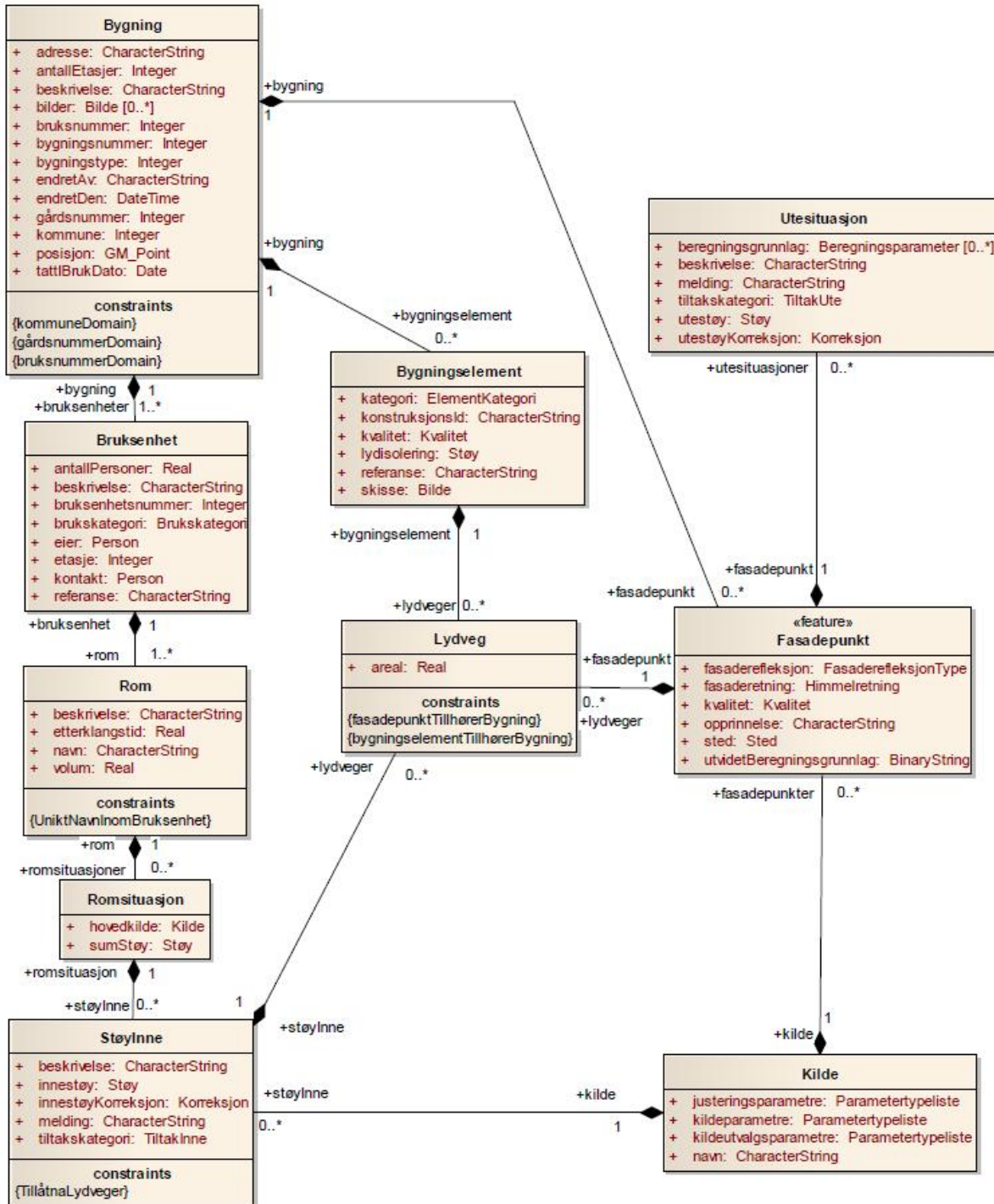


Figure 1: Conceptual Data Model for *Støybygg 3*

The basic structure of the data model can be described like this:

The database contains individual buildings (Bygning). Each building has one or more user units (Bruksenhet) with one or more rooms in. In each room the noise (StøyInne) is given separate for one or more situations (RomSituasjon). Each situation denotes a distinct alternative or scenario like “the existing condition”, “the condition after extra sound insulation” etc. On the outside of the building, the exterior noise is given for each of the present situations (UteSituasjon). The exterior noise is given separately at one or more geometric points (Fasadepunkt). At each situation, a link between the noise outside the building, and the rooms inside, is established by a number of sound transmission paths (Lydveg). Each path goes from a distinct outdoor point (Fasadepunkt) to one specific room, through a specific building element type (Bygningselement). The building element types are kept in a separate list (Bygningselement) for the building. Each type describes sound insulation characteristics for actual elements in the building. Beside this, the database structure will keep separate record on noise from different outdoor noise sources (Kilde) like road traffic, railroad traffic or aircraft traffic.

2.2 Implementation and use

The database structure is implemented in a relational database system from Oracle. For large organizations this can be integrated in their enterprise database solutions. For smaller user environments the tool may use the free product *Oracle Express Edition*.

The application is designed with a loose connection between the user interface and the database. This means that most user actions, like data editing or import from other sources, are kept outside the database. Communications with the database are consequently only done through separate *load* and *store* actions. Alternatively datasets can be stored in separate binary files outside the database, for temporary storage or data transfer between users. For one of the major users (*Norwegian Public Roads Administration*) this is utilized to let the database itself contain official data sets only, while temporary or experimental versions of the data sets are kept outside the main database.

3 Program Architecture

The new tool is implemented as a Windows application. It is composed of a number of internal modules as indicated by the yellow boxes in figure 2 below. Black arrows illustrate the dataflow between the internal modules and from / to external units.

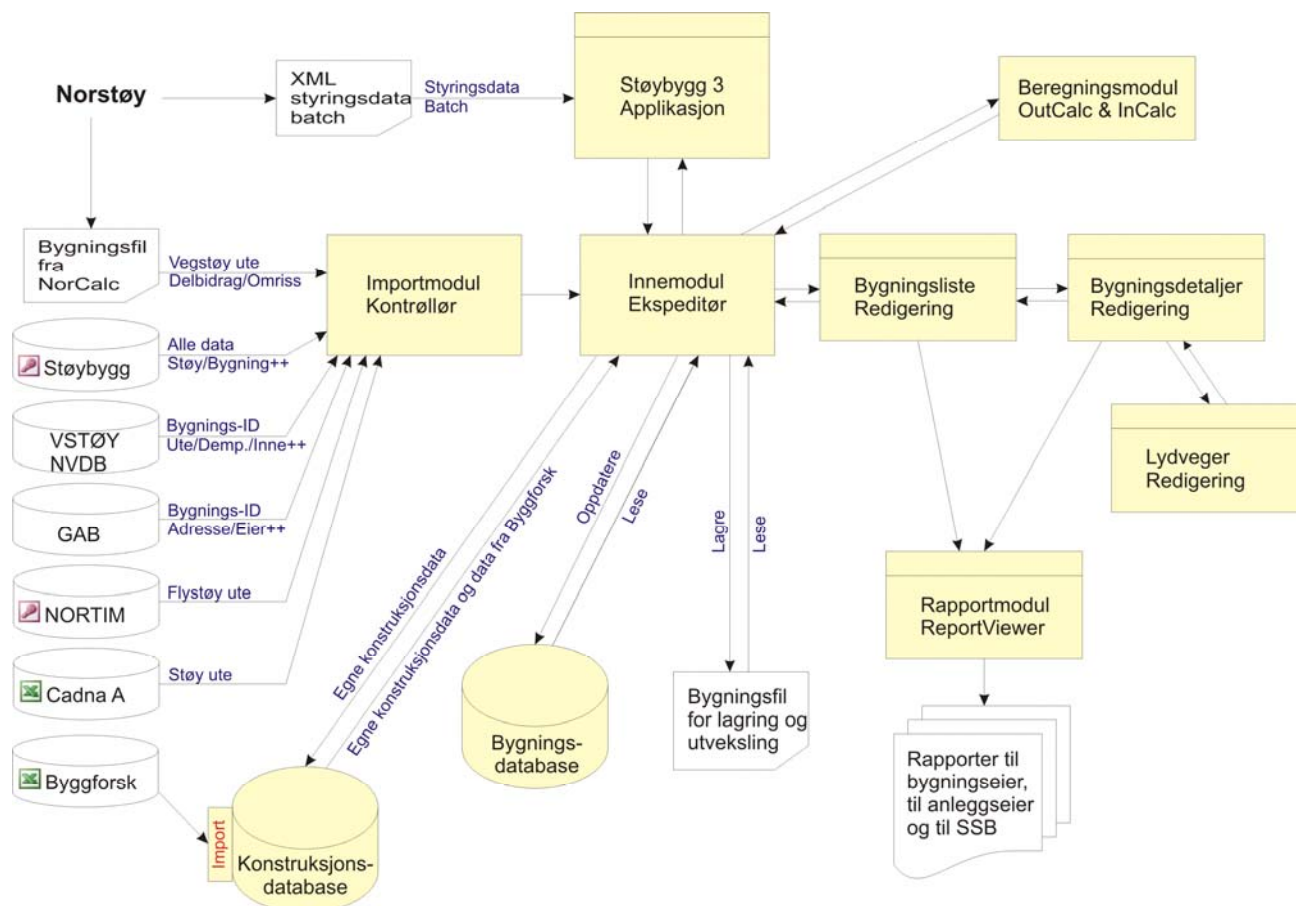


Figure 2: Architecture of *Støybygg 3*

The upper internal module of the tool (*Støybygg 3*) is the main application window. Its role is to provide ownership to the rest of the modules and provide a main Window frame with a few basic functions, to the user. The central core of the tool (*Innemodul*) is controlling and executing all the core functions of the module. This module can set up the underlying modules for user interfaces featuring a grid view for a list of buildings (*Bygningsliste*), a tabbed window for detailed building information (*Bygningsdetaljer*), and a separate window for details concerning sound characteristics of rooms and elements (*Lydveger*). From either of these windows the user can access a reporting tool to produce relevant reports.

The tool is equipped with a separate module for importing data (*Importmodul*) from external data sources. This may be sources of building information like *GAB*, existing building registers like *VSTØY* and *Støybygg 2*, and programs for outdoor noise, like *NORTIM*, *Cadna A* and *Norstøy*.

As far as *Norstøy* is concerned, the new tool is able to import comprehensive data (*Bygningsfil fra NorCalc*) that include partial contributions to the overall noise, and use it to recalculate alternative outdoor noise levels according to adjustments to road traffic parameters. The sound related calculations are done in a separate module (*Beregningsmodul*), which is able to recalculate outdoor noise (*OutCalc*), and calculate indoor noise (*InCalc*).

In addition to this, the application can run in an automated sequence mode, taking instructions from an external control file (XML styringsdata). By this mechanism the tool will provide powerful post processing functionality to Norstøy. The actions of recalculating outdoor noise, computing indoor noise, storing final results and producing reports, can all be run automatically from Norstøy.

The main database (Bygningsdatabase) is described in chapter 2 above. Beside this there will be a small construction database (Konstruksjonsdatabase) with space for sound insulation data for commonly used building constructions. This database is specific to the user of the tool. Data is copied from this into the main database according to user selections when setting up specific sound transmission paths (see chapter 2.1). The construction database will typically consist of 1/3 octave spectrum data prepared by *SINTEF Building and Infrastructure* (Byggforsk), together with similar data provided by the user.

4 Features

Based on the described data model and program architecture, the new tool is able to provide a large variety of functions and capabilities to the user. Here is a list of features that are expected to be of importance to most users.

- Acoustics
 - All outdoor data and insulation calculations are done in 1/3 octave bands (no more C-corrections)
 - Indoor noise is calculated in 1/3 octave bands
 - Statistics of maximum noise is calculated from actual traffic frequency and standard probability distributions
 - Building constructions are illustrated by sketches and graphical spectrum curves
 - Standard sound insulation data are supplied when construction information is missing
 - Summery noise is calculated from all present noise sources
- Scope and availability
 - Compliance to the requirements derived from national regulations (TEK, NS8175, Grenseverdiforskriften and T-1442) and international directives (EU).
 - Flexibility in definition of noise units, and towards future regulation changes
 - Compliance to requirements concerning national statistics and long term noise monitoring initiated by the government
 - Compatible with Støybygg and VSTØY
 - Freely available to anyone
- Variations
 - Unlimited number of noise situation alternatives for a building
 - Unlimited number of noise source types
 - Unlimited variation of noise measurement units
- Other
 - Buildings are identified according to the official register (GAB / Matrikkelen)
 - Space in database for pictures and maps
 - Flexible definition of reports on different detail levels

The new tool is expected to be available to the public by the end of 2010