Full Length Research Paper

Designing three dimensional property right database for Turkey

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Current cadastral systems are two dimensional. Therefore, three dimensional (3D) property rights and restrictions cannot be registered and their legal status not fixed in these systems. The need for 3D information is increasing day by day in vertical grown up cities. The cadastre, which was used for proposing land tax at the first time, is defined as the geographical information systems (GIS) used for modelling between human and land relationships; thus, the cadastre turns into multi-layer cadastre at the present time. Consequently, 3D cadastre should be examined in GIS and integrated with querying 3D right and at least property units in geospatial database should be restricted for modelling property rights and physical objects. By the reason of missing 3D topology, current information systems do not make 3D geospatial analysis perfectly. This paper aims that some 3D queries can be made in the created database. Conceptual and logical system design was implemented with unified modelling language (UML) by using Microsoft Visio 2003 software and data types which supported ESRI ArcGIS. On the other hand, 3D models were formed by using MicroStation V8 and ArcScene 9.0 softwares.

Key words: Three dimensional (3D) cadastre, object oriented database designing, geographical information systems, spatial modeling.

INTRODUCTION

Land and land-related problems, which begin with the birth of a human and continue to be part of his life to the end, will have a growing importance in the centuries to come. One of the most important factors behind this is the fact that land is a productive tool which itself cannot be produced and the fact that it has turned into a scarce resource owing to mal-utilization.

Land, vital for human life, takes on an important role in the field of economics since it is a dependable investment asset; besides, because of the intensive land use due to the rapid increase in human population in the latter half of the 20th century, concepts such as "land management" and "land administration", defined as a process of determining, recording and publishing data relevant to its possession (ownership), value and usage, emerged. This

was pushed by new policies for sustainable development and by the implementation of these policies (Çağdaş and Gür, 2003).

Concepts of land management and land administration are included in Bathurst Declaration issued jointly by FIG (Fédération Internationale des Géomètres) and UN (United Nations) in 1999, and land is defined in that declaration as: "the surface of the Earth, the materials beneath, the air above and all things fixed to the soil" (Grant and Williamson, 1999; URL-1).

Such global developments led to the preparation of Cadastral 2014 project realized by FIG, with a view to defining what the future role of cadastre should be. The first Statement of Cadastre 2014 says: that the whole legal status of the land, including its public rights and restrictions, will be shown in Cadastre 2014 (Kaufmann and Steudler, 1998; URL-1).

The aforementioned declaration and reports touch the importance of land and land-related data, however, it

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does not mention three dimensional (3D) cadastre aspects clearly. For future cadastral systems, the need to record 3D data that exist in the real world gets increasingly more attention. While developments occur in the world, land management is viewed as an information system in the "Cadastre 2023 of the Future-Draft Report on the Cadastre of Turkey", published by Turkish Chamber of Survey and Cadastre Engineers (2003), and this information system encompasses the following four information systems (URL-2):

i. Cadastral information system
ii. Infrastructure information system
iii. Environmental information system
iv. Socio-economic information system

Taking global developments into account, this paper addresses some problems experienced when registering the third dimension of ownership in Turkey and proposes a three-dimensional property database which could help to solve these problems.

CADASTRE IN TURKEY

The current situation

The first cadastral survey in Turkey was initiated in 1912 during the Ottoman Empire; however, it came to a halt because of wars. The process was reinitiated in 1924 after the new republic was founded and several related laws came into force:

- "Cadastral Law" (no. 658, enacted in 1925)
- "Cadastre and Cadastral Survey Law" (no. 2613, enacted in 1934)
- "Land register Law" (no. 5602, enacted in 1950)
- Land Register Law (no. 509 in 1964 and upon its nullification in 1966 by the Supreme Court)
- Law no. 766

Currently, cadastral survey is carried out in accordance with "Cadastral Law no. 3402" and "Amendment to Cadastral Law no. 5304". In cadastral surveys carried out according to law no 658, ground floors and upper floors of plazas are shown separately on map sheets. In that respect, started in 1929 and completed in 1934, the map sheet on Figure 1 is a document that bears historical significance as regards the register of 3D ownership rights. To the right, an overview of the cadastral map (prepared on a scale of 1:500) is given, respectively, the first floor, basement, and the second floor are shown separately; and to the left is the ownership information related to these real estate assets.

However, such plans are not currently in usage. Instead, such buildings' boundaries on land are only measured and shown on cadastral maps and they are registered according to the clauses of Condominium Right Law.

3D property rights

According to Turkish Republic Constitution clause no. 35, property rights have been recognized, however, it has also been pointed out that some restrictions for public good can be imposed as well. Clause no. 718 of Turkish Civil Law defines the scope and limits of private property rights as follows: "Right of land includes the space over and the strata beneath the surface, to the extent that its usage is of use. Legal restrictions reserved, this ownership covers buildings, plants and resources" (URL-3).

According to Turkish legal system, superficies, conduits (flows or water rights), right of way and source are easement rights (annexed to land), whereas, using land and benefiting from it (usufruct rights) and residence rights/rights of habitation belong to the individual. Another item restricting individual exploitation of land is the right of hypothec, which is a right in kind. Since they are reliable for hypothec transactions, real estate assets are of interest to cadastre.

Apart from these, Condominium Ownership Law which was issued in order to solve the residential problems encountered by urban dwellers takes on the responsibility of solving the problem of multiple ownership of real estate.

Problems experienced in Turkish cadastral system

Cadastral survey in Turkey is carried out in accordance with Cadastral Law no. 3402. According to clause 16 of this law, real estate designated as public property but which are not privately ownable (such as roads, squares, bridges, the sea, lakes, rivers, etc.), are considered unregistered in Turkish Cadastral System. Problems as regards securing ownership rights which is the duty of cadastre under the terms of both the Constitution and the Civil Law arise when registering the real estate assets beneath, on or over unregistered land.

Rail transport systems, pedestrian underpasses and overpasses are being planned in order to overcome traffic problems, particularly in cities. Problems are encountered on pedestrian underpasses, overpasses and in underground arcades due to the third dimension (3D) of property right. As these passes and stations are generally beneath unregistered land, a cadastral transaction is not carried out in these assets.

Turkish cadastre is of a legal kind. According to the current law, the boundaries in the cadastral plan are considered as real boundaries and recognized as such by the state. The cadastral measurement methods employed previously are still being employed in this age
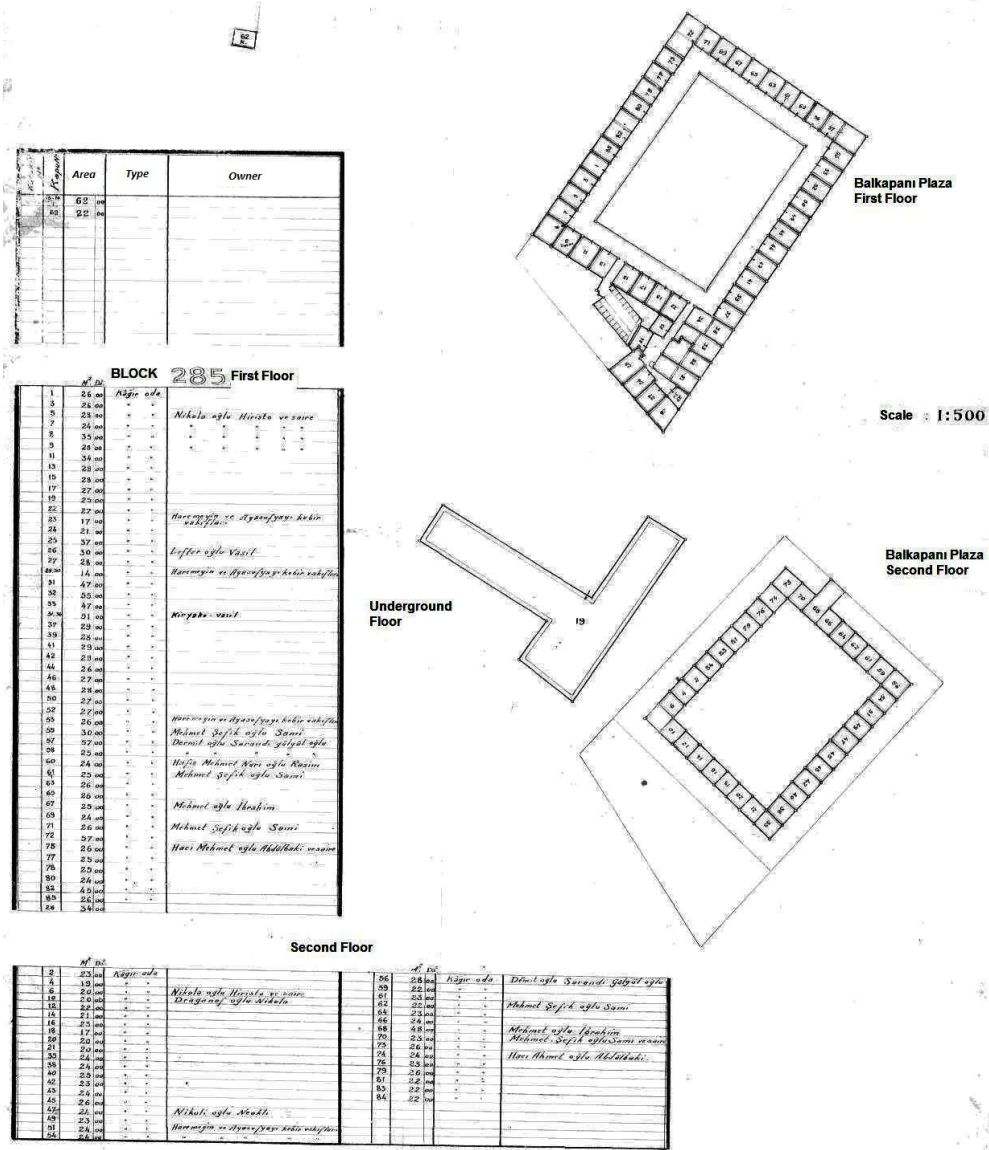
Figure 1. Balkapani Plaza upper floors (TKGM).

of technological advancements, and this leads to discrepancies between the measured values in the plat and the current values, which prevents modern expectations from being met.

Another issue of 3D property right is the technical infrastructure elements, an important component of urban planning. Since technical infrastructure elements are not considered to be real estate assets according to Civil Law, they cannot be registered and a technical infrastructure/underground lines cadastre is out of the question.

Yet, another issue of interest to 3D property right in Turkey is the assets registered according to Condominium Right Law. Since Condominium Right Law, issued in order to solve residential problems faced along

with the increase in migration from rural to urban areas, undertakes to solve multiple property right problems, it is of interest to 3D Cadastre.

3D PROPERTY DATABASE FOR TURKEY

Humans live in a given period of time in a world of 3 dimensional entities. The rapidly increasing human population in the latter half of the 20th century and the increased depletion of natural resources, as well as a need for 3D (4D) information about ownable and socially scarce (as a resource) land, led to the creation of a concept called 3D cadastre (defined by FIG as advanced land administration) (URL-1).
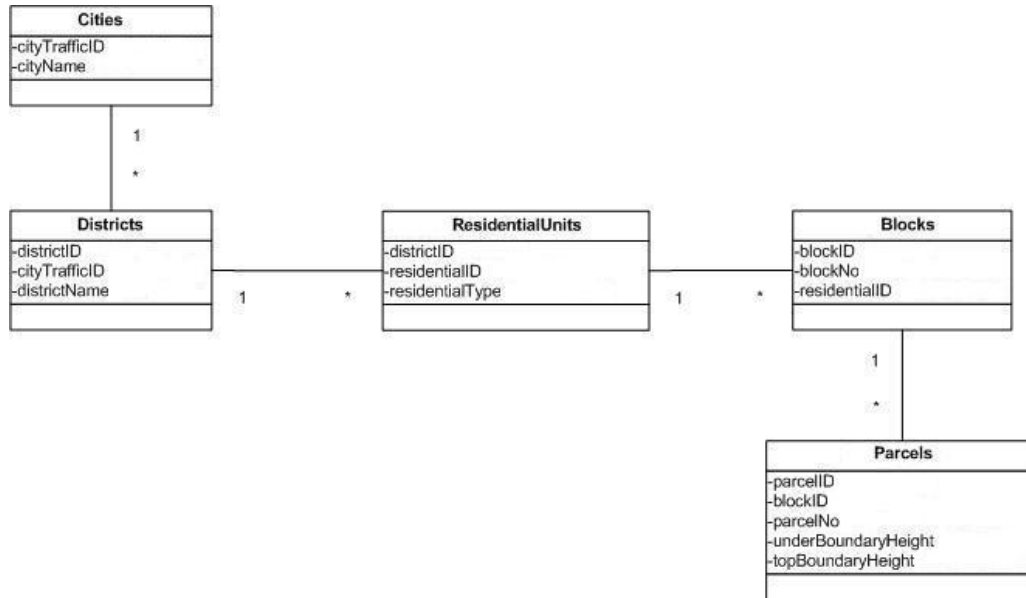
Figure 2. UML diagram belonging to cities, districts, and residential unit classes (Ayazli, 2006).

3D cadastral models, developed in order to solve problems created by 3D cadastre, can be analyzed under two classes as conceptual models and logical models. Three different models can be used in conceptual modelling (Stoter, 2004). These are:

i. Full 3D cadastre
ii. Hybrid cadastre
iii. 3D tags linked to parcels in current cadastral registration

What the data models related to 3D cadastre should be like is analyzed in the logical modelling. There are different approaches to the subject of data modelling. In Israel, Benhamu and Doytsher (2002) suggested Multilayer Data Management Model. In Holland, Stoter suggested an object relational model in order for 3D cadastre to be realized and her point of view being like that, she included the spatial data model and the management data model in her doctoral thesis (Stoter, 2004).

Under present conditions, hybrid cadastre is the most suitable solution for 3D cadastre and this study. Since the traditional 2D parcel will stay intact in this solution, the harmony between the prospective 3D system and the current systems will easily be there (Stoter, 2004). Therefore, the database model has been designed on a basis of hybrid cadastral method and object relational database. Accepted as the standard conceptual modelling language, unified modelling language (UML) has been used in the model.

The primary aim of the prepared model is not to establish a cadastral information system but rather, to create a 3D property database which makes it possible to inquire about some 3D matters and which also serves the aim of 3D cadastre.

Cities, districts, residential unit classes

Cadastral survey in Turkey is done on a residential unit level (ward). Therefore, the model works on a residential basis and relevant data is recorded on the system in accordance with this. (Figure 2)

Classes belonging to unregistered assets

In the current cadastral system, public polygon and public line classes are the classes in which unregistered assets like roads, parks, squares, etc., are included in the cadastral spatial database with 2D geometry and they are not related to parcels. UML diagram in Figure 3 shows classes related to unregistered assets.

Blocks, parcels and owner classes

Turkish cadastre is one that is based on residential districts and villages divided into parcels. Thus, this having been taken into account in the model, blocks, parcels and owner classes have been formed. Because the system has been designed in accordance with hybrid cadastral method, the traditional parcel has been preserved. Yet, elevation data included in urban plans are recorded on the system as maximum height attribute values and thus 3D right volumes are formed (Figure 4).
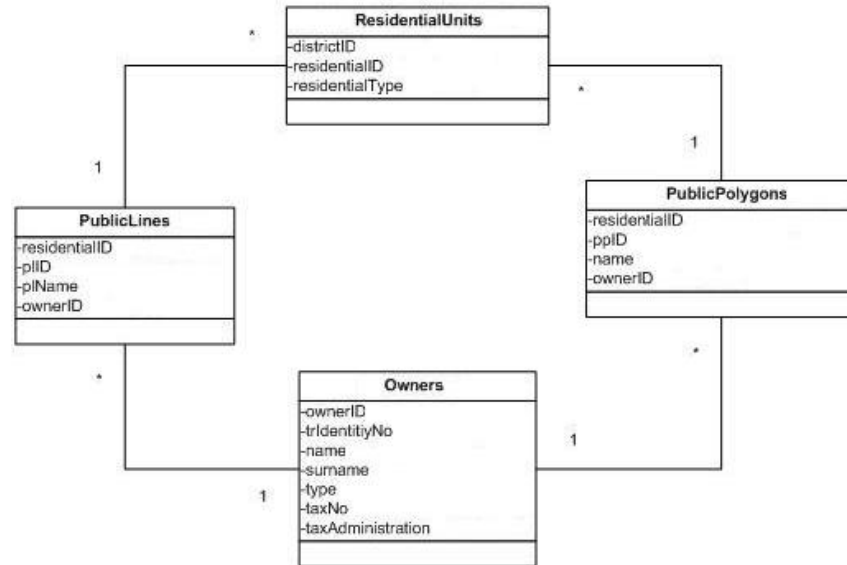
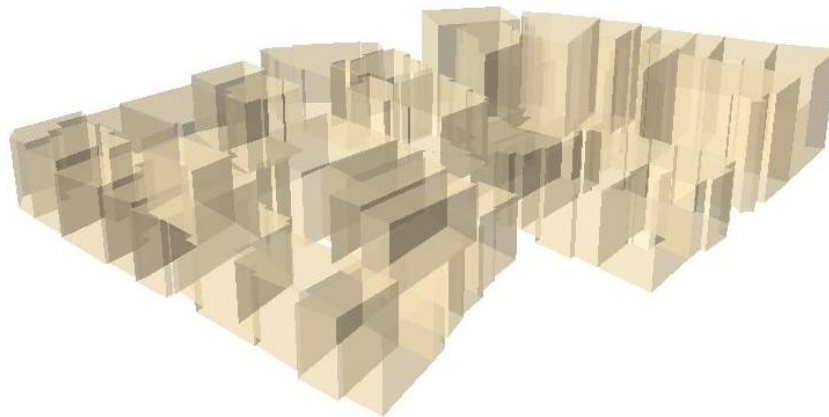**Figure 3.** Unregistered assets (Ayazli, 2006).

Figure 4. Representation of 3D rights (Ayazli, 2006).

Construction classes

These classes have been created in order to make it possible to inquire about the position of assets on, under or over the parcel. On-surface polygon class includes apartment blocks. Sub-surface class includes underground arcades. Construction underground line class includes technical infrastructure elements. On-surface line class includes right of way. On-surface point class includes electricity posts and alike. Rights and restrictions related to these can also be recorded in this procedure. This enables us to inquire about property rights and restrictions on the parcel in a 3D way (Figure 5).

In the current cadastral system, buildings are shown on cadastral maps according to the area they occupy on the ground, but floor plans of buildings and their independent sections cannot be registered on cadastre in this case. Assets like basement, staircase etc, accepted as common property according to Condominium Right Law require updated data particularly in the case of real estate evaluation transactions. Urban plans offer insufficient guarantee to real estate evaluation companies, and these companies seek government guarantee, employees say.

Therefore, base depth of buildings in the study has been calculated by using foundation plans provided by municipalities (Figure 6). Since technical infrastructure elements are not considered real estate in Turkey, their cadastre is out of the question. Besides, although standards about the underground positioning of technical infrastructure elements were formed in 1970s and 1980s by Turkish Standards Institute (TSE) and Infrastructure
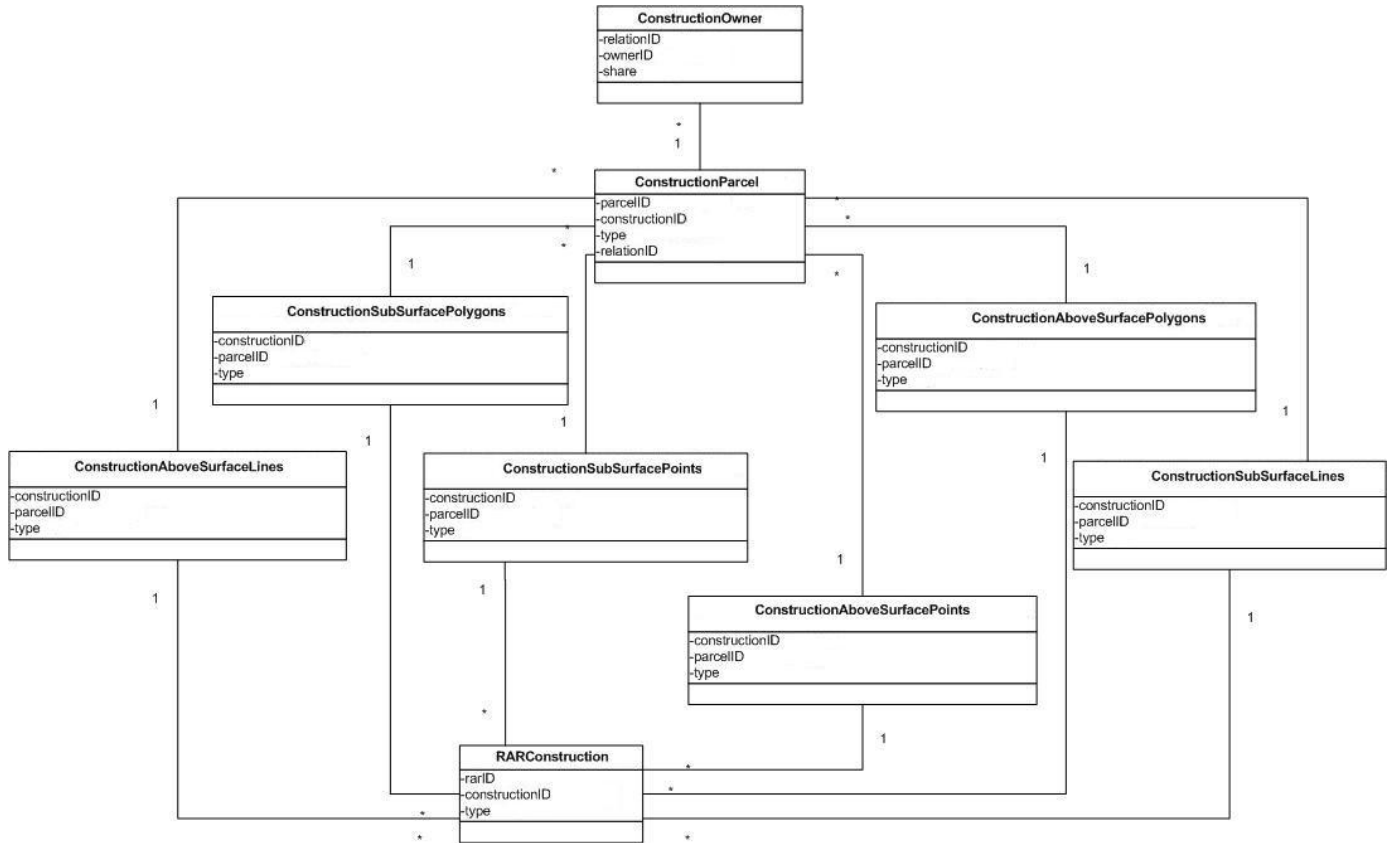
Figure 5. Construction classes (Ayazli, 2006).

Coordination Centre (AYKOME), organizations ignore these standards while preparing their projects and easement rights cannot be established on these parcels. This has led to an extremely complicated construction type underground. However, infrastructure departments in metropolitan cities (Istanbul Water and Sewage Administration, İstanbul Gas Distribution Company, etc.) have been trying to solve this problem at least partially by establishing their own geographical information systems.

Relevant regulations prepared by metropolitan municipalities define infrastructure elements as "drinking water and channel projects and electricity, gas, telephone, TV connection lines, tram lines and energy lines which are generally underground, as well as all roads and their coverings" (Metropolitan Municipalities Coordination Centres and Fund Regulations).

According to the aforementioned definition, each infrastructure element has been considered separately while creating the 3D property database.

Classes related to right and restrictions

The RAR class, short for Rights and Restrictions, includes the rights and restrictions on real estates. This lets us inquire about the rights of the individual on land and also the restrictions limiting the use of land for public good (easement rights) (Figure 7).

Dwelling unit class includes assets which are subject to private ownership and which are defined as independent section in Condominium Right Law.

RESULTS AND DISCUSSION

Advances in IT throughout the world lend even more significance to cadastral databases which encompass all types of spatial data for GIS based on parcels. 3D cadastre can only exist in geographical information systems (GIS) and it is responsible for the production, maintenance and preservation of data needed for the three dimensional cadastral geographical database as well as cadastral aims.

The designed database has been created with an aim to provide a solution to some problems encountered while registering the third dimension of property in Turkey and therefore, it is not in perfect unison with cadastral developments across the globe. Moreover, it is not to be expected to solve every problem experienced in cadastre in Turkey.
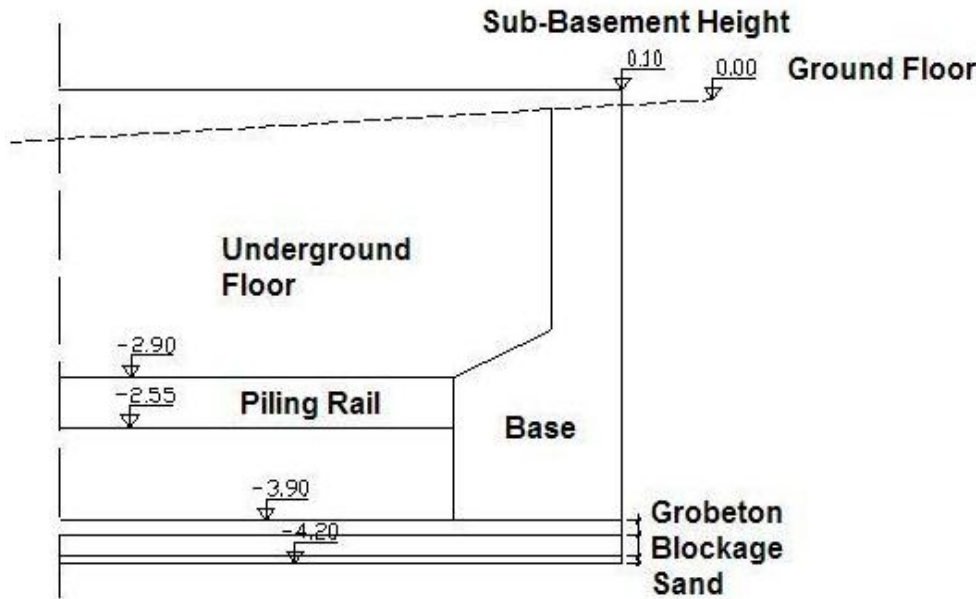
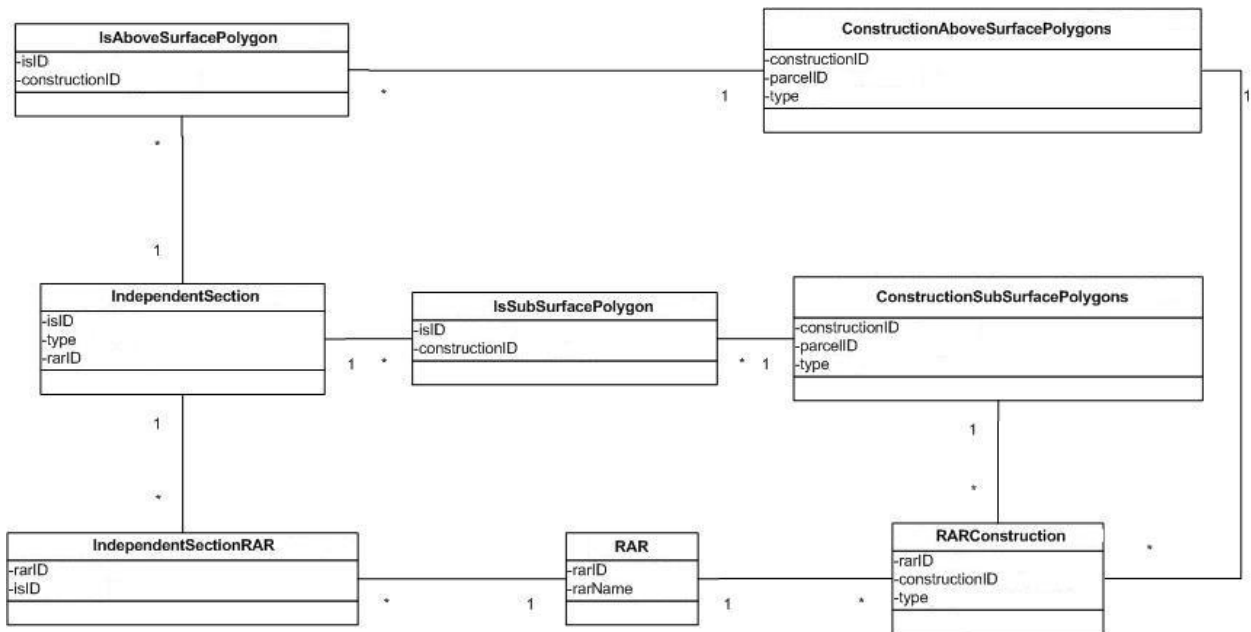**Figure 6.** Base depth calculation (Ayazli, 2006).

Figure 7. Rights and restrictions and independent sections (Ayazli, 2006).

Digital cadastre and Turkish Land Registry and Cadastre Information System (TAKBIS) are projects still underway in Turkey. Since these projects are unfinished, therefore, reaching reliable results is not considered possible; the compatibility of the created database with TAKBIS has not been tested yet. In addition to this, how much the system will contribute to National Spatial Data Infrastructure (NSDI) is not known because NSDI project has not been completed yet.

As elevation data is inadequate in Turkish Cadastral System, and as there are unregistered assets, the accuracy and reliability of data generated by the system is not to be expected to meet the accuracy requirements desired in cadastral projects. The prepared project is independent from the General Directorate of Land Registry and Cadastre (TKGM) and has not been

considered as a project. Therefore, the designed system is not (yet) legally binding and strictly speaking, it does not have a legal basis. On the other hand, the legal boundaries of two-dimensional parcels have been preserved in order to make it easier to incorporate the database into the current cadastral system and to prevent possible property problems created through data generated by the database. For this reason, the design has been made by implementing the hybrid cadastre method and 2D legal boundaries of current cadastral parcels have not been changed in the new system.

3D queries are supposed to be made via the created database because the mathematical basis for 3D topology has not been established yet. The formation of 3D right volumes on the parcel has been made possible by including the elevation values in plans. Thanks to this, property rights which have been unjustly gained through illegal construction will be revealed in the cadastral system and the state's dependability and responsibility related to real estate will be consolidated.

Roads, parks, etc., which are unregistered according to the cadastral law in effect, and technical infrastructure elements which are not considered real estate according to Civil Law, will be registered in the created database. In this way, cadastre will aim to offer a solution to planning problems encountered in public places, particularly in big cities.

Turkish cadastral system is not one that aims to collect taxes. With the novelty of inclusion of the tax numbers of the owners within the system, the system also serves tax-related work and aims to help overcome problems experienced in the taxation of real estate assets.

By calculating the base depth of buildings, it has been made possible to register the spaces defined as common property in Condominium Right Law. This particularly meets the demand for current geographical data related to real estate assets in insurance and real estate evaluation transactions and makes it possible to determine the trespasses -if there is any-, and meets the expectation of state's guarantee in transactions as well.

CONCLUSIONS

Because land is a non-manufacturable scarce social resource, despite the increase in world population, expectations from cadastre which will form a basis for all kinds of both rural and urban projects change through time and place new responsibilities on it.

First used historically in order to collect taxes, cadastre is presently turning into a type of land administration with new global developments. For a sustained development to be realized, all data related to the utilization of land need to be registered. It is this role that land administration takes on.

Hybrid cadastre conceptual model is the most appropriate solution for 3D cadastre under present conditions. Since the traditional 2D parcel will stay intact in this solution, the harmony between the prospective 3D system and the current systems will easily be there.

For an efficiently operating 3D cadastral system, countries first need to establish a sound 2D cadastral system lest, 3D cadastre, which inherently has some legal and technical problems, should have problems related to two dimensional circumstances and fail.

Under present conditions, the establishment of a 3D cadastre in Turkey is not of top priority. However, even if its establishment may seem like a dream for the time being, the required cadastral projects and reforms should start urgently in order to be able to survive in a globalizing world and to keep pace with developments throughout the world. NSDI should be immediately completed and incorporated into TAKBIS project should immediately be completed and put in practice.

Deadlocks in the system need to be removed through new legislation in harmony with the legal structure of Turkish cadastral system; a second cadastral survey should immediately begin and be completed quickly. Only by means of a cadastral system in which ownership rights are accurately designed and guaranteed can prosperity be achieved.

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