

Seismic issues

The joint project of the “Tevfik Seno Arda High School” building

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Helsinki, 12th November 2009

Contents

- Turkish Constructional Steelwork Association-TUCSA
- Recent earthquakes in Turkey
- Tevfik Seno Arda High School

Background

Architectural concept

Structural system

Structural details

Facades

Construction phase

Completion of construction and Today

- International Symposium

STEEL STRUCTURES: CULTURE & SUSTAINABILITY 2010

Turkish Constructional Steelwork Association (TUCSA)



- TUCSA was formed in 1992 as an IPO to promote use of steel in construction and is a member to ECES since then.
- Association has members from the sector in four groups:
 - I. Steelwork Contractors
 - II. Academicians, Designers, Consultants, Inspectors
 - III. Steel Producers and suppliers
 - IV. Complementary Manufacturers

TUCSA Activities

- Publications
- Steel Day
- Fairs
- Education Programs
- Student Programs
- Competitions and Awards
- TUCSAmak Certification Program



Steel Day

Every Year in Autumn



- Presentation of realised projects
- Special topics by invited speakers
- Exhibition of products and services
- Social activities

Fairs

Every Year in May



Showcase for the steel sector



Members participate together in International Turkey Build Fair within a seperate haul.



Education Programs

- Educational Seminars and Workshops

In collaboration with Universities or Chamber of Architects or CE in different cities

- Promotional Seminars

Introductory information on steel buildings (one day events) in different cities in various parts of Turkey in collaboration with chambers of Architects or CE.

- EU Projects



Every Year



Each team consists of at least one student from civil engineering and one student from architecture departments of the universities. International participation was also encouraged in 2006.

Student Tours



Visits to sites and factories are organised for student groups at least four times a year.

ECCS Design Awards

Every Odd Year



Steel competition is organised in Turkey in order to select the project to be candidate for ECCS Design Awards.

TUCSAmark Certification Program

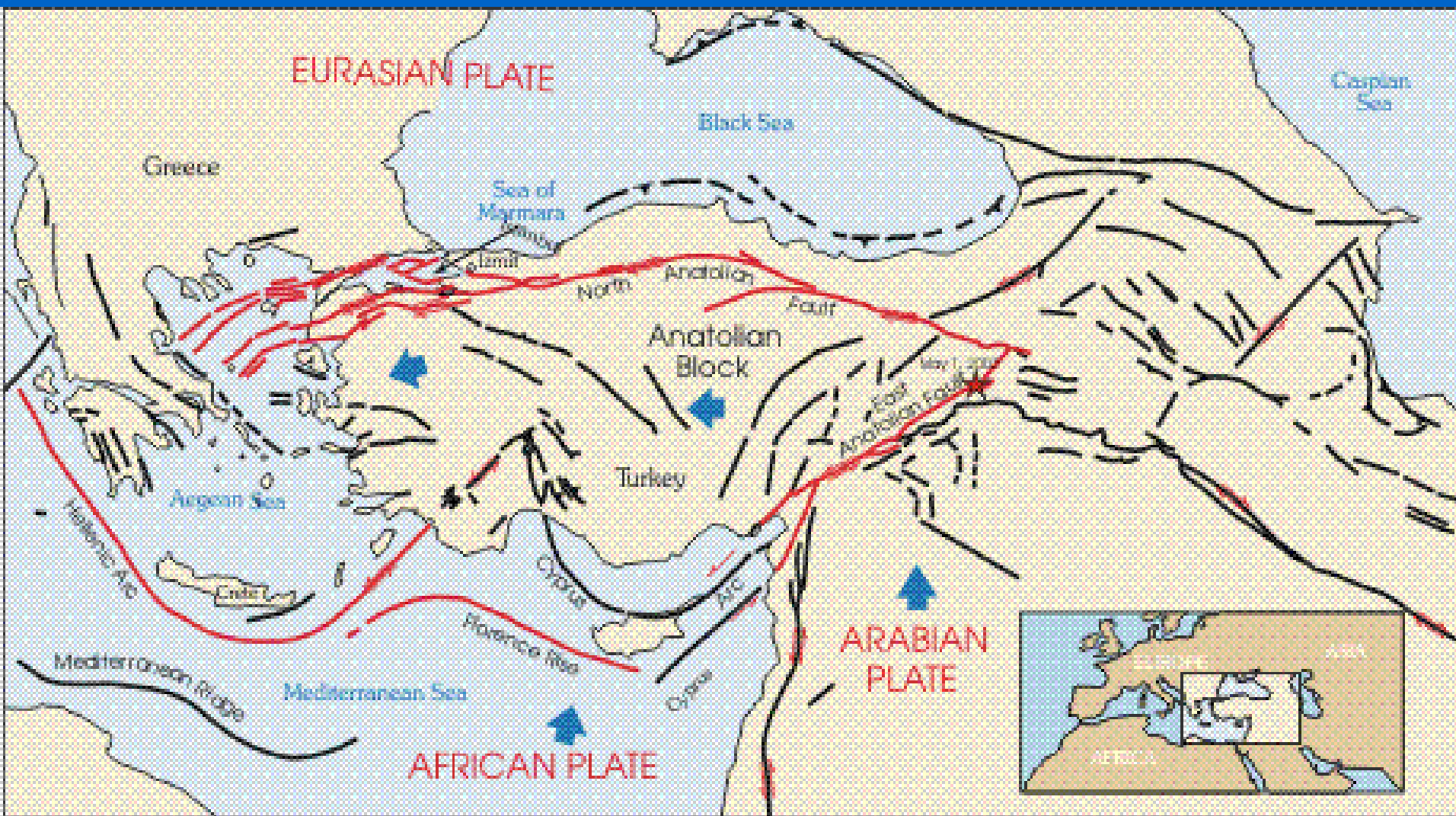
Certification program for TUCSA members

- Classification, Evaluation and Certification
- Classification by
 - Activity type and field
 - Contractors
 - Designers
 - Producers
 - Building materials and services producers or suppliers
 - Capacity and financial strength
 - Quality Systems
- Evaluation
 - TUCSA Technical Committee
 - Bureau Veritas
- Certification



Recent Earthquakes in Turkey

Turkey is a tectonically active region that experiences frequent destructive earthquakes. A large piece of continental crust almost the size of Turkey (the Anatolian block), is being squeezed to the west. The block is bound to the north by the North Anatolian Fault and to the south-east by the East Anatolian fault. The North Anatolian fault system is one of the most studied and best-understood fault systems. The faulting in the region is very complicated and extensive.



(<http://www.koeri.boun.edu.tr>)

No	Date	Local Time	Location	Intensity	Magnitude	Causality	Damaged Buildings
1	13.03.1992	19:08	ERZİNCAN	VIII	6.8	653	8057
2	01.10.1995	17:57	Dinar (AFYON)	VIII	6.1	90	14156
3	27.06.1998	16:55	Ceyhan (ADANA)	VIII	6.2	146	31463
4	17.08.1999	03:01	Gölcük (KOCAELİ)	X	7.8	17480	73342
5	12.11.1999	18:57	DÜZCE	IX	7.5	763	35519
6	06.06.2000	05:41	Orta (ÇANKIRI)	VII	6.1	1	1766
7	03.02.2002	09:11	Sultandağı (AFYON)	VII	6.0	43	2598
8	27.01.2003	08:26	Pülümür (TUNCELİ)	VII	6.0	1	24
9	10.04.2003	03:40	Urla (İZMİR)	VII	5.6	-	87
10	01.05.2003	03:27	BİNGÖL	VIII	6.4	168	2874

Gölcük (17.08.1999)



Gölcük (17.08.1999)



İzmit (17.08.1999)



izmit (17.08.1999)



Adapazarı (17.08.1999)



Adapazarı (17.08 1999)



Adapazarı (17.08.1999)



Avcılar – İstanbul

(17.08.1999)



Avcılar – İstanbul (17.08.1999)



Kaynařlı (12.11.1999)



Düzce (12.11. 1999)



Bingöl (01.05.2003)



Bingöl (01.05.2003)



Construction type in Turkey is mainly reinforced concrete framed buildings. There are many stone/brick masonry and timber-reinforced hybrid buildings in the older and poor districts of the cities and villages. Ratio of steel construction is 5% in overall building inventory and most of them are industrial plants, which mean number of steel construction is almost none in residential buildings inventory.

The most disturbing aspect of the damage to multi-story commercial and residential reinforced concrete buildings was that many modern buildings collapsed completely and many other buildings had partial collapsed. The majority of partial collapses involve the first two floors.

The causes of damages can be attributed to one or a combination of the following:

1. Poorly designed, for example,
 - NOT designed by professionals!!
 - soft first story,
 - inadequate detailing and reinforcements of column-beam connections and columns,
 - design of strong beam/weak columns rather than strong-column/weak beams,
 - creation of short-columns due to infill walls or offsets in design,
 - inadequate details,
2. Lack of inspection and supervision at the design and construction stages,
3. Questionable quality of materials used,
4. Bad workmanship,
5. Site effects.

Rehabilitation stage is rather difficult than properly construct. Besides if the structure has too many members to be strengthened, and/or the lateral rigidity of the structure is not adequate, and/or there are important system deficiencies, like soft stories, weak stories, or short columns, member strengthening may not be economically feasible.

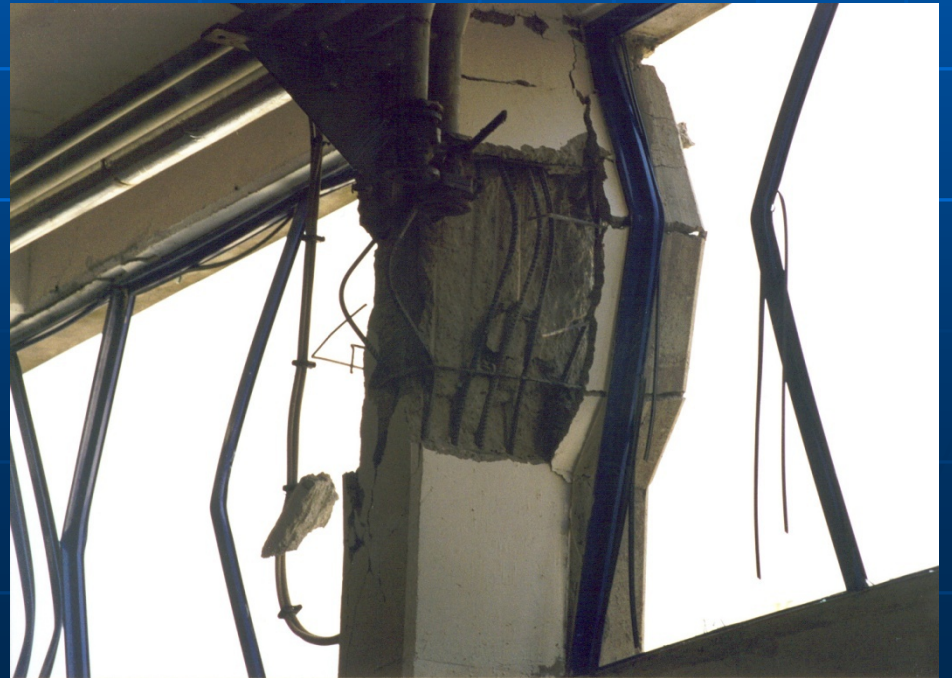
A structure should have adequate lateral stiffness, strength and ductility for having satisfactory seismic performance.



NOT designed by professionals,
wrong repairing







Tevfik Seno Arda High School



- “Tevfik Seno Arda High School” is a joint project of ECCS and TUCSA with Arcelor as the main sponsor to build a seismic resistant school building in Kocaeli/Turkey.
- It is a marketing project to demonstrate the feasibility and advantages of steel structures for public buildings.

Background

- After the earthquake in Bingöl in the year 2003, in May and September of the same year two presentations regarding the earthquake nature of Turkey were given at the board of directors meeting held in Brussels and in the annual meeting held in Lucerne respectively.
- At the end of general assembly meeting, members of ECCS have decided to build a steel framed school in the earthquake area under the coordination of Turkish Constructional Steelwork Association. And Arcelor would be the sponsor for the steel skeleton.
- So, the joint school project of ECCS and TUCSA initiated with the wishes to present the completed building, during the General Meeting in Nice 2005 for the 50th Anniversary of ECCS.

- The school project is considered as the most comprehensive and the largest project of ECCS. Furthermore it is a of research & development project of Arcelor as main supporters.
- ECCS had particularly requested to construct the school on an area which was damaged after the earthquake.
- Before the Kocaeli erthquake there was a high school on the selected site and during the eartquake it was heavily damaged and demolished later on.

Protocol with Partners



Protocol signed by ECCS, TUCSA & Arcelor in Istanbul on 27 April 2005.



Protocol signed with the Governor in Kocaeli on 28 April 2005.



School site was visited after the protocol ceremony.

Architect Mr. Yaşar Marulyalı, one of our members, has prepared preliminary design and submitted to ECCS. The design was highly appreciated and works have begun.



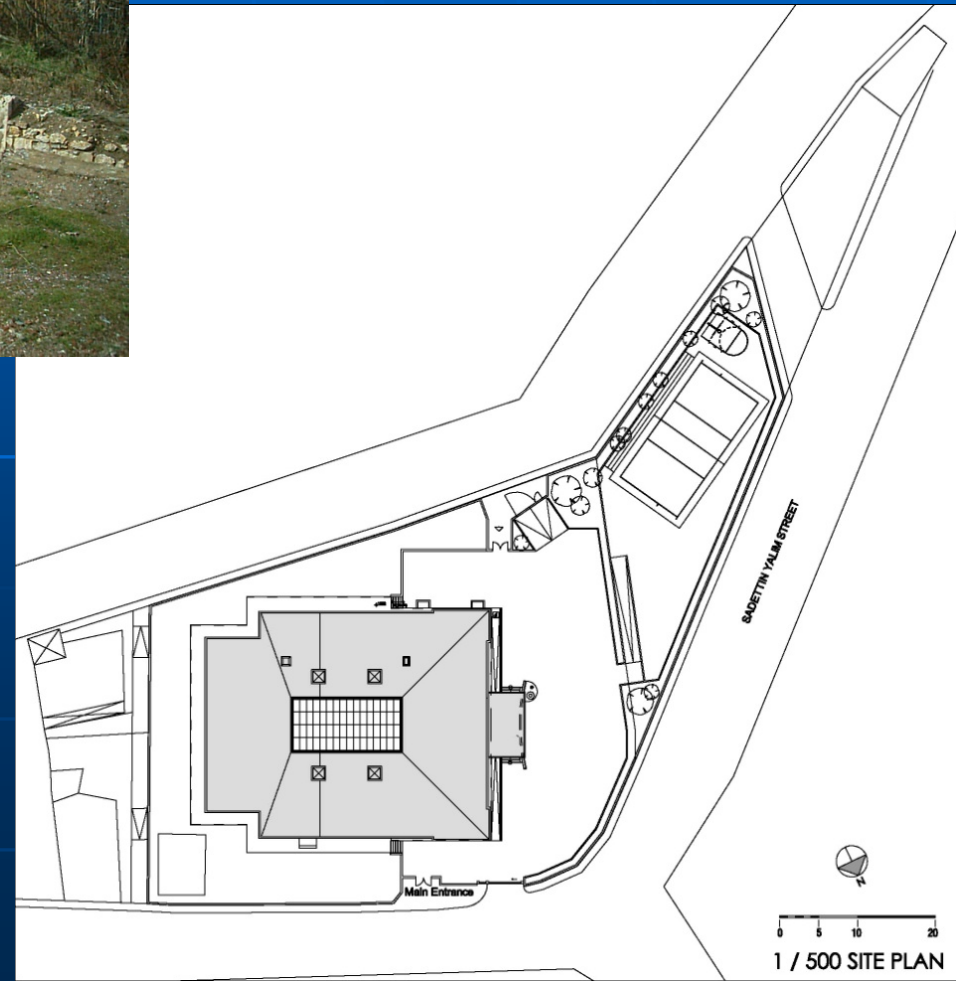
Architectural Concept

- The land is 2,844 m². The base area of the building is 950 m² whereas total utilizable area is 3150 m².
- There are 15 classrooms, 4 laboratories, 1 library, a hall that can be used for sports and social events, and administrative and social areas within the high school building to be composed of a basement and 3 floors.
- Sustainability
 - The atrium on the entry level is illuminated naturally through the glass case on the roof. The sunlight illuminates also classes through windows on inner walls. It provides energy save and comfortable environment.
 - Since the thermal insulation of the building is very good, heating expenses are about 1/4 of similar schools around.
 - Atrium provides a covered area for students where they may meet for social activities particularly in heavy winter conditions. This area may also be used like a large conference room or for sportive activities as needed.
- It is designed to be a modular model for school buildings so the design of school allows scalable construction to make it double, triple or bigger size.



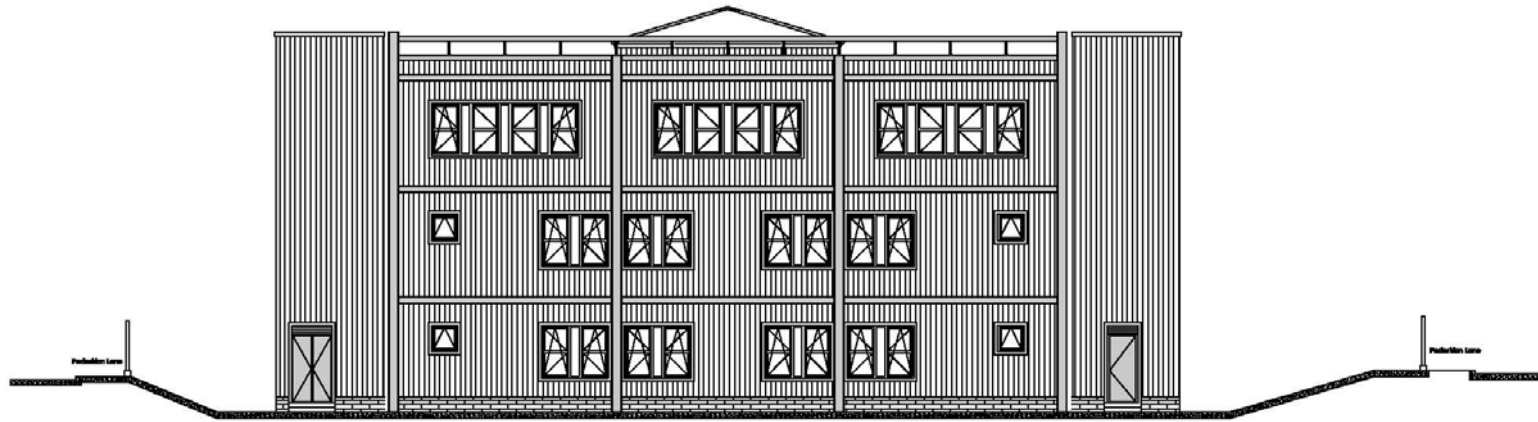
The foundation remains of the demolished school.

Site plan

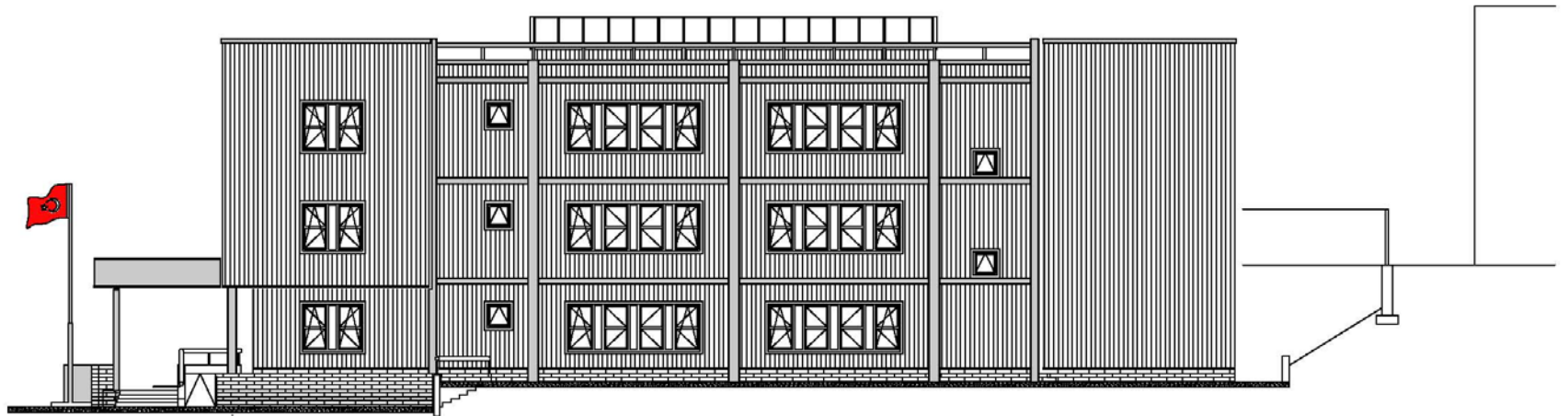




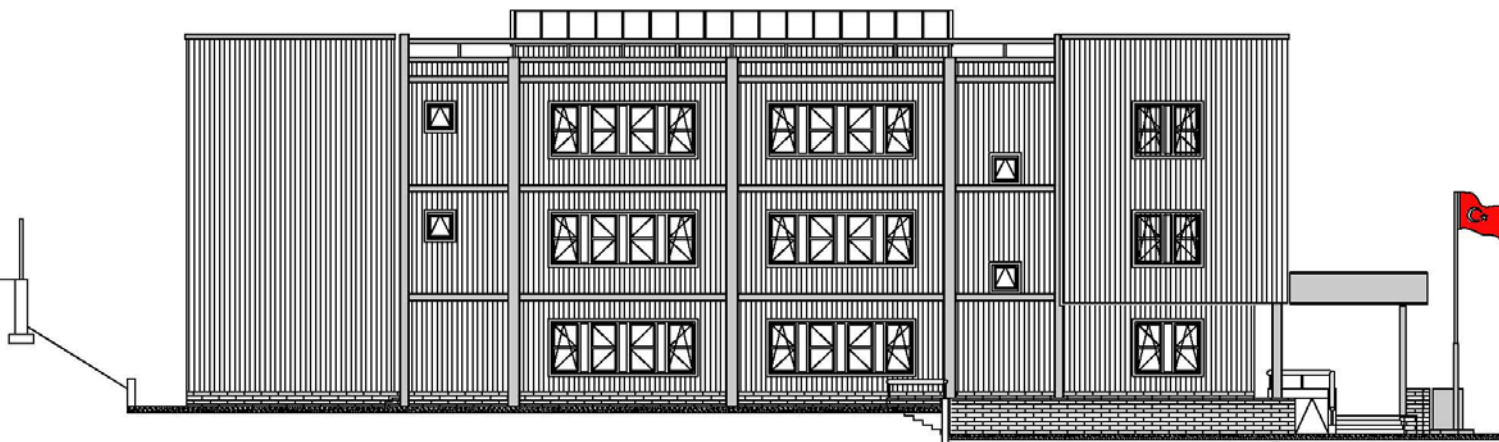
FRONT ELEVATION



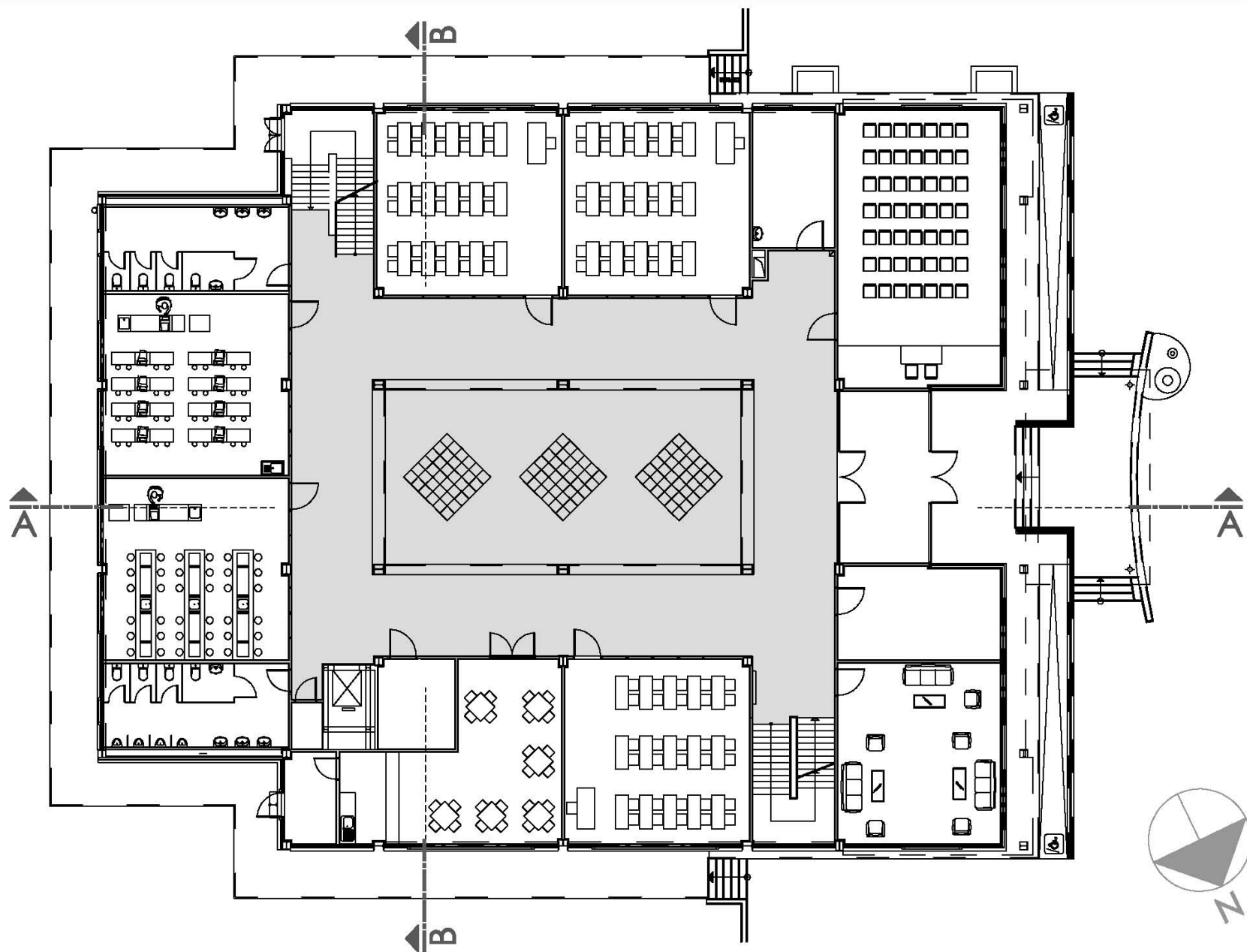
BACK ELEVATION



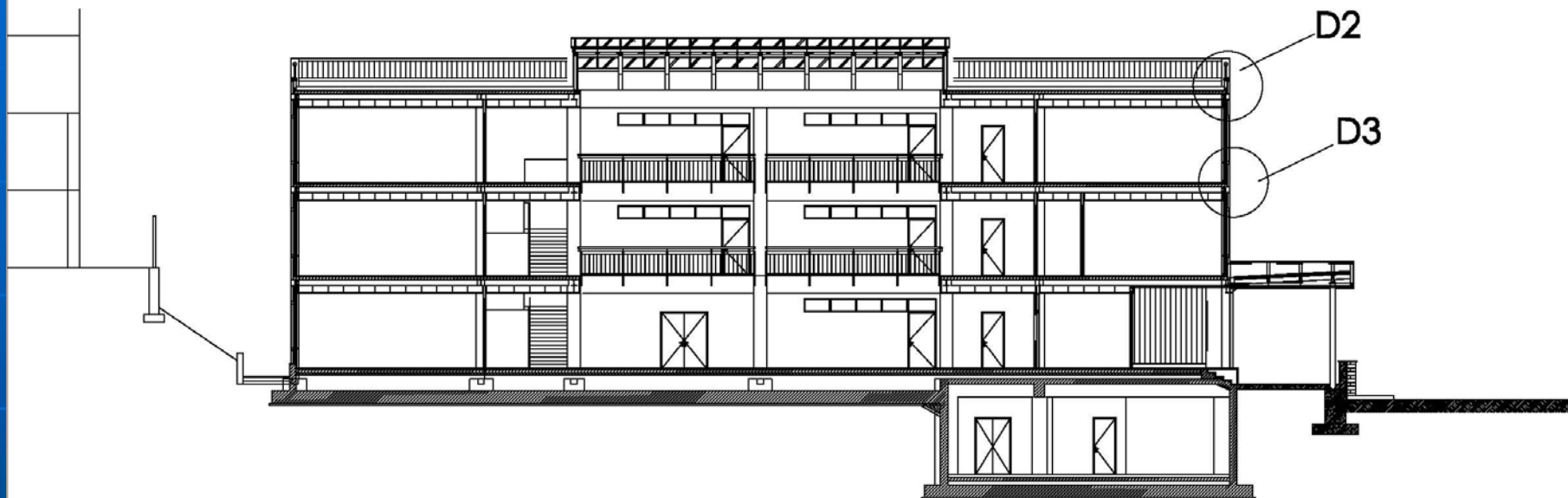
RIGHT SIDE ELEVATION



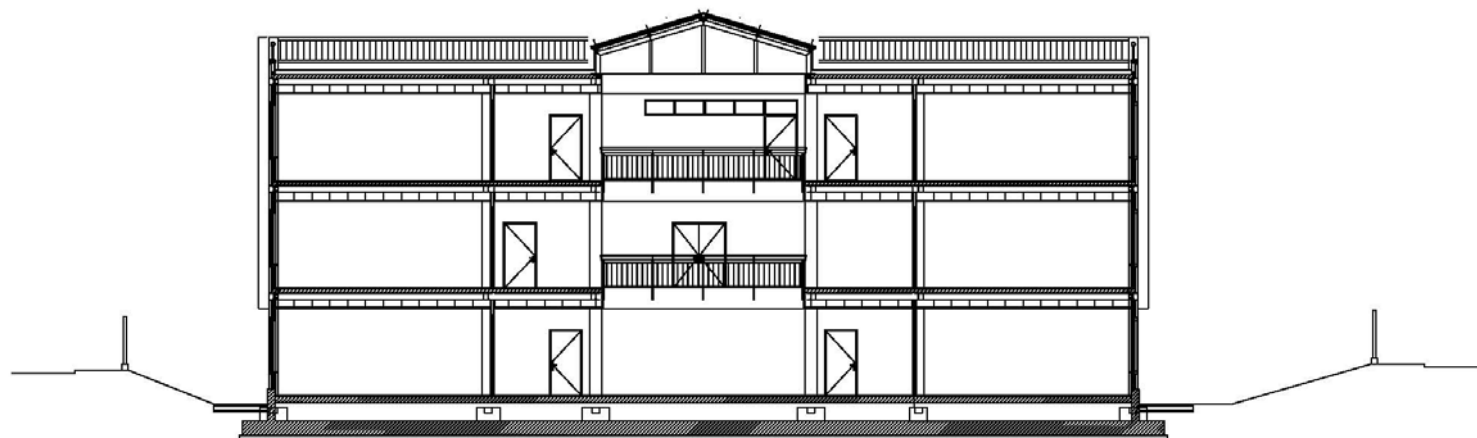
LEFT SIDE ELEVATION



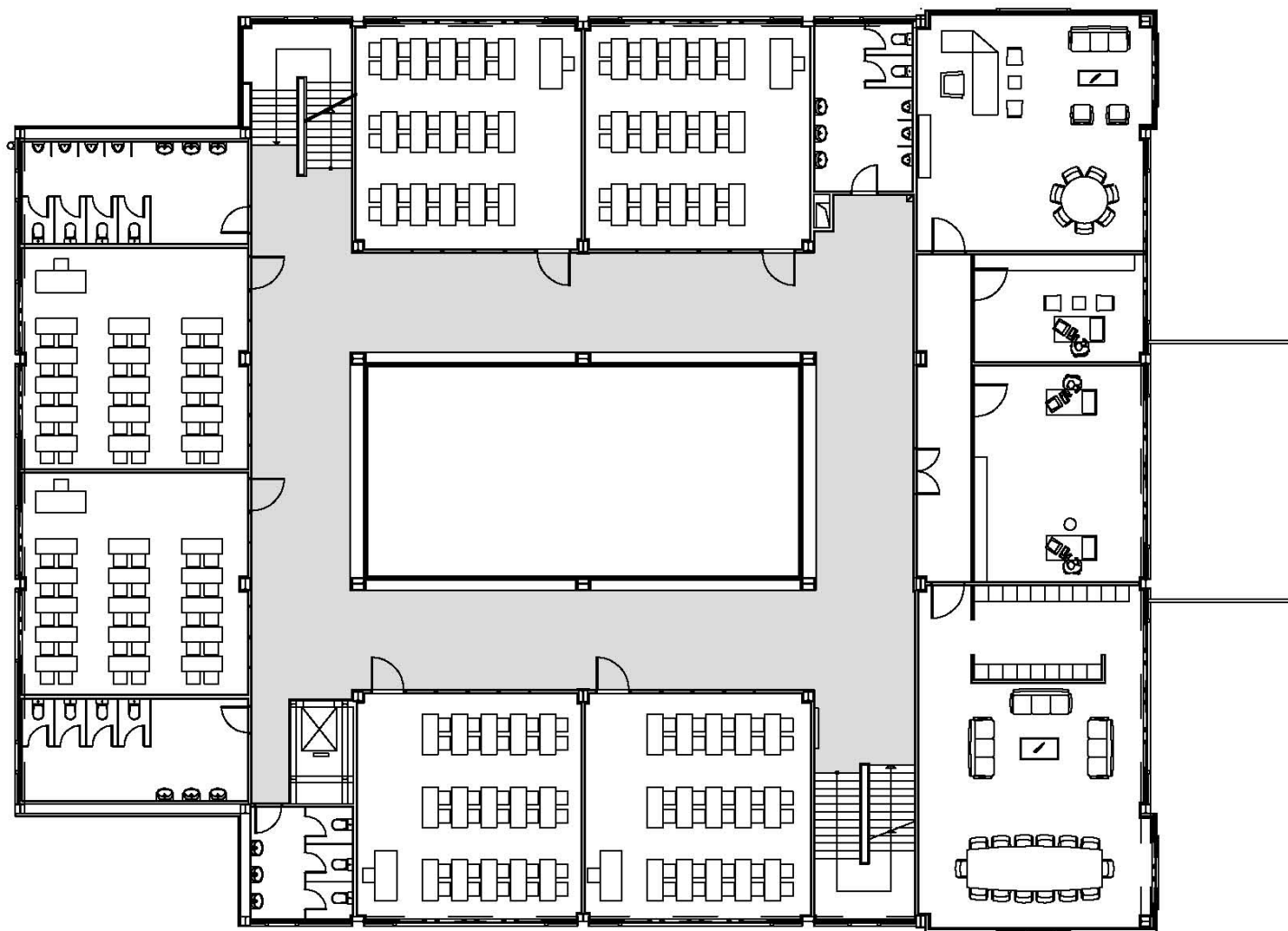
1 / 200 GROUND FLOOR PLAN

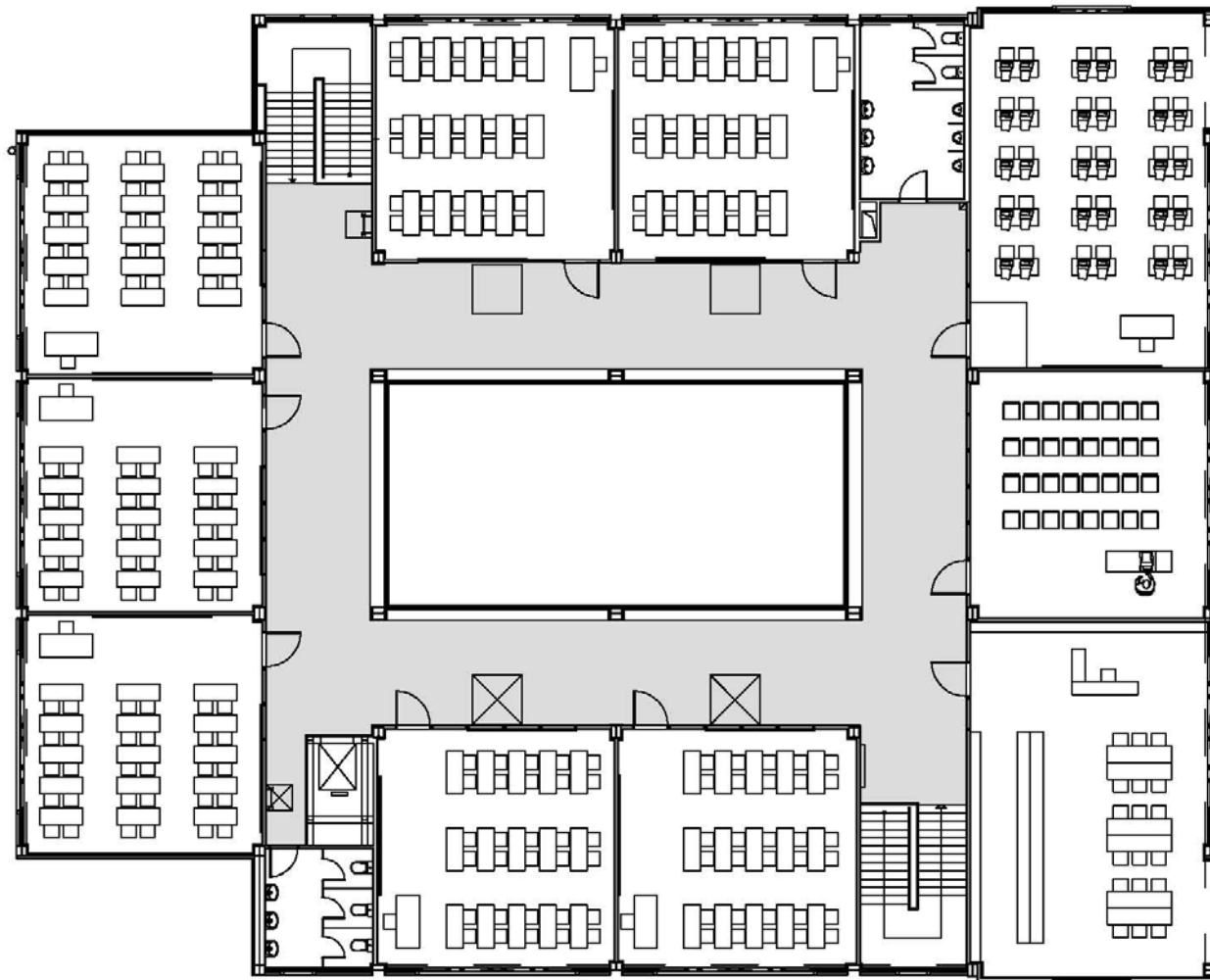


A-A SECTION



B-B SECTION





1 / 200 SECOND FLOOR PLAN

Structural system

- Tevfik Seno Arda High School is designed as 3 storey steel construction with plan dimensions of 28.80 m x 36.00 m. The total height of the building is 10.80 m and the storey height is 3.60 m.



- The structural system is designed as moment frames with 7.20 m spans in both directions in line with the architectural requirements. The frames are connected with IPE 300 floor beams.

- The floors are designed as composite slabs with 12 cm reinforced concrete covering the steel beams.
- An atrium area and glass covered roof is designed in the middle of the building in (7.20 x 14.40) m² area, to take the sunlight in.



- For the main structure elements (columns and beams) wide flange profiles such as HEA, HEB are selected, and for secondary beams IPE profiles are used.
- The total weight of the steel structure is 250 tones.

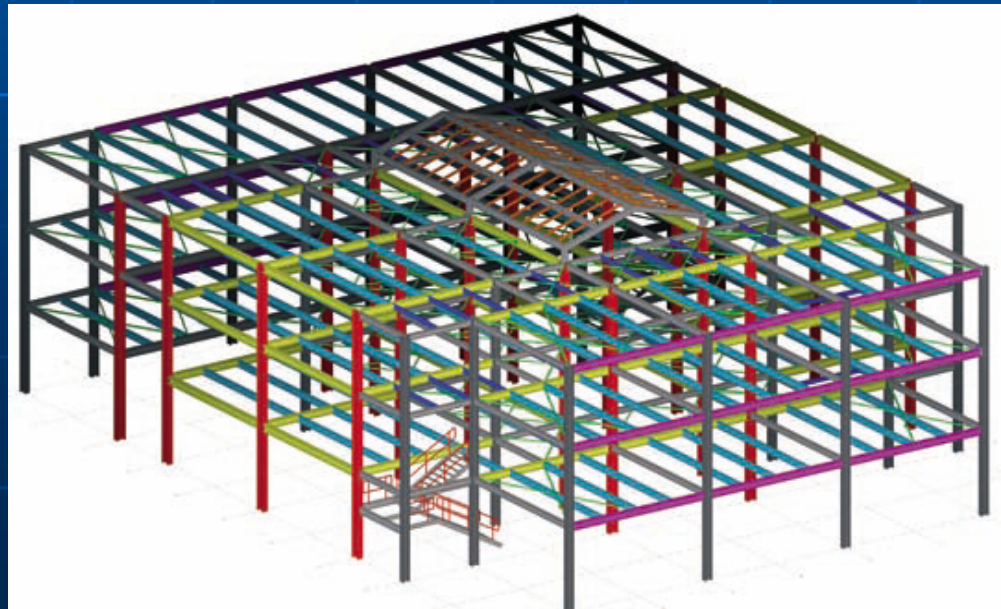
- All the structural calculations of the building are prepared according to “Turkish Earthquake Code-1997”.
- The foundation design is made according to the results of soil investigation report conducted for the area. The foundations are calculated as 50 cm concrete mat foundation.
- S275 JR steel grade are used for the profiles and S235 JR for the plates. For the connection of the beams and columns high tension bolts with grade 10.9 are used.
- The columns are connected to the foundation with a group of anchor bolts as a fixed supports.
- All the structural elements are manufactured with bolted connections at the workshop.

Loads

- Dead load (self weight)
- Live load: 500 kg/m²
- Coefficients used in earthquake load calculations:
 - Zone factor: $A_0=0,4$ (earthquake zone 1)
 - Spectral coefficient: $S(T)=1.66$
 - Soil class: Z3 (load bearing capacity is low)
 - Structure behavior coefficient : 5 (for both earthquake directions)
- Wind load: It is neglected. (It is very low in comparison with earthquake load.)
- *Transfer of Vertical Loads*: Slabs and columns
- *Transfer of Horizontal Loads*: Slabs and moment frames.

Analysis & Design

- Combinations with earthquake loads are considered in section design.
- Staad.PRO structural analysis program is used in the analysis and design of the system.
- Earthquake forces are applied to the structure automatically by Staad.PRO according to modal analysis method.

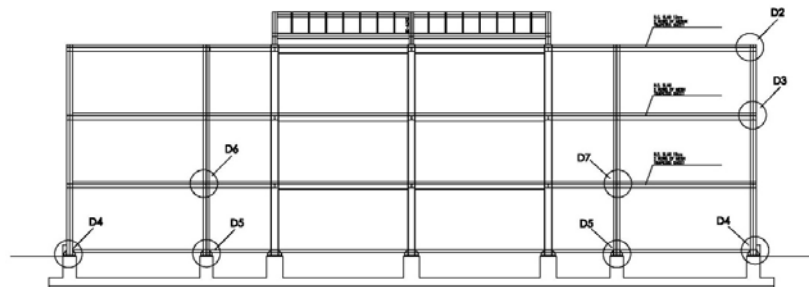


Structural details

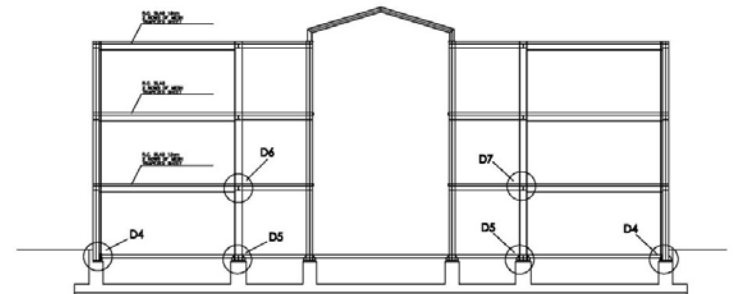
Floor system

Composite slabs. Horizontal bracings are used in order to prevent horizontal displacements caused by concrete pouring. Decking sheets provided by Corus as donation.

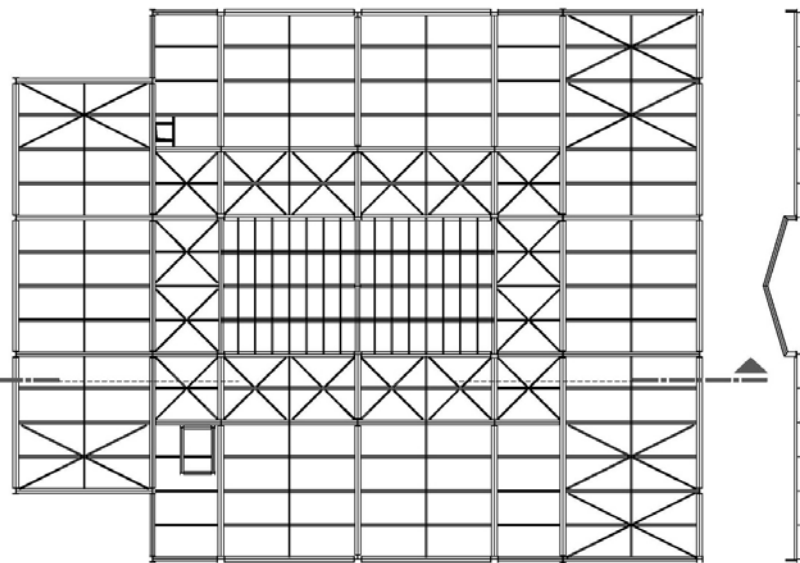




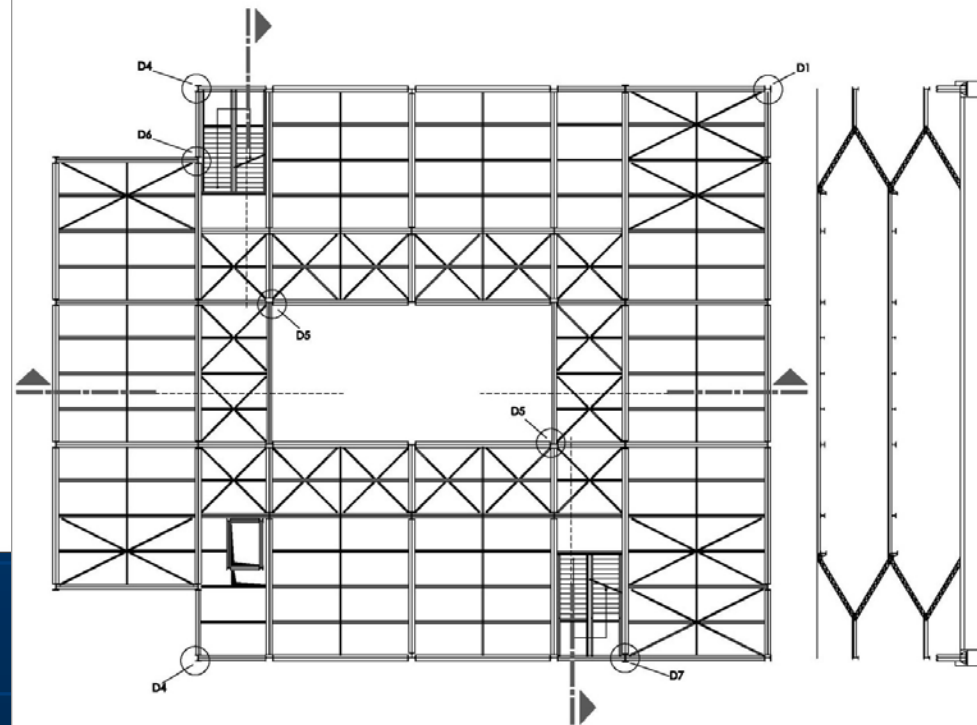
LENGHT SECTION



WIDTH SECTION



1 / 200 ROOF PLAN +11.230

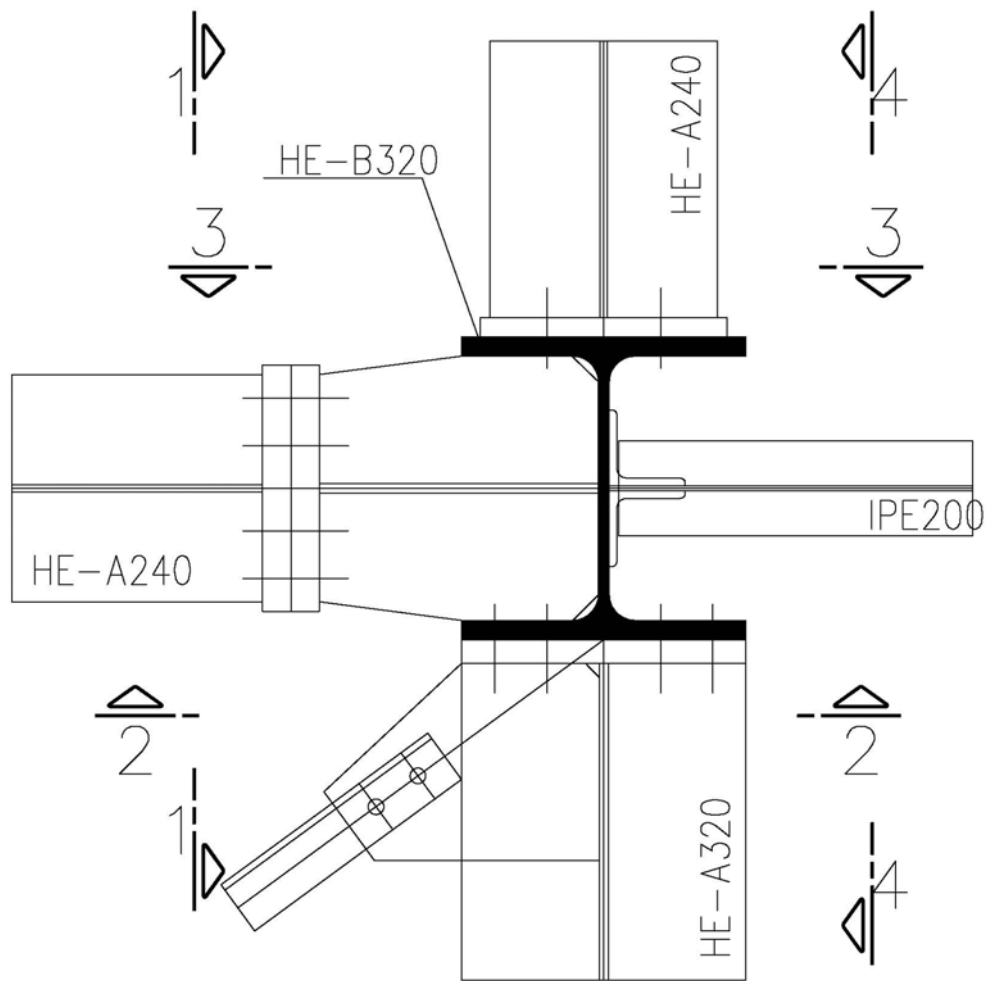


1 / 200 PLAN AT ELEVATIONS +4.030, +7.630

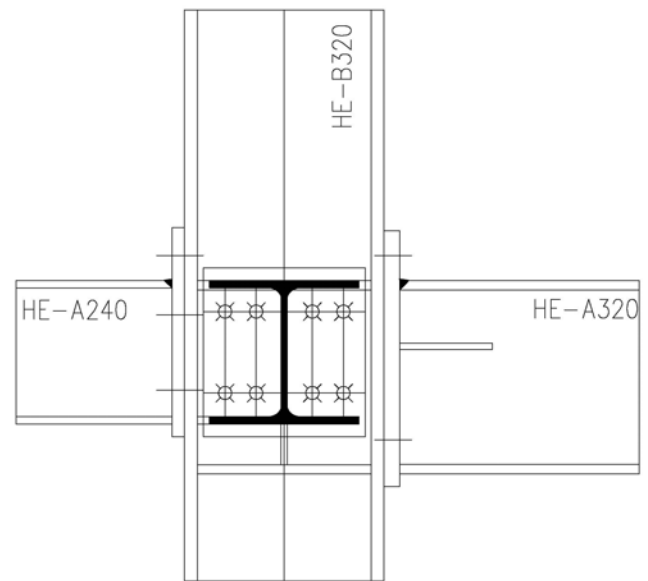
Beam-column connections

Moment frames in two directions.

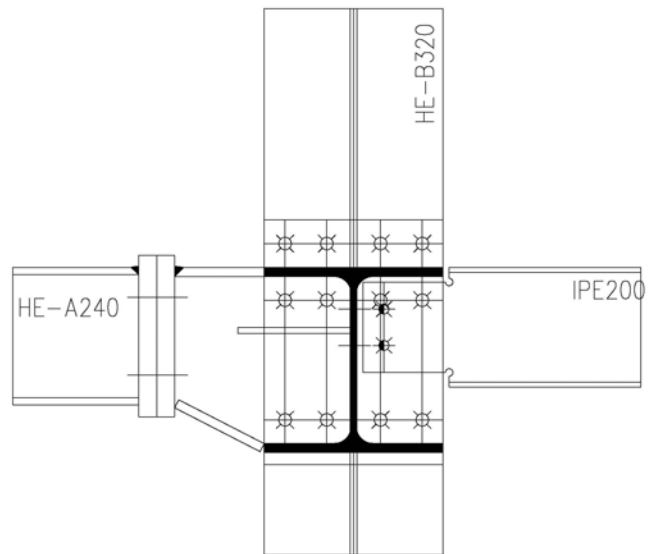




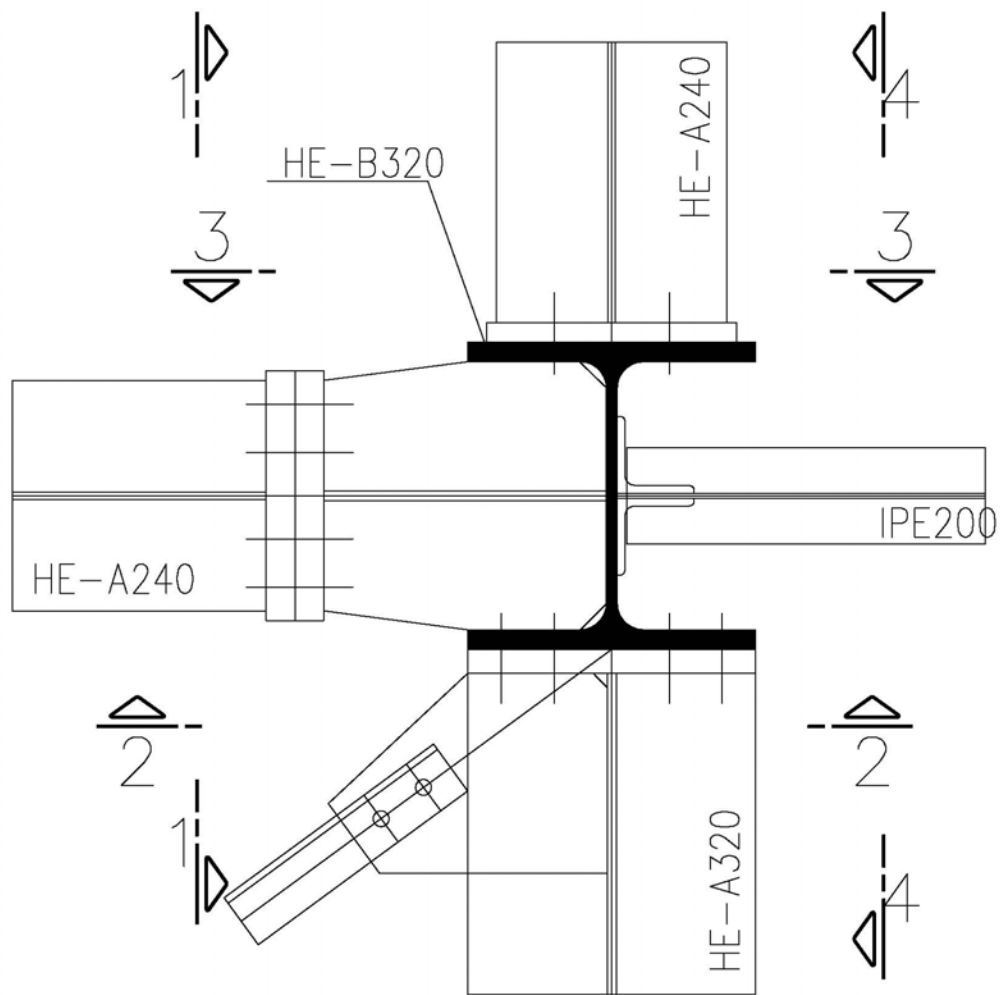
1 / 5 D6 DETAIL



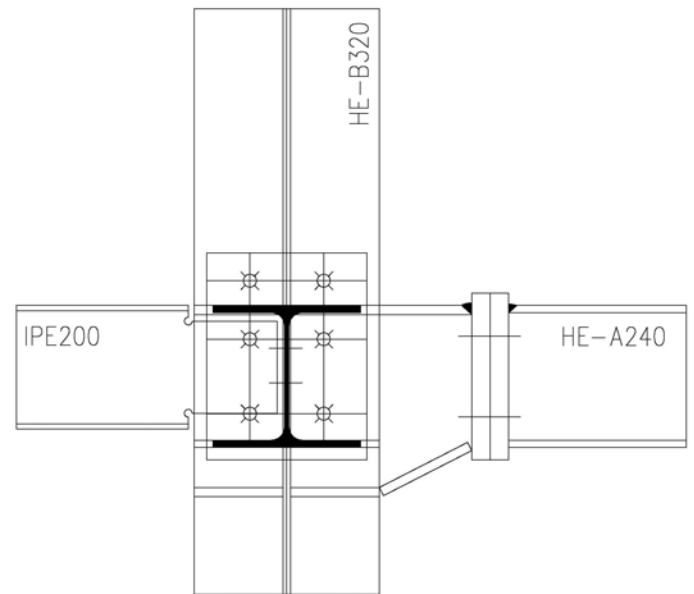
1 / 5 SECTION 1-1



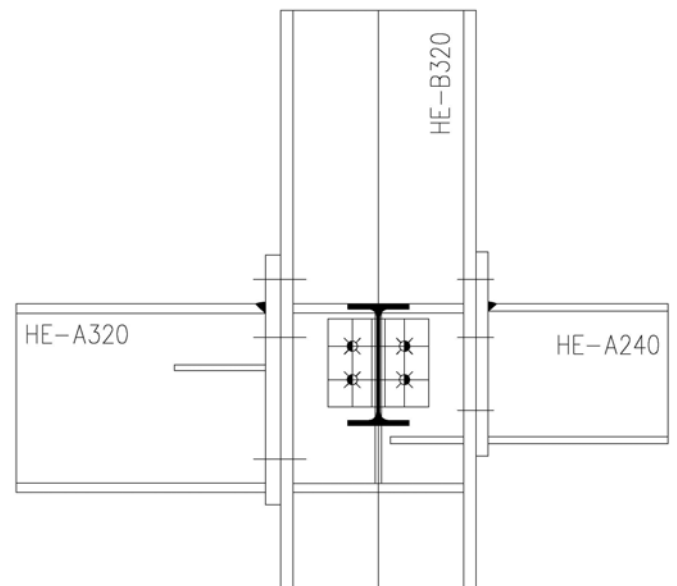
1 / 5 SECTION 2-2



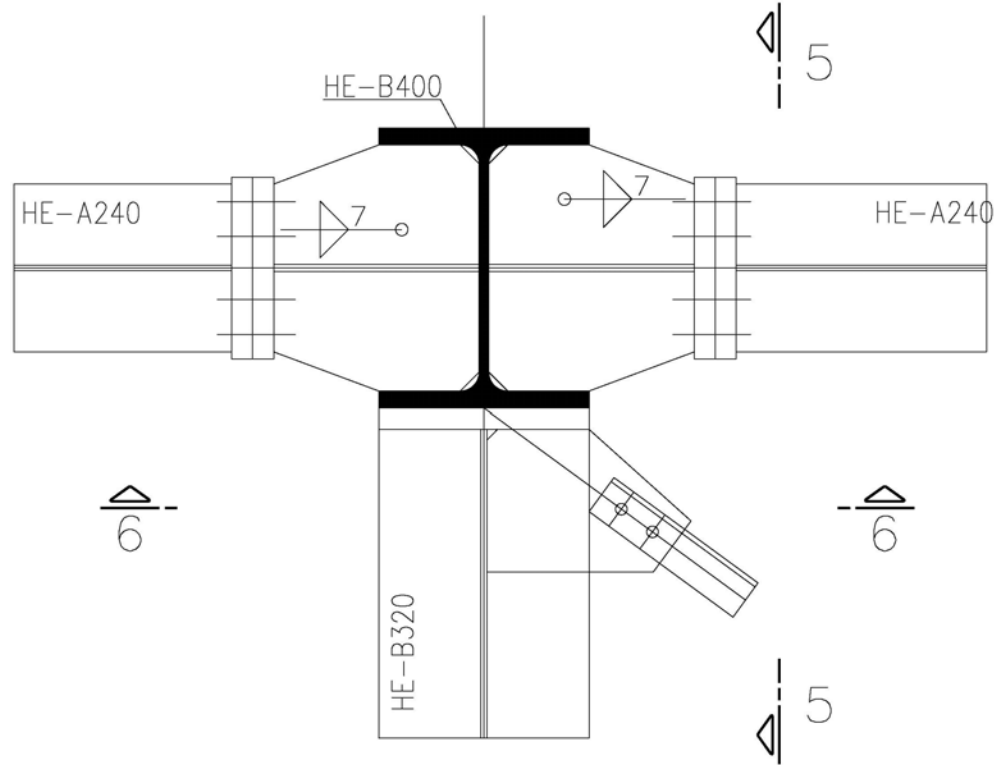
1 / 5 D6 DETAIL



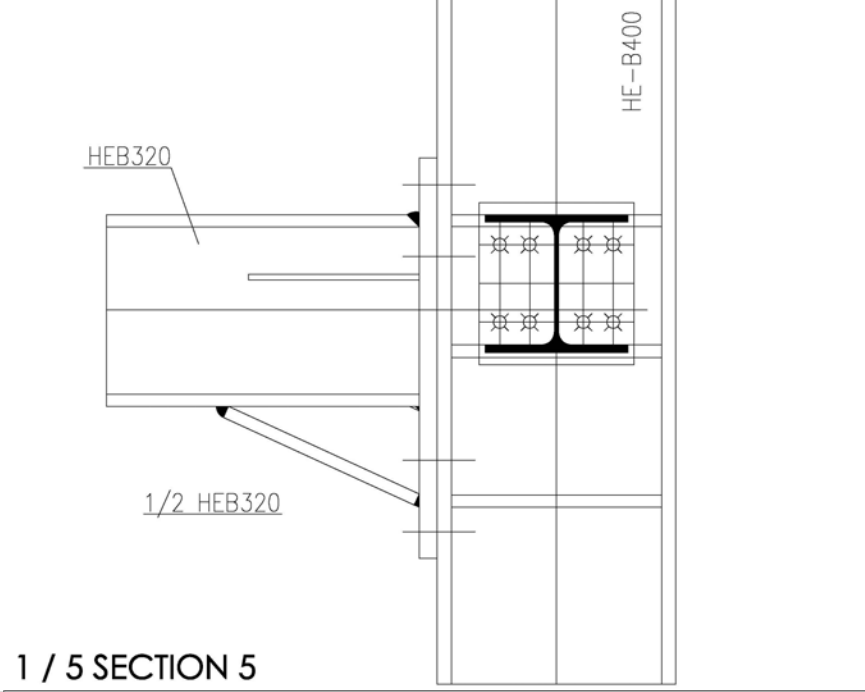
1 / 5 SECTION 3-3



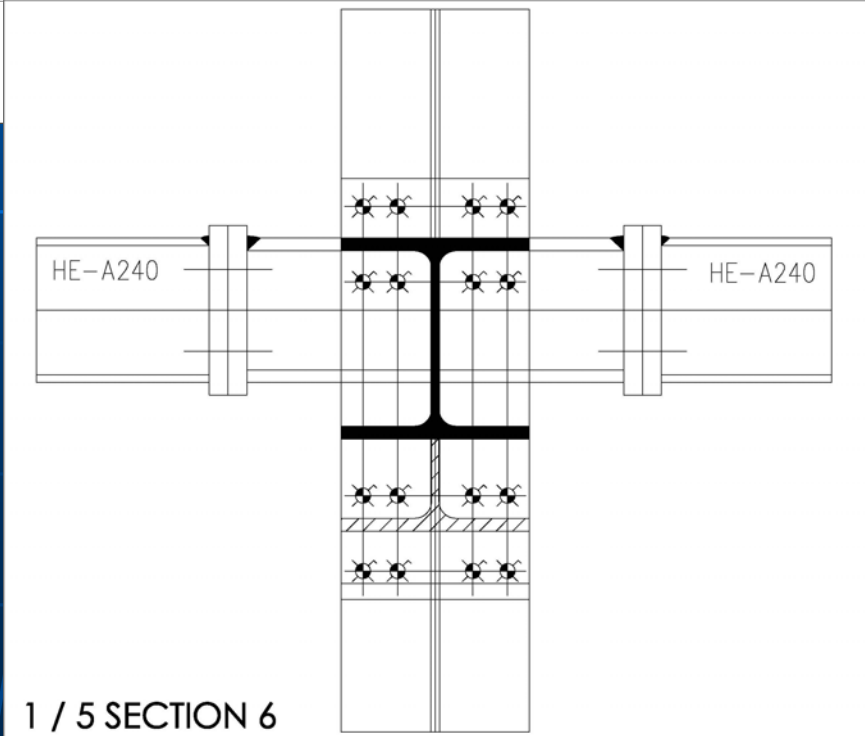
1 / 5 SECTION 4-4



1 / 5 D7 DETAIL



1 / 5 SECTION 5

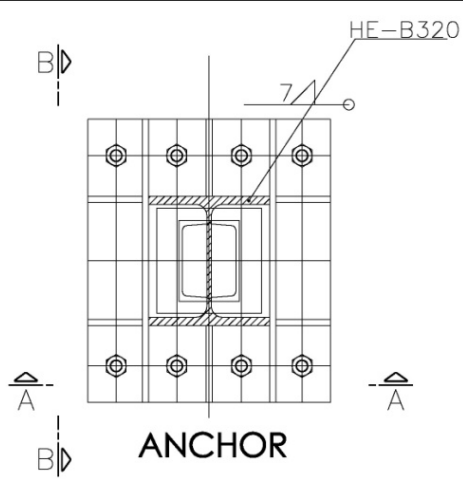


1 / 5 SECTION 6

Column base

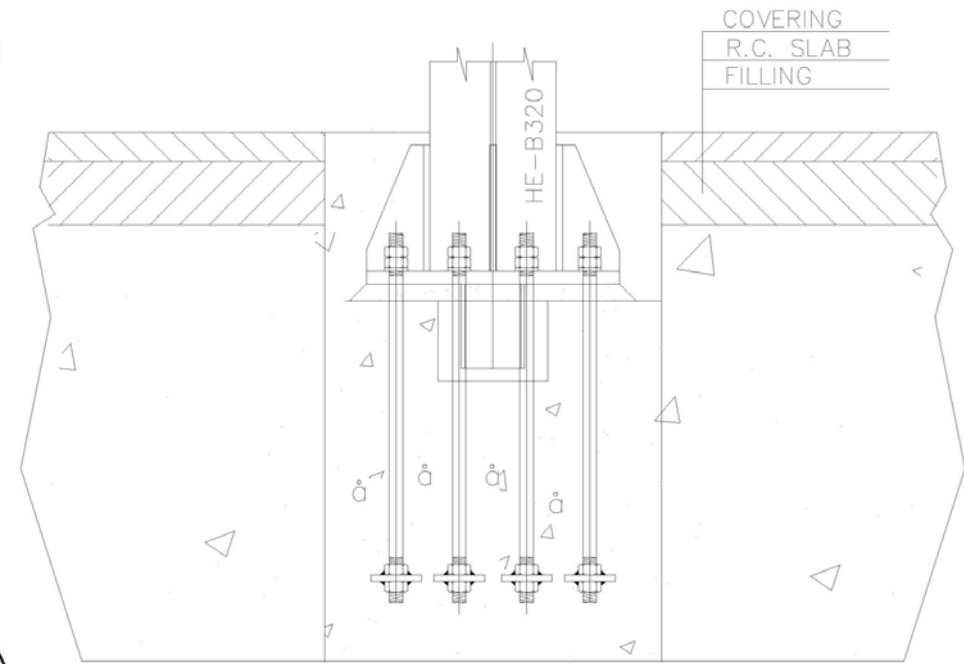
Columns are connected to the foundation as fixed supports.



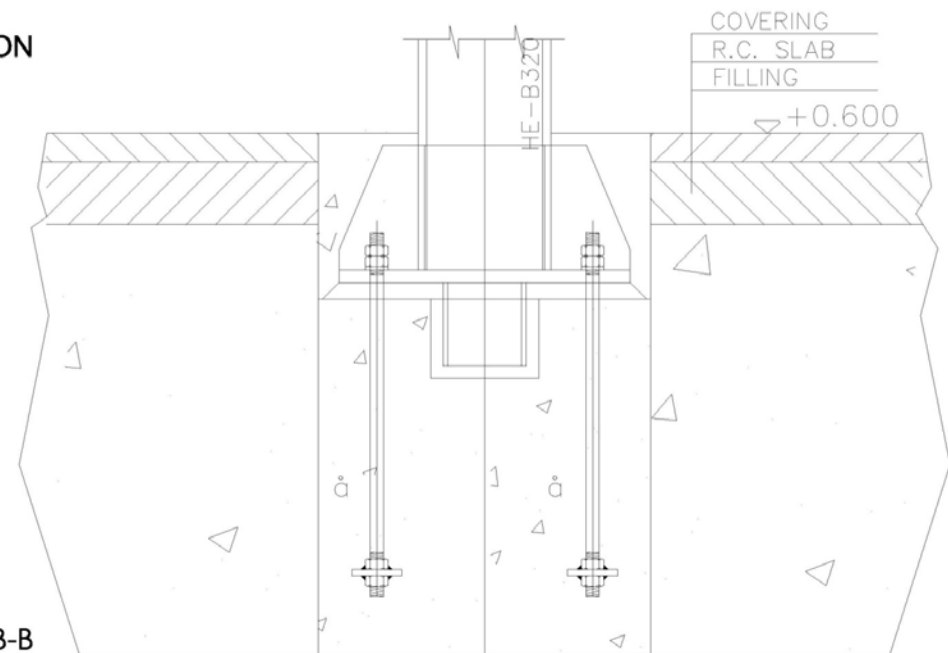


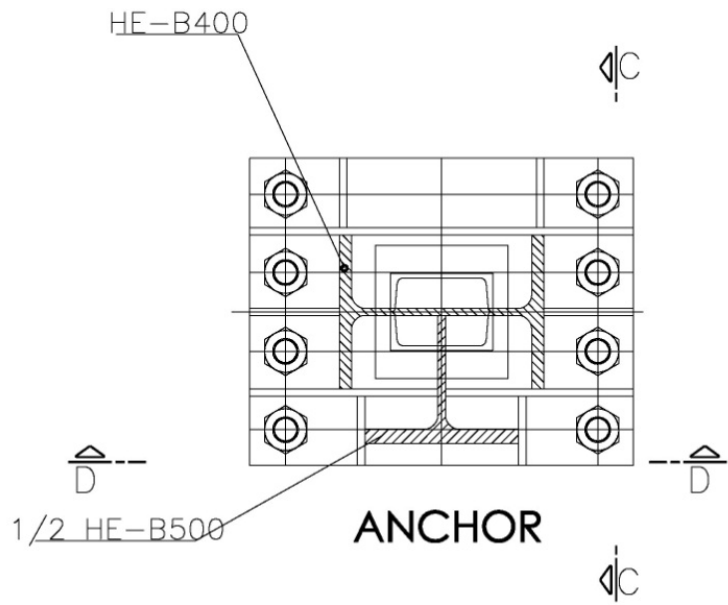
1 / 5 D4 PLAN DETAIL

1 / 5
D4 SECTION
DETAIL



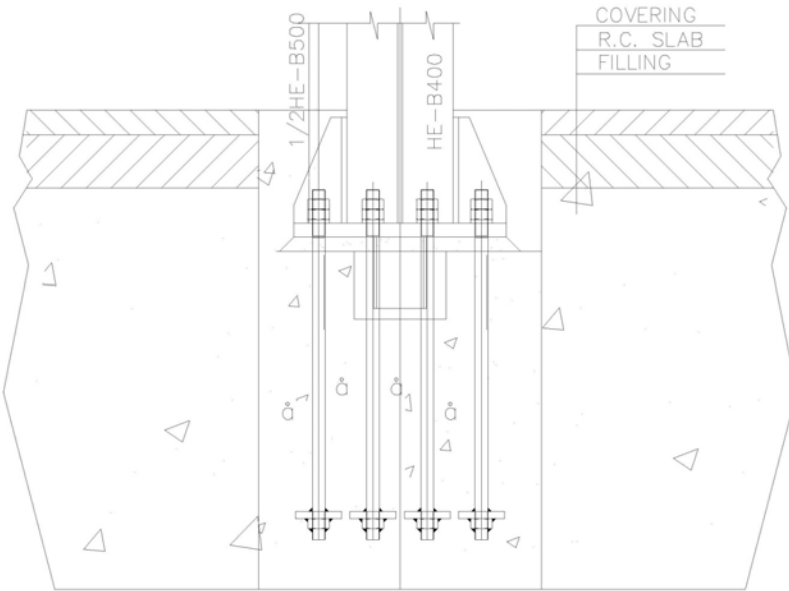
1 / 5
D4 SECTION
DETAIL





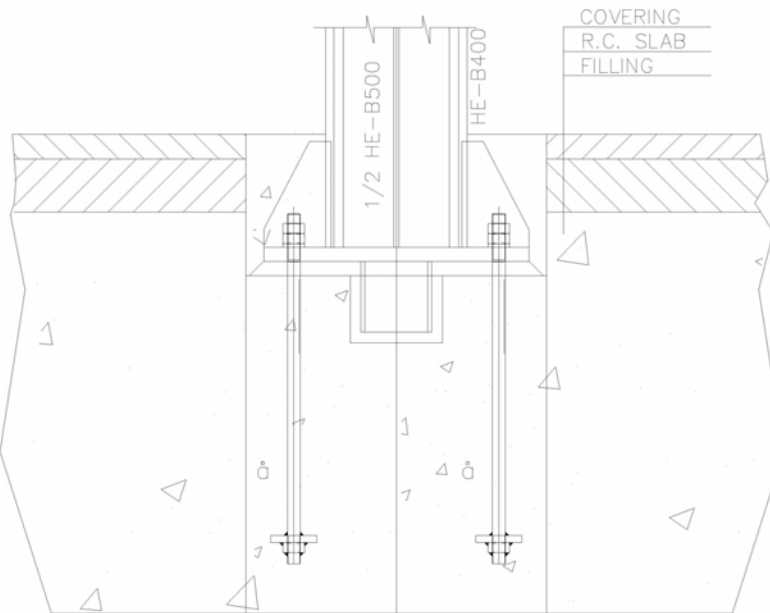
1 / 5 D5 PLAN DETAIL

1 / 5
D5 SECTION
DETAIL



SECTION C-C

1 / 5
D5 SECTION
DETAIL



SECTION D-D

Fire Protection Design

- Initial fire protection design was made by using the Turkish Fire Code. In this case, it was preferred to take the following measurements:
 - To cover the columns and beams with gypsum boards,
 - To install sprinkler system,
 - To coat atrium columns with fire retardant paint
- R&D Department of ARCELOR supported the fire protection design and the system was re-evaluated in accordance with the Natural Fire Safety Concept. This procedure takes into account the real fire characteristics and active fire fighting measures so it is more realistic.



Calculation of the structure submitted to natural fire scenarios

- The numerical simulations are made using the Software SAFIR of the University of Liège.
- The loads that are taken into account for the calculation are :
 - The self weight of the structure (steel and concrete)
 - The variable loads (3 kN/m²)
- The security factors applied to the different loads in case of fire are different from those that apply during the cold calculation.
- Four fire scenarios have been simulated by applied to the SAFIR software.

- At the end of the simulation, the structure has small remaining displacements but during the calculated fire scenario, the global stability of the structure is maintained.
- Atrium column is designed considering the earthquake loads; so it is an HEB 400 (over designed).

Revised Fire Protection Design

- The following revisions have been made:
 - Sprinkler system was not needed,
 - Protection of the columns in the atrium was not needed,
 - Roof smoke exhaust system was added.
- A remarkable saving was achieved.

Facades

Bare frames completed by decking and facades





Cold-formed steel cassettes ($t=150$) inside of hot rolled frames



Vapour barrier is applied above the cold-formed steel cassettes
Note: Before vapour barrier, OSB (t=11) may be applied above cassettes

Preparations for
mounting of facade
trapezoidal sheets



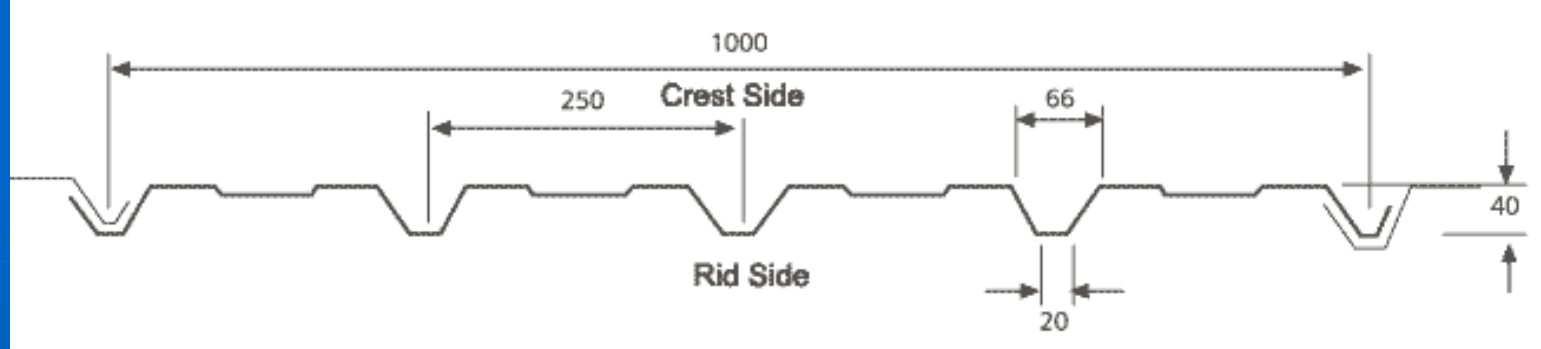
Coverage confined by the exposed columns and beams is more difficult to provide a water proof facade

Outer coverage is easier to provide water proof facade

Details are also very important to convince Turkish investors to use steel facade



Coverage of facades

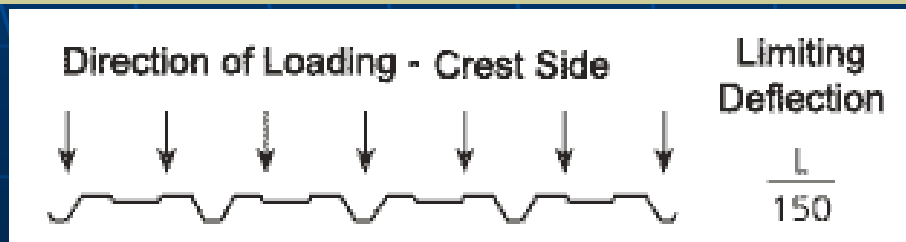


Profile properties



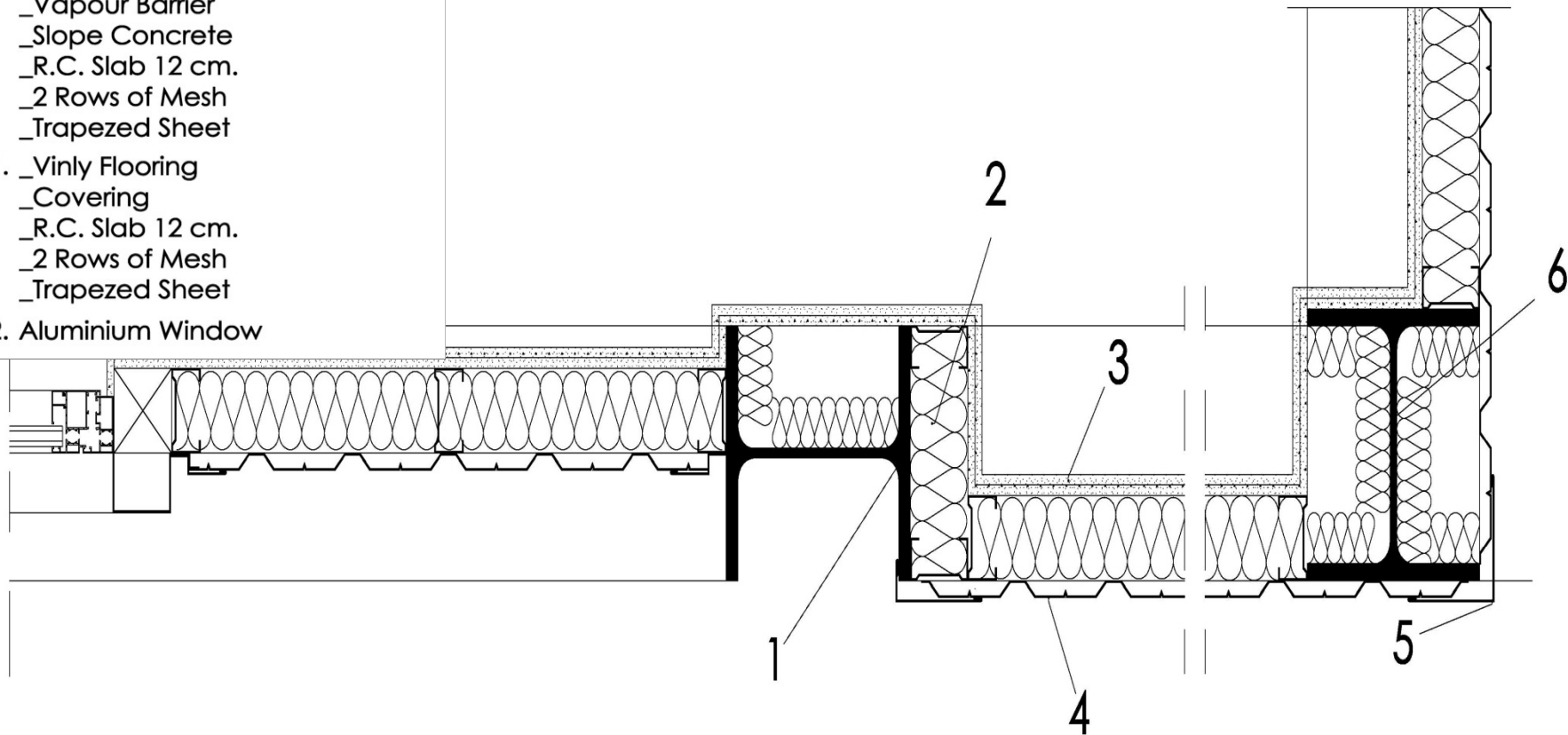
Sheet Thickness (mm)	Weight (kg / m ²)	Moment of Resistance k.N.m / metre width	Moment of Inertia mm ⁴ / metre width	Section Modulus mm ³ / metre width
0.50	4.80	54420	3715	0.817
0.60	5.75	61320	4816	1.059
0.75	7.20	68910	6525	1.436
0.80	7.67	70920	7103	1.563
1.00	9.59	2.071	77210	9414

Loads



Materials in D1-D2-D3 Details

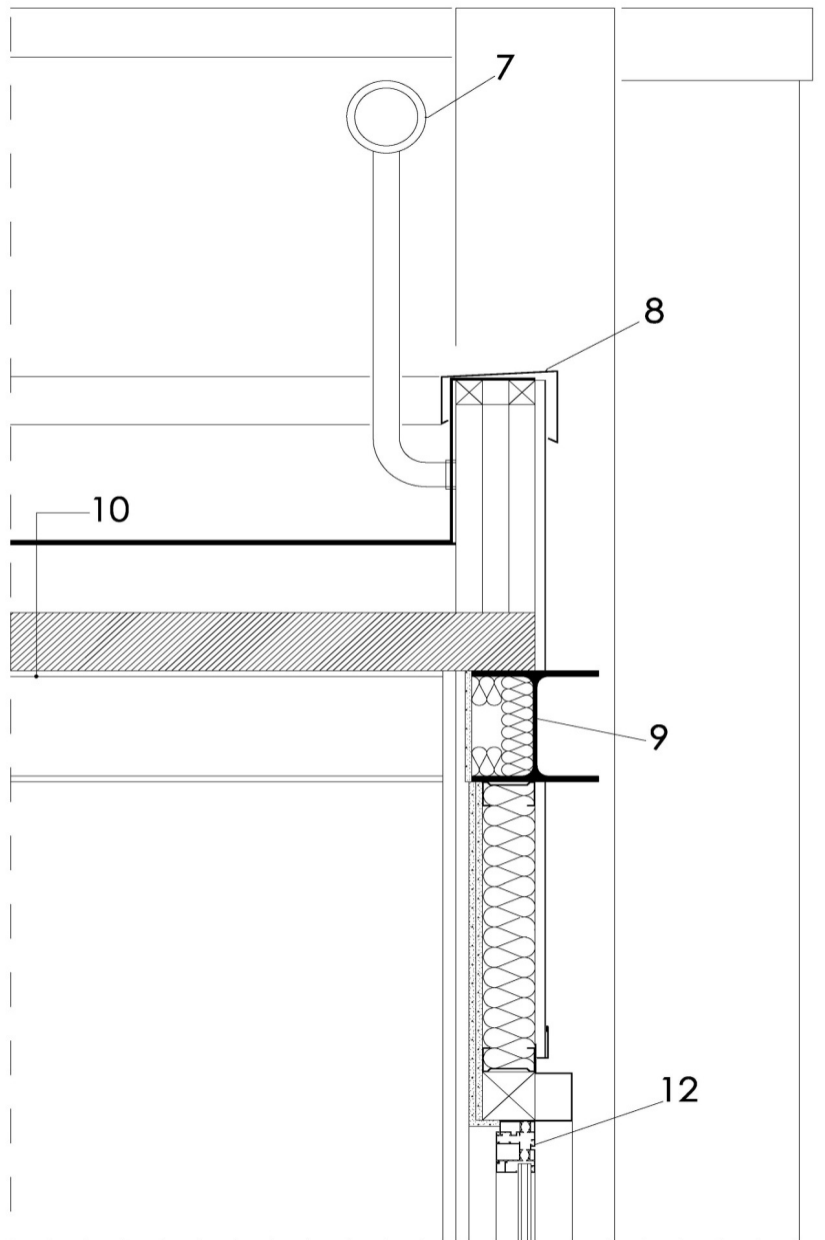
1. Steel Column
2. Heat Insulation
3. Gypsum board
4. Metal Cladding
5. 15 x15 Outer Corner Flange
6. Steel Beam
7. Stainless Steel Pipe Guardrail
8. Coping Sheet
9. Steel Beam
10. _Water Proofing
_Heat Insulation
_Vapour Barrier
_Slope Concrete
_R.C. Slab 12 cm.
_2 Rows of Mesh
_Trapezed Sheet
11. _Vinly Flooring
_Covering
_R.C. Slab 12 cm.
_2 Rows of Mesh
_Trapezed Sheet
12. Aluminium Window



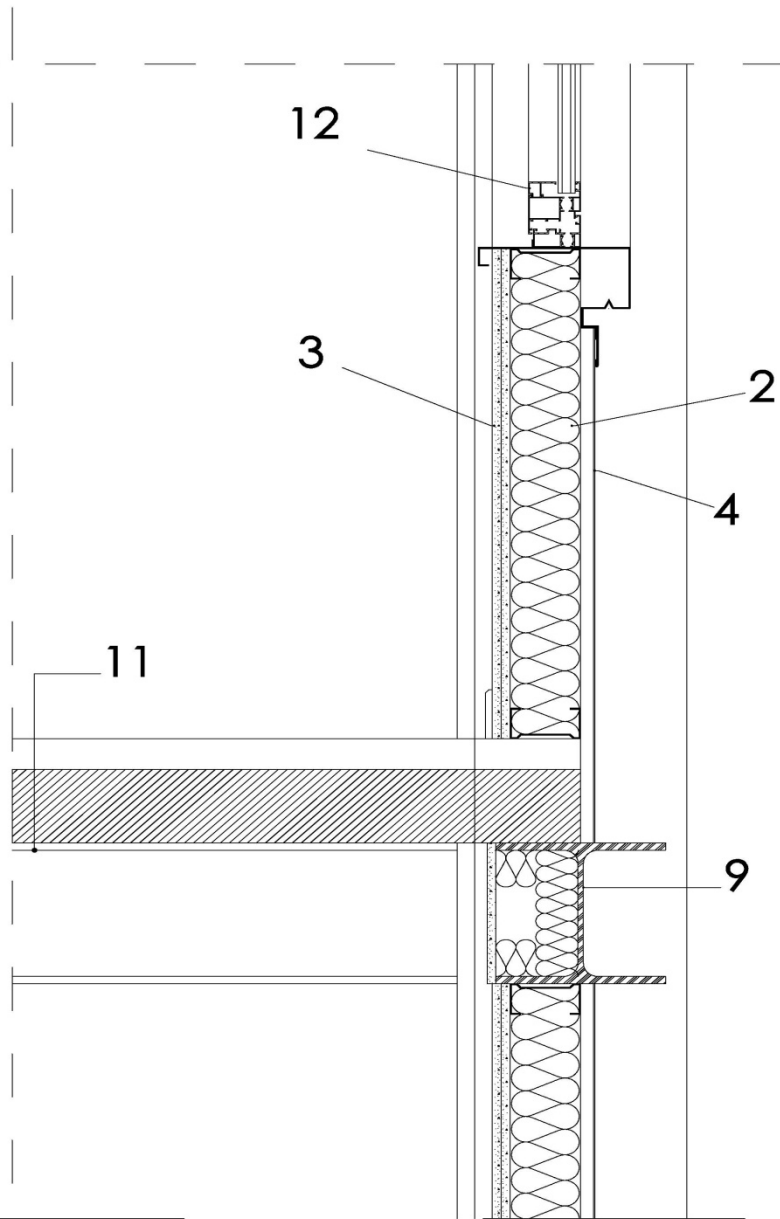
1 / 5 D1 PLAN DETAIL

Materials in D1-D2-D3 Details

1. Steel Column
2. Heat Insulation
3. Gypsum board
4. Metal Cladding
5. 15 x15 Outer Corner Flange
6. Steel Beam
7. Stainless Steel Pipe Guardrail
8. Coping Sheet
9. Steel Beam
10. _Water Proofing
_Heat Insulation
_Vapour Barrier
_Slope Concrete
_R.C. Slab 12 cm.
_2 Rows of Mesh
_Trapezed Sheet
11. _Vinly Flooring
_Covering
_R.C. Slab 12 cm.
_2 Rows of Mesh
_Trapezed Sheet
12. Aluminium Window



1 / 5 D2 SECTION DETAIL



1 / 5 D3 SECTION DETAIL

Materials in D1-D2-D3 Details

1. Steel Column
2. Heat Insulation
3. Gypsum board
4. Metal Cladding
5. 15 x15 Outer Corner Flange
6. Steel Beam
7. Stainless Steel Pipe Guardrail
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_Covering
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_2 Rows of Mesh
_Trapezed Sheet
12. Aluminium Window



Construction Phase

Excavation started on 13 August 2005.



The first column of the school was erected on 14 September 2005.



- Formalities of importing the donated steel took long time.
- Consequently, manufacturing was rescheduled.
- Then, erection of the structure started.



Snow covered the school construction at the beginning of 2006.



Structure and composite slabs were completed before the spring of 2006.





Due to financial difficulties, only the shell and core was completed prior to May 2006.

A meeting was held at the school on 12 May 2006 in order to show the current situation.



Completion of Construction and Today



- Construction was finished on the 24th of November 2006.
- Education started on 27 November 2006.



Students: “Thank you for this safe and lovely school !”





ECCS

ANNUAL MEETING

&

INTERNATIONAL SYMPOSIUM

STEEL STRUCTURES: CULTURE & SUSTAINABILITY 2010



Symposium 21-23 September 2010

Steel Day of TUCSA 23 September 2010

ECCS Steel Bridge Awards Ceremony 23 September 2010

ECCS Meetings 24 September 2010

Istanbul, Turkey

Türk Yapısal Çelik
Derneği

TUCSA
1992



- ECCS leading event, the symposium, to be held on 21-23 September 2010, is a must-attend for all the industrialists and academicians.
- It will bring together leading architects, engineers, city planners, contractors, academicians and researchers from the world of steel construction.



INTERNATIONAL SYMPOSIUM
20-22 September 2010
Istanbul, Taksim The Marmara, TURKEY

STEEL STRUCTURES:
2010 CULTURE & SUSTAINABILITY

Main Organizer:
European Convention for Constructional Steelwork (ECCS)

Local Organizer:
Turkish Constructional Steelwork Association (TUCSA)

Co-Organizers:
American Institute of Steel Construction (AISC)
Cold-Formed Steel Engineers Institute (CFSEI)
Hokii University (HUKU)
International Association for Steel and Spatial Structures (IASS)
International Society for City and Regional Planners (ISOCARP)
Istanbul Technical University (ITU)
Steel Framing Alliance (SFA)
The Building Information Centre (BIC)
TMMOB Chamber of Architects (TMMOB MÇ)
TMMOB Chamber of Civil Engineers (TMMOB MCE)
TMMOB Chamber of City Planners (TMMOB İMÇ)
World Steel Association (WISA)
Yildiz Technical University (YTÜ)

Symposium Chair:
Chair: Nevin YARDIMCI, Turkey
Co-Chairs:
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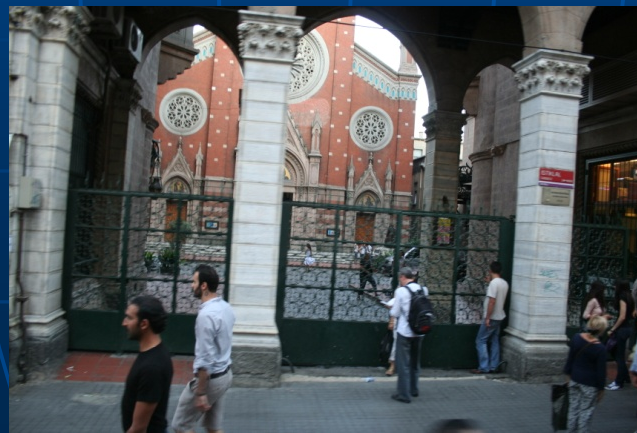
Symposium Secretary:
A. Bener AYDOĞAN

Scientific Board:
Chair: Nevin YARDIMCI, Turkey
Co-Chairs:
Husein BAKIRBAĞCI, Turkey
José SANCES DA SILVA, Portugal
Cevdet YORULUN, Turkey

KEY DATES
09 November 2009 Deadline for Submission of Abstracts
18 January 2010 Evaluation of Abstracts and Approval
Request for Final Papers
19 April 2010 Deadline for Submission of Final Papers
31 May 2010 Final Acceptance

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- All events will be organised at The Marmara Hotel, Taksim Square in Istanbul.
- During the symposium, accompanying persons will take part in daily excursions in Istanbul.





As for the social events:

- Monday evening; a cocktail prolongé will be held for the symposium attendees.

- Tuesday evening; Symposium Dinner will take place onboard a pleasure boat while cruising on the Bosphorus.





- Wednesday evening; The traditional “ECCS Gala Dinner” will be held at an interesting place, Esma Sultan Seaside Mansion by the Bosphorus.

- Thursday evening; Presidents & Directors Dinner will be held at the roof of The Marmara Hotel with excellent panoramic views of the Golden Horn, the Sea of Marmara and the Bosphorus.





It is a great pleasure for me to invite you all to Istanbul for
September 2010 for the ***International Symposium***
“Steel Structures: Culture & Sustainability 2010”

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Amul in September 2010.