Integrated Fire Engineering and Response
COST ACTION TU0904

FIRE DESIGN OF A NEW FACTORY BUILDING IN ATHENS

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Chania 14-15 October 2011

Objective of the study

The basic objectives of this study are the following:

➢ The first target is to present the fire protection requirements of the building, according to the national regulations of Greece

➢ The next target is to study two different approaches for the fire design of the building

  ✓ The first approach is based on the use of the fire protection materials, in order to achieve the required fire resistance

  ✓ The second approach proposes alternative cross sections and the fire resistance is achieved without fire protection materials

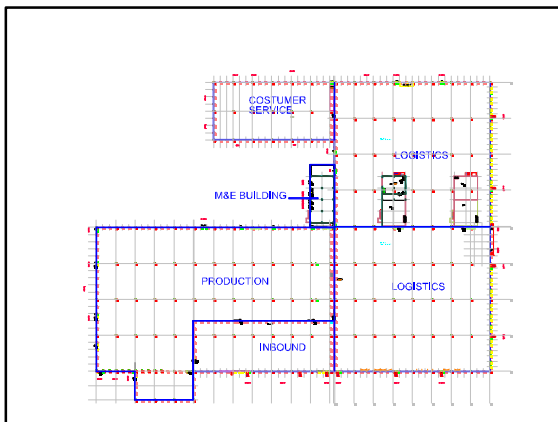➢ Finally, the effectiveness of the two different approaches is compared, in terms of financial cost

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Case study

Elements of the building:

✓ Use: Industry – Industrial warehouse - Logistic Center –Offices

✓ Place: Athens

✓ Total Area: 56040.78 m^2

✓ Maximum Height: 12m

Parts of the building:

✓ Production
✓ Inbound
✓ Logistics
✓ Costumer service

Fire design of the building according to the national regulations

The current fire design of the building is based on the P.D. 71 «Regulations for fire protection of buildings» (FEK 32, issue A/17.2.1988)

✓ Article 11 – Industrial buildings-Storage buildings
✓ Article 8 – Offices

Two different cases are considered, taking into account the use of the different parts of the building:

✓ Industry
✓ Warehouse

Fire design of the building according to the national regulations

Case 1: Fire design of the industrial building (Type Z1)

According to the regulations

✓ Maximum permitted area of the fire compartment: **5000m^2**
✓ If the appropriate sprinklers system is used, the area can be enlarged by the factor **2.5**
✓ The permitted area is scaled by the factor **1.5**, if the approach of the fire-fighting vehicles is assured by an access road on the perimeter of the building
✓ Final maximum area of the FC **A_{max}=18750m^2**
✓ The permitted volume of the FC is defined **V_{max}=28000m^3**

Taking into account the geometric characteristics of the building
➢ the production area, should be divided into 6, at least, different fire compartments or
➢ the height of the building should be 1.49m!!!

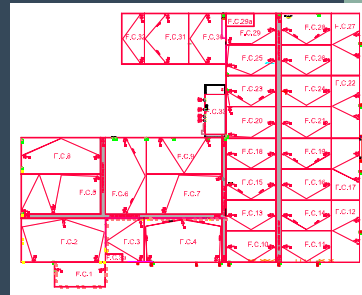## Fire design of the building according to the national regulations

Case 2: Fire design of the warehouse (Type Z1)

According to the regulations

- ✓ Maximum permitted area of the fire compartment: **2500m²**
- ✓ If the appropriate sprinklers system is used, the area can be enlarged by the factor **4**
- ✓ The permitted area is scaled by the factor **1.5**, if the approach of the fire-fighting vehicles is assured by an access road on the perimeter of the building
- ✓ Final maximum area of the FC A_{max}= **15000m²**
- ✓ The permitted volume of the FC is defined V_{max}=**15000m³**

Taking into account the geometric characteristics of the building
- ➤ the warehouse area should be divided into 16, at least, different fire compartments *or*
- ➤ the height of the building should be 1.00m!!!

Fire design of the building according to the national regulations

Special deviations from the existing regulations are required!!!!

Fire design of the building according to the deviation from the rules
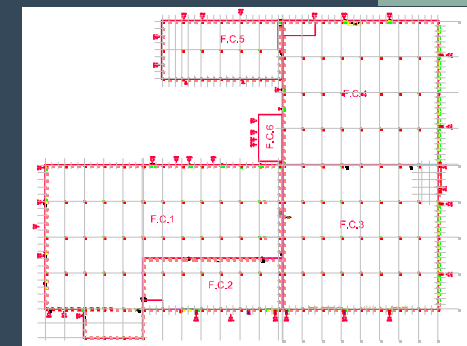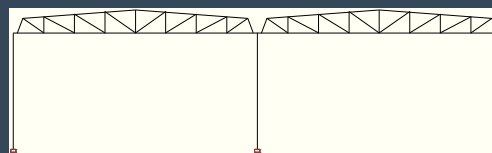

Fire design of the building according to the national regulations

The results concerning the steel structure:

Fire compartment	Use	Area (m2)	Height (m)	Volume (m3)	Required fire resistance
FC1	Production	15133.6	11	155079	30min
FC2	Inbound	3706.52	11	380307	60min
FC3	Logistics 1	10957.35	11	120530	90nin
FC4	Logistics 2	10973.65	11	120710	60min
FC5	Costumer service	4300	11	38064	60min

Typical frame of the structure

Total Span: 40m
Column Height: 9.30m
Total height: 11.20m

Note: The draft study concerns only the customers service building

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The first approach for the design of the building

- ➤ **Seismic design:**
  According to the national regulations (EAK 2000)

- ➤ **Fire design:**
  The fire protection requirements are achieved through fire-proof painting

The second approach for the design of the building

➢ **Seismic design**:
According to the national regulations (EAK 2000)

➢ **Fire design**:
According to Eurocode 3-Part 1.2

Step 1: Calculation of the temperature of structural members of the typical sub-frame, at the desired time t

Step 2: Static analysis for the fire combination $G + \psi_2 Q$

Step 3: Checking if the cross sections that are coming from the seismic design are appropriate, taking into account the fire combination at the desired time t

Step 4: Determination of the new cross sections at the time t of the fire

Step 5: Repeat Step 2 for the new cross-sections

Step 6: Checking if the new cross sections are adequate

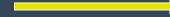**The second approach for the design of the building**

The results of the previous methodology indicate the following increase of the self weight of the structure

Seismic design	30minutes	60minutes
214.72kN	289.33kN	378.62kN

+34.75% →

+76.33% →

Comparison of the approaches

	Self-Weight	Financial cost	Fire-proof paint	Financial cost	Total cost
	kg	€	kg	€	€
30min					
Approach 1	21472	34355	842	6421	**40776**
Approach 2	28933	46293	-	-	**46293**
60min					
Approach 1	21472	34355	3011	14229	**48584**
Approach 2	37862	60580	-	-	**60580**