THE ISSUE OF SAFETY IN TUNNELS (1)

TUNNEL ST. DEMETRIO: EQUIPMENT & TRAFFIC DATA

Catania
Syracuse

Emergency Ventilation System

Longitudinal Ventilation average speed on the cross section of a peak in the direction of traffic:

Average of the distance via thermo sensors (calibrating): 3 minutes from the ignition signal point to evacuation of the tunnel. 

Delay for stopping approaching traffic

80 m/s

63% Flammable Liquids (motor spirit, diesel oil, etc.)
31% LPG
6% Others

TUNNEL ST. DEMETRIO: F-N CURVE IN THE SOUTH DIRECTION

CONCLUSIONS: QRAM AND FLUID DYNAMICS/EVACUATION MODELS

Data Collection
Data Preparation
Risk Calculation
Using QRAM

Is Risk acceptable?
NO

Additional risk reduction measures:

- Precautionary measures:
  - Setting and road markings
  - Traffic lights
  - Tracer poles
  - Provision of exit access via fire extinguisher

- Protection measures:
  - Pedestrian and cyclist walkways
  - Ventilation system
  - Directional signs
  - Rapid access exit hatches
  - System of emergency management

Risk Acceptability
- Absolute criteria
- Relative criteria

TUNNEL ST. DEMETRIO: DATA PREPARATION

Traffic
Vehicles
BLK/Day
Number of Lanes
10

Bus Coaches
HGV
LPG in Bulk
LPG in Cylinder
1,00E-03
1,00E-02
1,00E-01

THE ISSUE OF SAFETY IN TUNNELS (2)

Quantitative Risk Analysis

- Directive 2004/54/EC
- QRAM (Organisation of Economic Co-operation and Development)
- PIARC (World Road Association)
- European Commission
- OECD (Organisation for Economic Co-operation and Development)

-Evacuation Models
-Evacuation, Rescue
-Qualitative Risk Estimation
-Measures Included in the model?
-YES

SOCIETAL RISK ACCEPTABILITY CRITERIA

As Low As Reasonably Practicable

ALARP area:
- prevention and/or mitigation actions must be taken to reduce the risk, as far as reasonably practicable
- Cost – Benefit Analysis

TUNNEL ST. DEMETRIO: SENSITIVITY ANALYSIS RESULTS

Number of Violations

N = \[ \frac{(P(T) \cdot P(F)) \cdot F(N)}{T} \]

F-N curve construction

Each scenario may appear as different events E_1...E_n depending on:

- the section of the path being considered (P(T))
- the location on the section (P(F))
- the traffic direction (A_1, A_2)
- the reference period of the day (QUIT, NORMAL, PEAK)

Air | A_1 | A_2 | QUIT | NORMAL | PEAK
--- | --- | --- | --- | --- | ---
V_c | 75 | 75 | 75 | 75 | 75
V_0 | 0 | 0 | 0 | 0 | 0
a | 0 | 0 | 0 | 0 | 0
v | 0 | 0 | 0 | 0 | 0

1) DANGEROUS GOODS AND ACCIDENT SCENARIOS

- No DGs
- 200 kW Fire
- 100 MW Fire
- Boiling Liquid Expanding Vapor Explosion
- Vapor Cloud Explosion
- Turbo Fire
- Dust Fire
- Toxic Release in the air
- BLEVE

THE ST. DEMETRIO TUNNEL

Natural Tunnel: Twin Bore Tunnel, One Direction Per Bore Polished Circular Section Traditional Excavation

CENTRAL DESIGN MANAGEMENT ANAS S.p.A.


Analisi del rischio per la sicurezza nelle gallerie stradali - ID191
Di Santo, C., Gkoumas, K., Bontempi, F.