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New Archival Evidence on the 1977 Vrancea, Romania Earthquake and its Impact on Disaster Management and Seismic Risk

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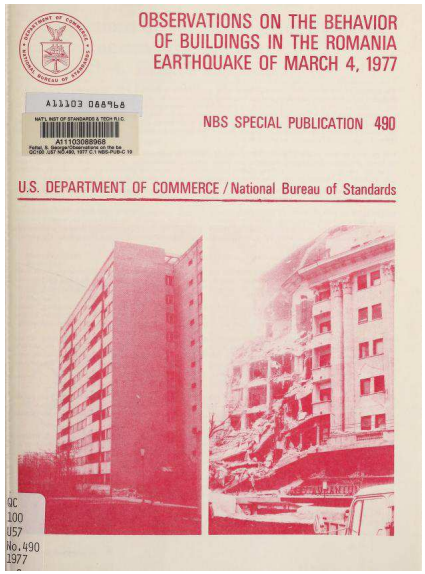
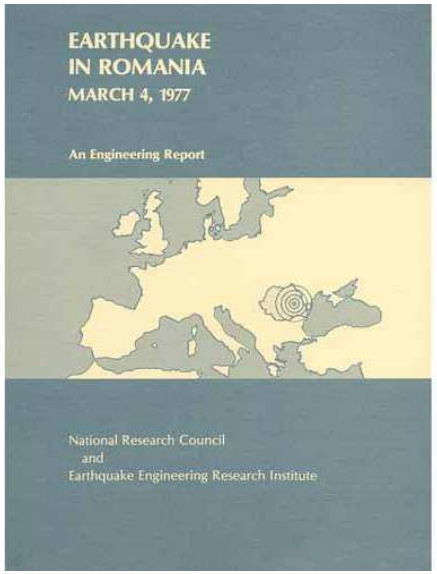
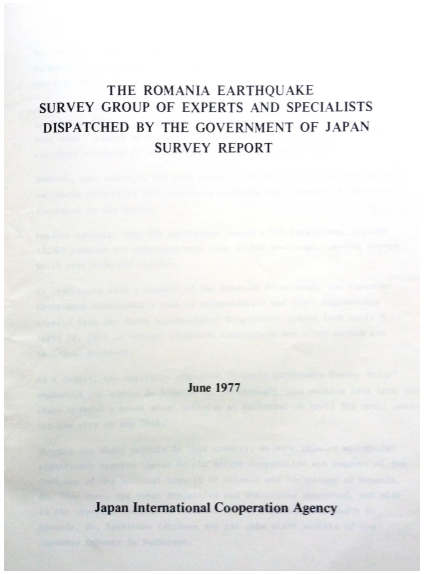
1. Introduction

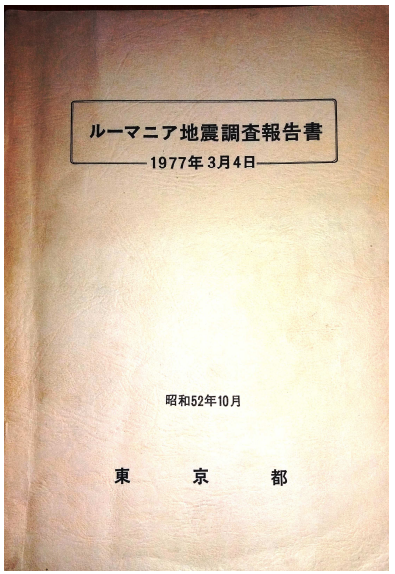
1. The March 4, 1977 Vrancea earthquake impact was known gradually from Romanian Communist Party (RCP) and Romanian Government communiqués, as well as from local mass-media, along the first month. Soon after March 4, teams of foreign specialists and press reporters arrived in Romania.

- The local and international engineering community was well informed about its consequences and lessons learnt:
  - In Reports of ICCPDC-INCERC, ICB/TUCEB, IPB, IPCT, IP Carpati, Counties IPJ, and CFPS;
  - in mass-media and books in Romanian such as Buhoiu, 1977,
  - in international reports and papers as Fattal *et al.*, 1977, Jones, 1977, 1986, Berg *et al.*, 1980 and the World Bank, 1978, 1983; JICA, 1977, etc.

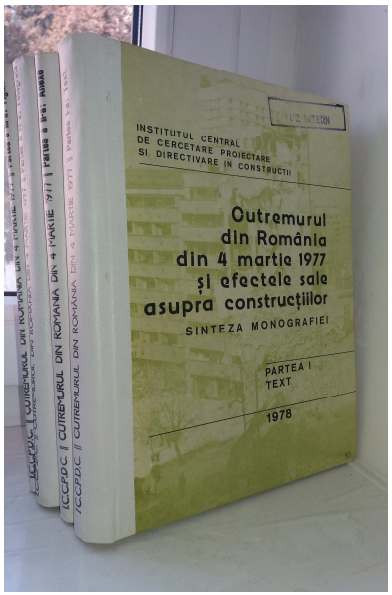


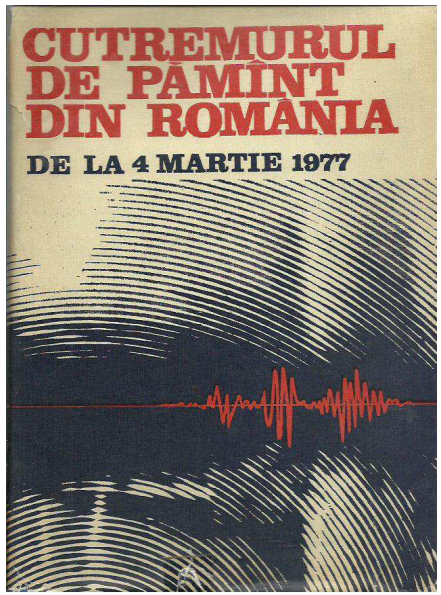


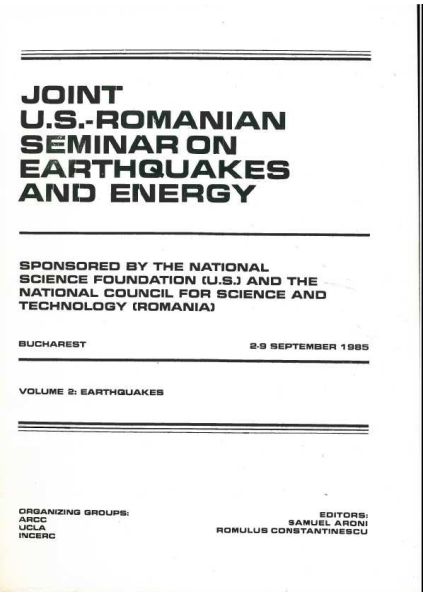




- Appreciation of prompt countermeasures, quick restoration of critical facilities and infrastructure, good behavior of the majority of structures designed according to the 1963 and 1970 seismic codes, all were emphasized.







- There was a **political context** around the earthquake impact. **The engineering community knew only a small part of the whole picture.**
- In 1979, Radio Free Europe broadcast how since July 4th, 1977 **the regime imposed local repairs instead of overall strengthening of damaged buildings** (Eng. Gh. Ursu's letters).
- Most recently the contemporary historical remembrance of post-disaster issues continues, through a recent history doctoral dissertation (Steinbrueck, 2017).

PRESENT PAPER APPROACH

Key question: Which is the impact of the 1977 year decisions on today's disaster management and seismic risk?

The authors accessed and studied **new archival sources** with the aim:

- **to deepen the understanding of key technical decisions of the time, in interaction with political decisions and secret police surveillance activities;**
- **to review the mass-media coverage in 1977, with today's wisdom;**
- **to improve knowledge about the current seismic risk in Romania.**

Authors evaluated the **press coverage and minutes vs communiqués of the RCP** of 1977 **to help us understand how the Ceauşescu regime's decisions evolved.**

Also, some **declassified cables of the US Embassy in Bucharest** of 1977 were consulted.

 
PROLETARI DIN TOATE ȚĂRILE, UNIȚI-VĂ!

Scînteia

ORGAN AL COMITETULUI CENTRAL AL PARTIDULUI COMUNIST ROMÂN

În seara zilei de 4 martie în jurul orei 21 și 30', a avut loc un puternic cutremur de pămînt, care a afectat o serie de zone ale țării

DECRET PREZIDENȚIAL

cu privire la instituirea stării de necesitate pe teritoriul Republicii Socialiste România

Decretează:

Dragi tovarăși și prieteni!

Cetățeni ai Republicii Socialiste România!

NICOLAE CEAUȘESCU


PROLETARI DIN TOATE ȚĂRILE, UNIȚI-VĂ!

Scînteia

ORGAN AL COMITETULUI CENTRAL AL PARTIDULUI COMUNIST ROMÂN

TOVARĂȘUL NICOLAE CEAUȘESCU

s-a aflat ieri, din primele momente ale reîntoarcerii în patrie, în locurile din Capitală care au avut cel mai mult de suferit de pe urma cutremurului

Ședința Comitetului Politic Executiv al C.C. al P.C.R.

Ceausescu, Mrs Ceausescu, Mircea Georgescu - Head of IGSIC and others on Victoriei Avenue, in front of Nestor Clock Collapse. (*„Fototeca online a comunismului românesc”, Fotografia #LA419,* Cota: *37/1977.*

POST-DISASTER POLITICAL AND ADMINISTRATIVE MANAGEMENT

- **March 5, 1977: “State of necessity” was decreed by President Ceausescu immediately after return from Africa.**
- **CPEx meetings were held on March 5 (ANR CCRCP, Chancellery 18/1977), March 6 (ANR CCRCP, Chancellery 21/1977), and March 7 to 11, as well as March 14 and 17.**
- **On March 22, 28 and 29, extended working conferences were also held.**
- **Later on, the July 4, 1977 meeting is a turning point.**

LOCAL AND INTERNATIONAL POLITICAL CONTEXT

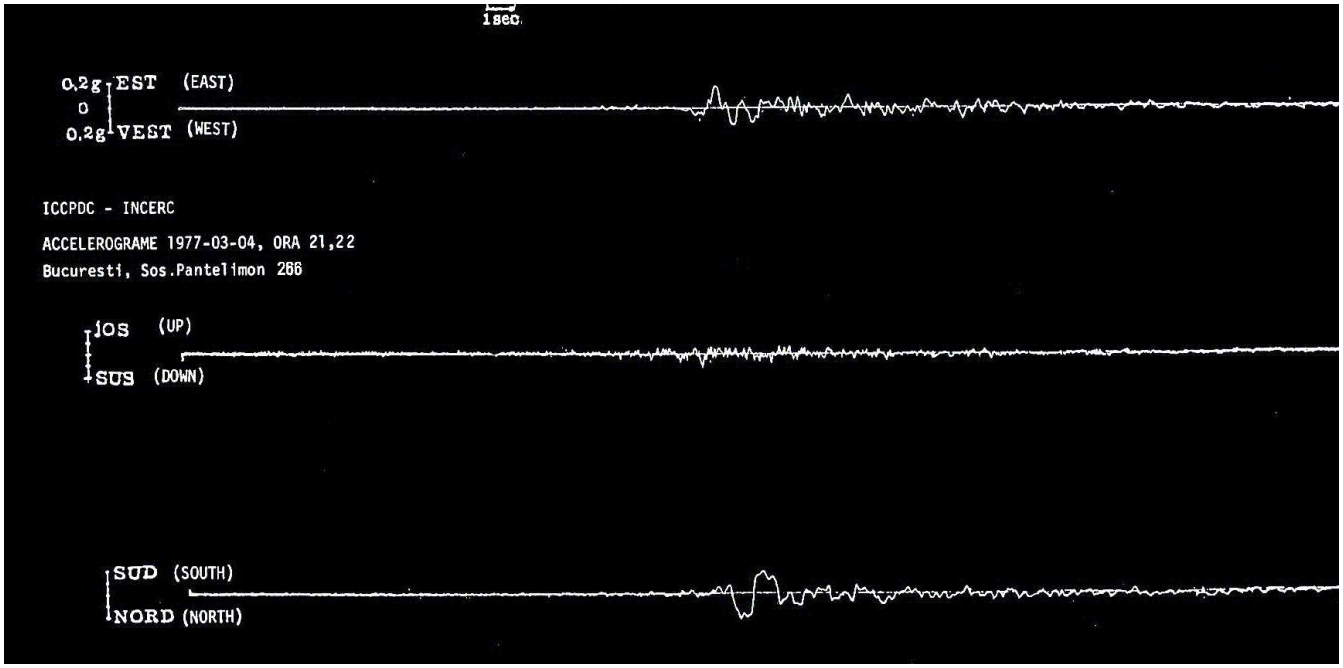
The international epoch context was related to:

- the situation of Romania among Warsaw Treaty and socialist block, after Praga 1968;
- the situation of RCP and of Ceausescu in the debate between USSR and China;
- the apparent favoured position of the regime, at least in its relationships with USA - granting of MFN clause, good commerce with UK and West Germany;
- the situation of emerging illegal unions, human rights activists, as a motion obviously pushed by the USA, Western politics and Free Europe Radio, VOA Radio etc, open or hide, as a tool to blow and dismantle the Iron Curtain Block, Prague Carta 77, local dissents etc;
- the Western media rumors and suppositions about how the regime will face the losses or will collapse.

2. Earthquake engineering and engineering seismology lessons after March 4, 1977

Earthquake engineering

- The technical aspects on the damage causes were discussed quite openly.
- To understand the specific pattern of March 4, 1977 Vrancea motion (Balan et al, 1982), one should consider a lesson, with significant international implications (Fattal *et al,* 1977; Berg *et al*, 1980), i. e. the ***INCERC Bucharest accelerogram.***
- ***The ground motion recording at Romanian Buildings Research Institute (INCERC) in NE Bucharest showed larger values than the 1970 seismic design code, and was one of the first recordings worldwide with significant long-period spectral content.***



INCERC Bucharest accelerogram, March 4, 1977 provided by a Japanese SMAC-B.

- This helped engineers to understand why the capital city damage and destruction were more concentrated on multi-story apartment blocks and office-commercial buildings (up to 12 stories) than other structures.
- **A highly improved seismic design code was introduced in 1978.**

However, after March 4, 1977 there were many missing data:

- damage data from internal reports (ICCPDC, 1978) – kept confidential
- data on the losses per economic sector – disclosed only to World Bank
- the human casualties' distribution - kept in Strictly Secret files of M I .

Significant local studies and data addressing such important issues were presented in: Balan *et al.,* 1982; Georgescu and Kuribayashi, 1992; Georgescu, 2003; Sandi *et al.*, 2008; and more recently in Georgescu and Pomonis, 2007; 2008; 2010; 2011 and 2012.

Engineering seismology issues

- Local situation of equipments forced the political and government leaders to ask and / or accept international assistance and cooperation
- Mobile seismic stations from Germany – University of Karlsruhe were deployed in Romania
- Teams of seismologists from USA, Germany, Yugoslavia, China, USSR, Greece, Turkey, Iran, Venezuela arrived.
- A Working meeting of Ceausescu with researchers of CFPS was held on March 8, 1977
- A CPEx Meeting of March 10, reiterated seismological concerns of RCP leaders.
- New Archival disclosures of early March 1977 show us:
  - The contradictory level of seismic issues knowledge within the RCP leadership;
  - The belief of some seismologists that epicenter was, possibly, near Bucharest, embraced in the first days also by Ceausescu !
  - The fear of some unknown shaking cause: nuclear explosion (?) connected with the difficulty of understanding long-distance Vrancea motions patterns, both for earyh-sciences researchers and political leaders;
  - There were expectations on earthquake prediction capability, using animals.
  - **Ceausescu was not immediately informed about INCERC accelerogram.**
- These issues will be detailed in another paper

NEW ARCHIVAL DATA - The level of technical knowledge within the RCP leadership

- What could the leaders learned about earthquake disasters ? 1940 - Vrancea, 1963 – Skopje, 1966 – Taskent, 1969 - Banja Luka, 1976 – Tangshan, 1976 – Van.
- Besides the communiqués, **when reading the minutes, the picture is different, in fact, the deciding leaders argued and debated quite chaotic, how search and rescue be done, who and how to ensure works, Ceausescu and his wife having the last word and blaming many close aides, without having any professional skills.**
- Some of the shortcomings were real, as the Army was used a decade in agriculture and was not equipped for disasters. The last disasters were floods in 1970 and 1975, different of an earthquake.

NEW ARCHIVAL DATA - The succession of superior leadership opinions, as revealed by Minutes of CPEx and official mass-media

- March 5, 1977 CP Ex Meeting
  - Buildings of CC RCP, Government (Palace Victoria), Council of State (Former Royal Palace) and Bucharest City Hall were damaged.
  - The **fear of aftershocks** prompted authorities to recommend evacuation of damaged buildings (Ceausescu is aware of experience of China – Tangshan Earthquake, July 26, 1976 – when the aftershock occurred in a second day.
- March 5, 1977: President Carter had informed US Embassy that "the United States stands ready to extend emergency assistance…".
- March 6, 1977 CP Ex Meeting (ANR CCRCP, Chancellery 21/1977)

- ◆Army and technical staff did wrong things on collapsed buildings sites
- ◆Students (??!!) to be allowed as voluntary for SAR operations
- ◆Visits in Bucharest and South. The order to record all damaged buildings

- **March 6, 1977: US Embassy cables inform that Foreign Affairs Minister Macovescu asked long-term financial assistance to help Romania maintain it independence vs Soviet Union**

Gathering of people around collapsed building sites was a natural social reaction, but I was considered unappropriate in CPEx Meetings, as all must work for SAR and debris cleaning (Ion Ghica – Colonade site)

- March 7, 1977 CP Ex Meeting - It is urged to not make assessment in haste
- March 8, 1977 Meeting with CFPS staff.
- March 8, 1977 CP Ex Meeting - The good organization of repair activity is stressed out
- **March 8, 1977: US Embassy cables inform about the postponing theatrical tour of Bulandra Theater in USA, because of Toma Caragiu death in Colonade Block collapse**
- March 9, 1977 CPEx Meeting - **Repair must be ended at May 1-st – The International Labor Day ! In 45 days !?**
- **March 9, 1977: US Embassy cables inform on the need and request of seismological equipment, since some 33% of apparata of Institute of Geology and Geophysics were lost and many other damaged. Prof. Bruce Bolt is on his way to Romania.**
- **Center of Earth Physics and Seismology was also in need of two stations**

- **Fast repairs have been ordered**
  - March 10, 1977 CPEx Meeting
    - Ending Law of Necessity State, except Bucharest, telecom services and Radio-Television
    - Ceausescu: there is a “chaos” at airport where the foreign aids are delivered
    - Order to start work on streets, seeking safety - **to strengthen even the buildings deemed to be later demolished** !! To be not a danger.
    - Expressing **first opinion** with CPEX staff about **the need of a new Civic Center**, somewhere on Victoriei Square or Calea Plevnei – Bd. Stirbey Voda because of damage in ALL buildings of RCP – Party and State use

- CC RCP building was considered by Ceausescu “a former prison” (in fact it was built in the 1940’s as Ministry of Interior)

PROLETARI DIN TOATE ȚĂRILE, UNIȚI-VĂ!

Scînteia

ORGAN AL COMITETULUI CENTRAL AL PARTIDULUI COMUNIST ROMÂN

Anul XLVI Nr. 10 747 | Joi 10 martie 1977 | 6 PAGINI — 30 BANI

Şedinţa Comitetului Politic Executiv al C. C. al P. C. R.

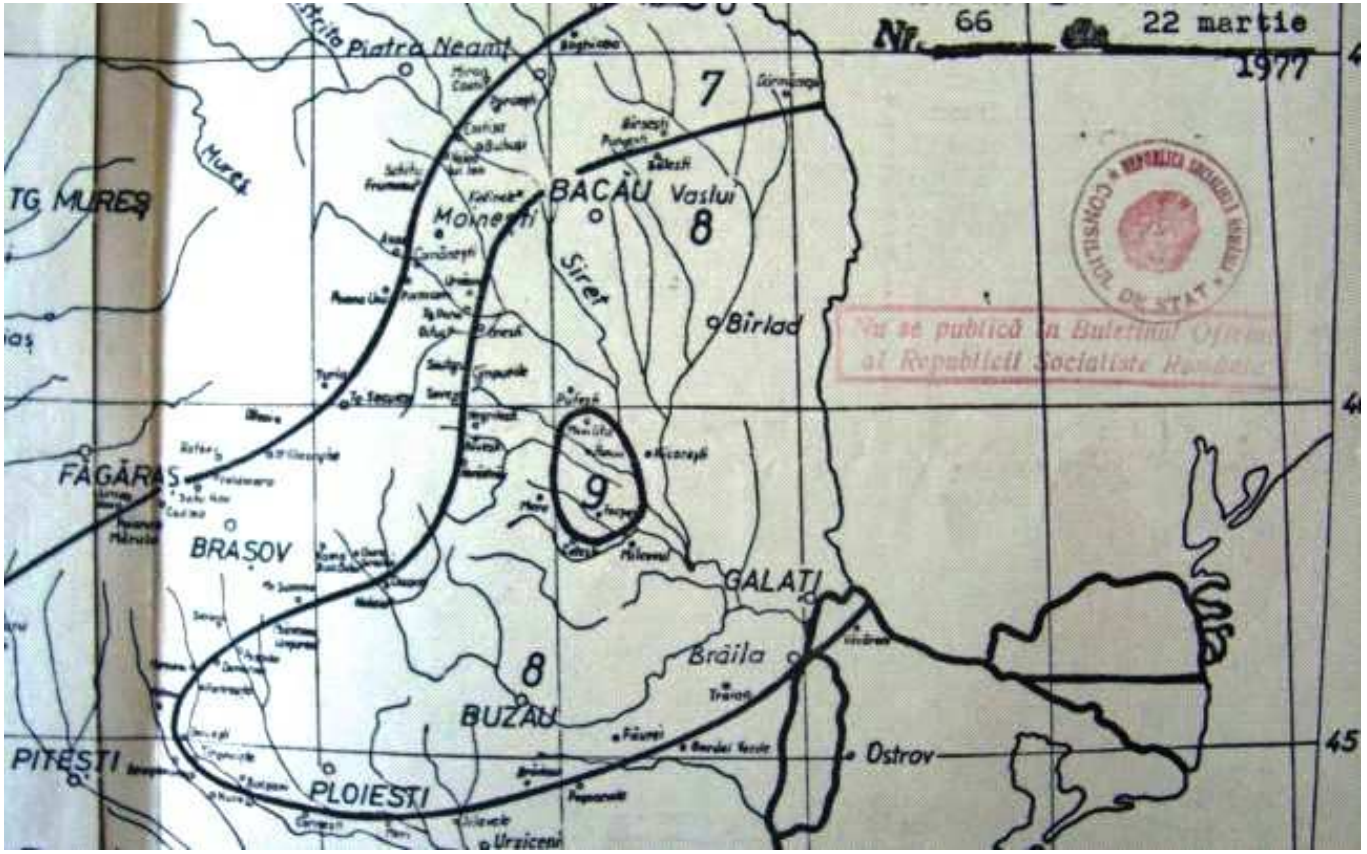
ziua de miercuri, 9 martie, în ... Comitetul Politic ... rii din greaua încercare prin care a trecut. ... stagnarea temporară a producției în unitățile avariate.

DECRET PREZIDENȚIAL
cu privire la încetarea stării de necesitate pe teritoriul țării, cu excepția municipiului București și a unităților sistemului de telecomunicații și a Radioteleviziunii

NICOLAE CEAUȘESCU
Președintele Republicii Socialiste România, Comandantul suprem al Forțelor armate ale Republicii Socialiste România

- **From 9 to 12 March, 1977, a USGS warning on a possible new Vrancea earthquake *triggered quite a diplomatic dispute with USA and this favored a recovery of the reluctant trust of Ceausescu in Romanian seismologists. Large press campaign to combat fear of aftershocks in Scinteia.***
- March 11, 1977 CPEx Meeting – how the insurance compensations money be used
- March 14, 1977 CPEx Meeting – the activity of identification and strengthening is on a good way, the extrication of the last bodies ended, debris not all cleared
  - urging to establish a team of **high qualified specialists**
- **March 22, 1977: President Carter's official letter to Ceausescu on assistance**
- April: The US Congress voted to appropriate 20 million USD to Romania.

- **The Decree No. 66/March 22, 1977 of State Council enforce a new seismic zoning map.**
- **Map not allowed for publication in Official Gazette !!!**



- **For Bucharest and many towns, design MSK degrees were cut in map of STAS 11100/1-77 enforced by Decree No. 163/May 11, 1978.**

3. Earthquake disaster patterns – new archival data

BUILDINGS' DAMAGE

First public data released on March 9, 1977 CPEx Meeting:

- 6 Bln Ro Lei loss from ca 20,000 dwellings destroyed and damaged, 195 enterprises, 7,000 families homeless

Table 1

Situation of damaged buildings as of March 18, 1977 by Ministry of Interior (MI),

(CNSAS Archive, Chancellery 9665. D 011737/vol. 105, p.139)

Extent of Damage	ROMANIA	out of which	
		Bucharest	Counties
Buildings & Dwellings destroyed	7,270	157	7,113
Buildings & Dwellings at risk	12,931	-	12,931
Buildings & Dwellings damaged	45,746	2,101	43,645

According to the above table, the lack of buildings at risk in Bucharest is unusual. This may be due to the tight political control in Bucharest and due to building evacuation orders.

SEARCH AND RESCUE AND FATALITIES

- First public data on March 9, 1977 CPEx Meeting: 1387 deceased, 10,396 injured
- Search and rescue operations lasted more than ten days at the 23 sites of major collapsed buildings in Bucharest.

Table 2

Number of deceased and situation of identification on March 31, 1977, (Attorney General and Ministry of Interior, **CNSAS Archive; ANR CCRCP, Section of Administrative and Politics 12/1977, p. 43)**

Fatalities situation	Place		
	Bucharest	Other localities	TOTAL
Deceased	1,420	150	1,570
of which Identified	1,219	150	1,369
of which Unidentified	201	-	201

UNIDENTIFIED BODIES

In Bucharest, 201 out of 1,110 bodies recovered from the rubble of the 23 collapsed-occupied buildings remained unidentified, and were buried afterwards, according to proper procedures in Domneşti Cemetery with indication of the collapse location. These 195 of the 201 were in just 10 building collapse sites. In addition, there were 310 deaths in Bucharest not linked to the 23 major building collapse sites.

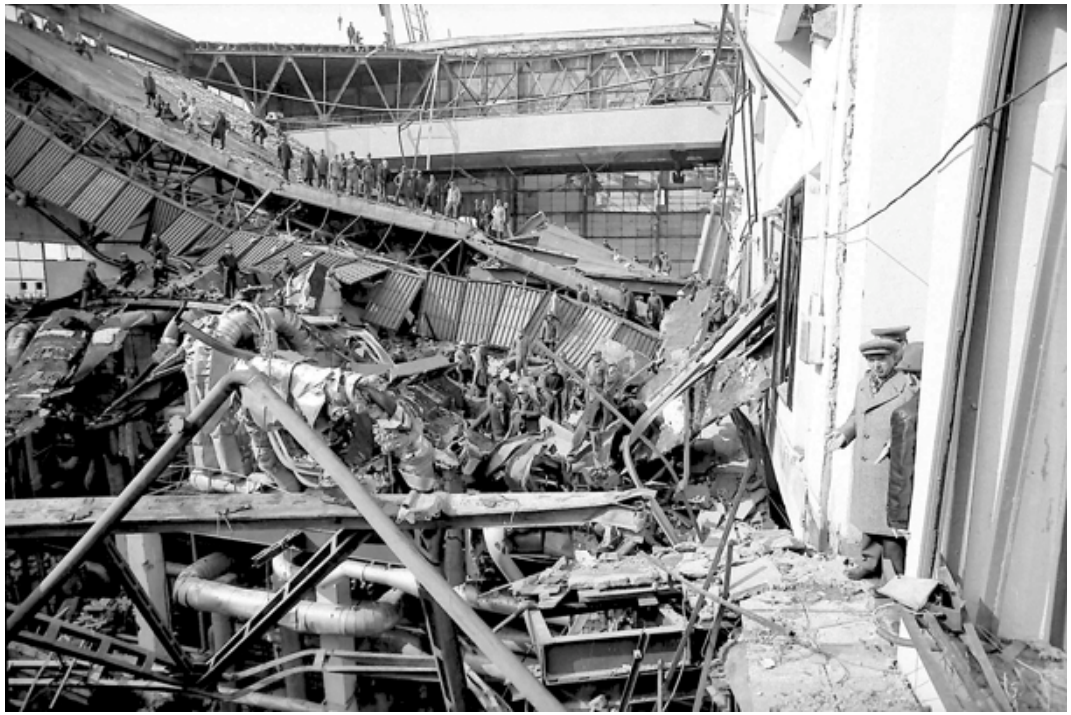
Ceausescu, Mrs. Ceausescu and high leadership members after a visit to Dunarea Block partial collapse, March 1977 (Agerpres photo)

Domnesti Cemetery (1977): Unidentified bodies from Dunarea Block and Arghezi Street (Museum of Bucharest photo stock)

TOTAL CASUALTY FIGURES

- The total of 1,570 deaths was mentioned by Ceauşescu in his public speeches and other documents and reported by the World Bank (1978).
- A final tally of 1,578 deaths was reported in BSSA, 1978 with 1,424 deaths in Bucharest (for details see Georgescu and Pomonis, 2010; 2011 and 2012).

- According to the Ministry of Interior (MI) archives, of the 1,420 dead in Bucharest, 1,110 (78%) died in the 23 collapsed buildings of which 97 were not registered residents. The deceased non-residents are only reported as a total, not by collapse site.
- **The remaining 310 victims in Bucharest** - it was possible that they were in other collapsed non-residential buildings (Office blocks Nestor and Carpați; Hotel Victoria; Faculty of Chemistry), damaged industrial workshops, smaller residential buildings, and in the streets.
- ***This issue has not been discussed until now and deserves further investigation.***
  - ***For the time being, the US Embassy cables of March 31, indicate that at Computing Center of MTTC a number of three technicians died on duty.***



Ceausescu visiting an impressive industrial hall roof collapse at TEC Grozavesti.

LETHALITY RATIO - NEW MI ARCHIVE DATA

The lethality ratio (ratio of deceased over the number of resident-occupants at the time of the earthquake) was 50% in the 21 pre-1940 collapsed buildings.

- Inspection of the data against photos pointed to the fact that lethality was highest in 13 buildings that collapsed entirely leaving very few survival voids as well as in few buildings where fire followed the collapse.
- Overall lethality was 62% in these thirteen buildings.

Pre-1940 high-rise blocks collapses with almost total volume loss and heavy lethality ratios

Scala block debris

The group of blocks in Ion Ghica, Bibliotecii and Colonade Streets

The lethality ratio in the two newer collapsed buildings was much lower at 16%.

Partial collapse of a section in Bloc OD16, Bd. Pacii No 7, Bucharest, built in 1974

Partial soft-story type collapse of Bloc 30 “Lizeanu’, Stefan cel Mare Street, No. 33, Bucharest, built in 1962

- Overall lethality in the 10 buildings that collapsed less catastrophically was 20%.

4. The emergency and recovery period vs political decisions with long-term impact

4.1 Research method

For the goals of the present paper, we selected only the issues with technical and legal consequences on seismic risk from the most important minutes of March 22 working meeting (ANR CCRCP, Chancellery 42/1977) and CPEx meetings of March 30 (ANR, CCRCP, Chancellery 42/1977) and July 4, 1977 (ANR, CCRCP, Chancellery 21/1977, ANR, CCRCP, Economics, 78/1977).

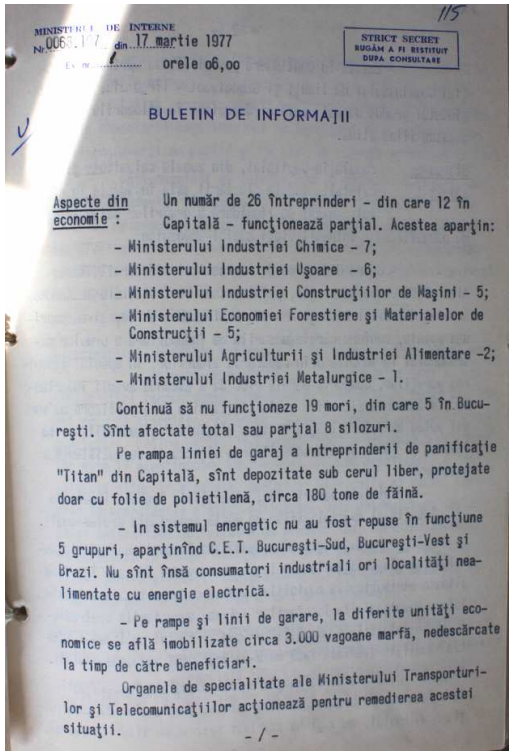
Early March, 1977 - Secret police surveillance of engineers

The surveillance was directed on the issue of **opinions about assessment, repair and strengthening.**

This issue proved – later on - to be Ceausescu's key issues of interest!

Authors opinion:

- **Knowing the thinking of engineers, he devised his approach in a different way towards engineers vs architects ! See March 22 vs July 4, 1977 meetings.**



MINISTERUL DE INTERNE
din 17 martie 1977
orele 06,00

STRICT SECRET
RUGĂM A FI RESTITUIT DUPĂ CONSULTARE

BULETIN DE INFORMAȚII

Aspecte din economie : Un număr de 26 întreprinderi - din care 12 în Capitală - funcționează parțial. Acestea aparțin:

- Ministerului Industriei Chimice - 7;
- Ministerului Industriei Ușoare - 6;
- Ministerului Industriei Construcțiilor de Mașini - 5;
- Ministerului Economiei Forestiere și Materialelor de Construcții - 5;
- Ministerului Agriculturii și Industriei Alimentare -2;
- Ministerului Industriei Metalurgice - 1.

Continuă să nu funcționeze 19 mori, din care 5 în București. Sînt afectate total sau parțial 8 silozuri.

Pe rampa liniei de garaj a întreprinderii de panificație "Titan" din Capitală, sînt depozitate sub cerul liber, protejate doar cu folie de polietilenă, circa 180 tone de făină.

- In sistemul energetic nu au fost repuse în funcțiune 5 grupuri, aparținînd C.E.T. București-Sud, București-Vest și Brazi. Nu sînt însă consumatori industriali ori localități nealimentate cu energie electrică.

- Pe rampe și linii de garare, la diferite unități economice se află imobilizate circa 3.000 vagoane marfă, nedescărcate la timp de către beneficiari.

Organele de specialitate ale Ministerului Transporturilor și Telecomunicațiilor acționează pentru remedierea acestei situații.

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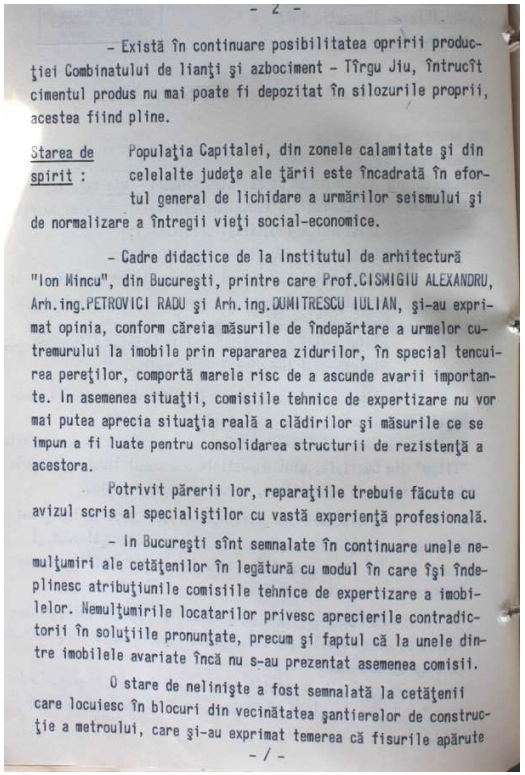


- 2 -

- Există în continuare posibilitatea opririi producției Combinatului de lianți și azbociment - Tîrgu Jiu, întrucît cimentul produs nu mai poate fi depozitat în silozurile proprii, acestea fiind pline.

Starea de spirit : Populația Capitalei, din zonele calamitate și din celelalte județe ale țării este încadrată în efortul general de lichidare a urmărilor seismului și de normalizare a întregii vieți social-economice.

- Cadre didactice de la Institutul de arhitectură "Ion Mincu", din București, printre care Prof.CISMIGIU ALEXANDRU, Arh.ing.PETROVICI RADU și Arh.ing.DUMITRESCU IULIAN, și-au exprimat opinia, conform căreia măsurile de îndepărtare a urmelor cutremurului la imobile prin repararea zidurilor, în special tencuirea pereților, comportă marele risc de a ascunde avarii importante. In asemenea situații, comisiile tehnice de expertizare nu vor mai putea aprecia situația reală a clădirilor și măsurile ce se impun a fi luate pentru consolidarea structurii de rezistență a acestora.

Potrivit părerii lor, reparațiile trebuie făcute cu avizul scris al specialiștilor cu vastă experiență profesională.

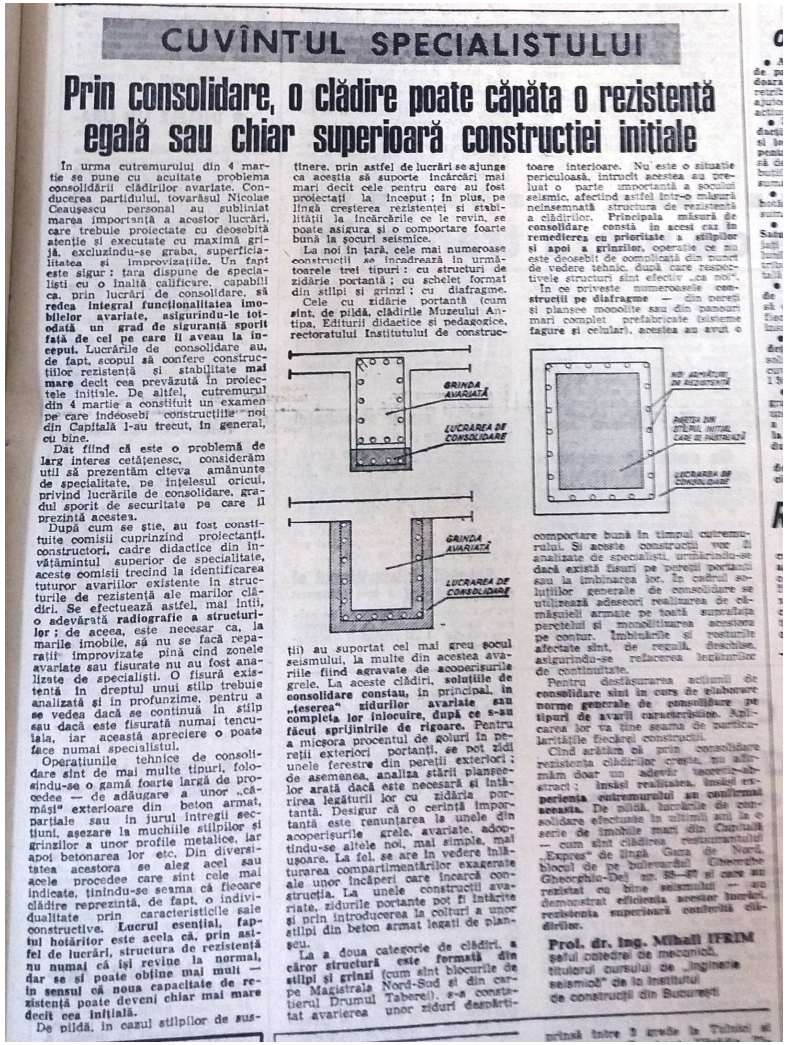
- In București sînt semnalate în continuare unele nemulțumiri ale cetățenilor în legătură cu modul în care își îndeplinesc atribuțiunile comisiile tehnice de expertizare a imobilelor. Nemulțumirile locatarilor privesc aprecierile contradictorii în soluțiile pronunțate, precum și faptul că la unele dintre imobilele avariate încă nu s-au prezentat asemenea comisii.

O stare de neliniște a fost semnalată la cetățenii care locuiesc în blocuri din vecinătatea șantierelor de construcție a metroului, care și-au exprimat temerea că fisurile apărute

- / -

MI Report, March 17, 1977 mentioning Prof. **Alexandru Cismigiu, Radu Petrovici** and **Iulian Dumitrescu** from “Ion Mincu” Institute / University of Architecture, as being against repairs that hide the damage

RCP AND GOVERNMENT ACTIVITY VS MASS-MEDIA COVERAGE DURING MARCH 1977



CUVÎNTUL SPECIALISTULUI

Prin consolidare, o clădire poate căpăta o rezistență egală sau chiar superioară construcției inițiale

În urma cutremurului din 4 martie se pune cu acuitate problema consolidării clădirilor avariate. Conducerea partidului, tovarășul Nicolae Ceaușescu personal au subliniat marea importanță a acestor lucrări, care trebuie proiectate cu deosebită atenție și executate cu maximă grijă, excluzîndu-se graba, superficialitatea și improvizațiile. Un fapt este sigur : țara dispune de specialiști cu o înaltă calificare, capabili ca, prin lucrări de consolidare, să redea integral funcționalitatea imobilelor avariate, asigurîndu-le totodată un grad de siguranță sporit față de cel pe care îl aveau la inceput. Lucrările de consolidare au, de fapt, scopul să confere construcțiilor rezistență și stabilitate mai mare decît cea prevăzută în proiectele inițiale. De altfel, cutremurul din 4 martie a constituit un examen pe care îndeosebi construcțiile noi din Capitală l-au trecut, în general, cu bine.

Dat fiind că este o problemă de larg interes cetățenesc, considerăm util să prezentăm cîteva amănunte de specialitate, pe înțelesul oricui, privind lucrările de consolidare, gradul sporit de securitate pe care îl prezintă acestea.

După cum se știe, au fost constituite comisii cuprinzînd proiectanți, constructori, cadre didactice din învățămîntul superior de specialitate, aceste comisii trecînd la identificarea tuturor avariilor existente în structurile de rezistență ale marilor clădiri. Se efectuează astfel, mai întîi, o adevărată radiografie a structurilor ; de aceea, este necesar ca, la marile imobile, să nu se facă reparații improvizate pînă cînd zonele avariate sau fisurate nu au fost analizate de specialiști. O fisură existentă în dreptul unui stîlp trebuie analizată și în profunzime, pentru a se vedea dacă se continuă în stîlp sau dacă este fisurată numai tencuiala, iar această apreciere o poate face numai specialistul.

Operațiunile tehnice de consolidare sînt de mai multe tipuri, folosindu-se o gamă foarte largă de procedee — de adăugare a unor „cămăși" exterioare din beton armat, parțiale sau în jurul întregii secțiuni, așezare la muchiile stîlpilor și grinzilor a unor profile metalice, iar apoi betonarea lor etc. Din diversitatea acestora se aleg acel sau acele procedee care sînt cele mai indicate, ținîndu-se seama că fiecare clădire reprezintă, de fapt, o individualitate prin caracteristicile sale constructive. Lucrul esențial, faptul hotărîtor este acela că, prin asemenea lucrări, structura de rezistență nu numai că își revine la normal, dar se și poate obține mai mult — în sensul că noua capacitate de rezistență poate deveni chiar mai mare decît cea inițială.

De pildă, în cazul stîlpilor de susținere, prin astfel de lucrări se ajunge ca aceștia să suporte încărcări mai mari decît cele pentru care au fost proiectați la început ; în plus, pe lîngă creșterea rezistenței și stabilității la încărcările ce le revin, se poate asigura și o comportare foarte bună la șocuri seismice.

La noi în țară, cele mai numeroase construcții se încadrează în următoarele trei tipuri : cu structuri de zidărie portantă ; cu schelet format din stîlpi și grinzi ; cu diafragme.

Cele cu zidărie portantă (cum sînt, de pildă, clădirile Muzeului Antipa, Editurii didactice și pedagogice, rectoratului Institutului de construcții) au suportat cel mai greu șocul seismului, la multe din acestea avariile fiind agravate de acoperișurile „teserea" zidurilor avariate sau complicîndu-le inlocuire, după ce s-au făcut sprijinirile de rigoare. Pentru a micșora procentul de goluri în pereții exteriori portanți, se pot zidi unele ferestre din pereții exteriori ; de asemenea, analiza stării planșeelor arată dacă este necesară și întărirea legăturii lor cu zidăria portantă. Desigur că o cerință importantă este renunțarea la unele din acoperișurile grele, avariate, adoptîndu-se altele noi, mai simple, mai ușoare. La fel, se are în vedere înlăturarea compartimentărilor exagerate ale unor încăperi care încarcă construcția. La unele construcții avariate, zidurile portante pot fi întărite și prin introducerea la colțuri a unor stîlpi din beton armat legați de planșeu.

La a doua categorie de clădiri, a căror structură este formată din stîlpi și grinzi (cum sînt blocurile de pe Magistrala Nord-Sud și din cartierul Drumul Taberei), s-a constatat avarierea unor ziduri despărțitoare interioare. Nu este o situație periculoasă, întrucît acestea au preluat o parte importantă a șocului seismic, afectînd astfel într-o măsură neînsemnată structura de rezistență a clădirilor. Principala măsură de consolidare constă în acest caz în remedierea cu prioritate a stîlpilor și apoi a grinzilor, operație ce nu este deosebit de complicată din punct de vedere tehnic, după care rezistențele structurii sînt efectiv „ca noi".

În ce privește numeroasele construcții pe diafragme — din pereți și planșee monolite sau din panouri mari complet prefabricate (sisteme fagure și celular), acestea au avut o comportare bună în timpul cutremurului. Și aceste construcții vor fi analizate de specialiști, urmărindu-se dacă există fisuri pe pereții portanți sau la îmbinarea lor. În cadrul solurilor generale de consolidare se utilizează adeseori realizarea de cămășuieli armate pe toată suprafața pereților și monolitizarea acestora pe contur. Îmbinările și rosturile afectate sînt, de regulă, deschise, asigurîndu-se refacerea legăturilor de continuitate.

Pentru desfășurarea acțiunii de consolidare sînt în curs de elaborare norme generale de consolidare pe tipuri de avarii caracteristice. Aplicarea lor va ține seama de particularitățile fiecărei construcții.

Cînd arătăm că prin consolidare rezistența clădirilor crește, nu afirmăm doar un adevăr teoretic-abstract : însăși realitatea, însăși experiența cutremurului au confirmat aceasta. De pildă, lucrările de consolidare efectuate în ultimii ani la o serie de imobile mari din Capitală — cum sînt clădirea restaurantului „Expres" de lîngă Gara de Nord, blocul de pe bulevardul Gheorghe Gheorghiu-Dej nr. 58—67 și cele au rezistat cu bine seismului, au demonstrat eficiența acestor lucrări, rezistența superioară conferită clădirilor.

Prof. dr. ing. Mihail IFRIM
șeful catedrei de mecanică, titularul cursului de „Inginerie seismică" de la Institutul de construcții din București

Scinteia, March 18, 1977

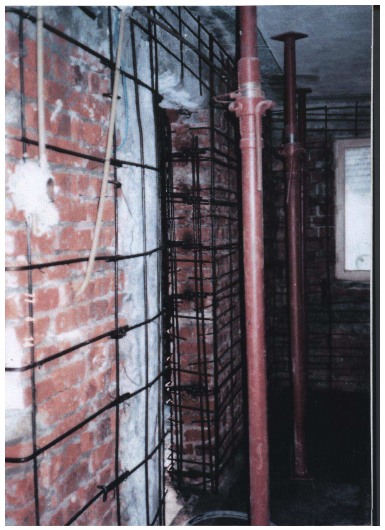
THE WORD OF SPECIALIST

"By strengthening, a building may obtain a resistance equal or even superior to the initial one"

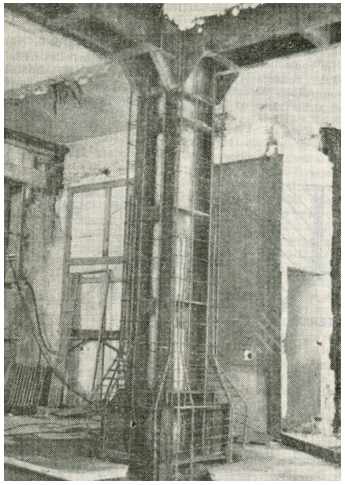
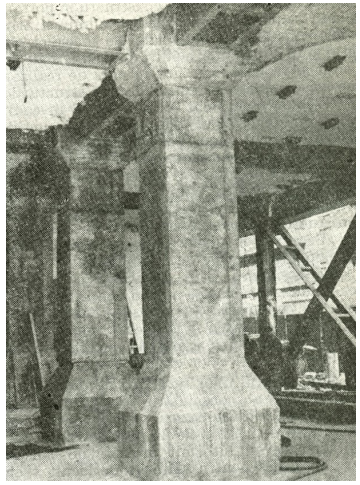
Prof. Mihail Ifrim
Head of Chair of Mechanics and Course of Earthquake Engineering
ICB / TUCEB

The paper is advocating the care, high qualification and the possibility ***to obtain an enhanced safety degree by strengthening works.*** The drawings show consistent jacketing solutions.

The advise is ***to not hurry, to identify all damages, i.e. the cracks in depth and this shall be done only by the specialist !***


Overall strengthening solutions were applied in the first three months

Generous and speedy strengthening of Electrolux building, Calea Victoriei

4.2 Minutes of March 22, 1977 meeting with architects and constructors

- Ceauşescu's introductory words made a clear connection between earthquake damage and the need to improve buildings' site location and traffic patterns in Bucharest's future development.
- The earthquake propelled the idea of a new Civic Center, discussed for the very first time on the March 10 CPEx Meeting. Ceauşescu was concerned about Victoriei Square and Victoriei Avenue, the need for a new Opera House and new monuments.

- Then, he expressed **the need for a Civic Center, and stated Arsenal / Uranus Hill as the place for its construction,** and gave 1984 as its target completion date.
- The operation was proudly declared as **"the first intervention of a large scale in the history of Bucharest".**

- He mentioned some 1,000 - 2,000 apartments, to be “replaced” with new ones. He stressed, ***“we do not stumble about some demolitions, we shall design a new planning…and we will work as if on an empty place”*** (ANR, Chancellery, 28/1977, 6-7, 12 reverse – 13 in archives; Țiu, 2014 p. 13, ANR, CCRCP, Economics, 41/1977, p. 4).
- About the buildings on Magheru Blvd. (the city’s most central boulevard), he accepted fewer demolitions and allowed reconstruction (ANR, CCRCP, Economics, 41/1977, p. 8).

4.3 Minutes of March 30, 1977 CPEx and the IGSIC instructions

On March 30, after visiting some of the collapsed building sites, Ceauşescu made statements that some scholars (Boia, 2016, Addenda p. 212 and p.1 of the copied CPEx Minute) consider to be a prelude for the extensive Bucharest demolitions. During that meeting he did say “if we will demolish all Bucharest it will be nice.” He then turned the discussion about dissidents (ANR, CCRCP, Chancellery 42/1977). We think this remark was about other situation.

These plans were discussed again on July 4, 1977. It was clear that Ceauşescu was the ultimate authority to decide if, where, and when demolitions would take place.

The mental process of making such a decision, as well as of others, will be discussed in the final part.

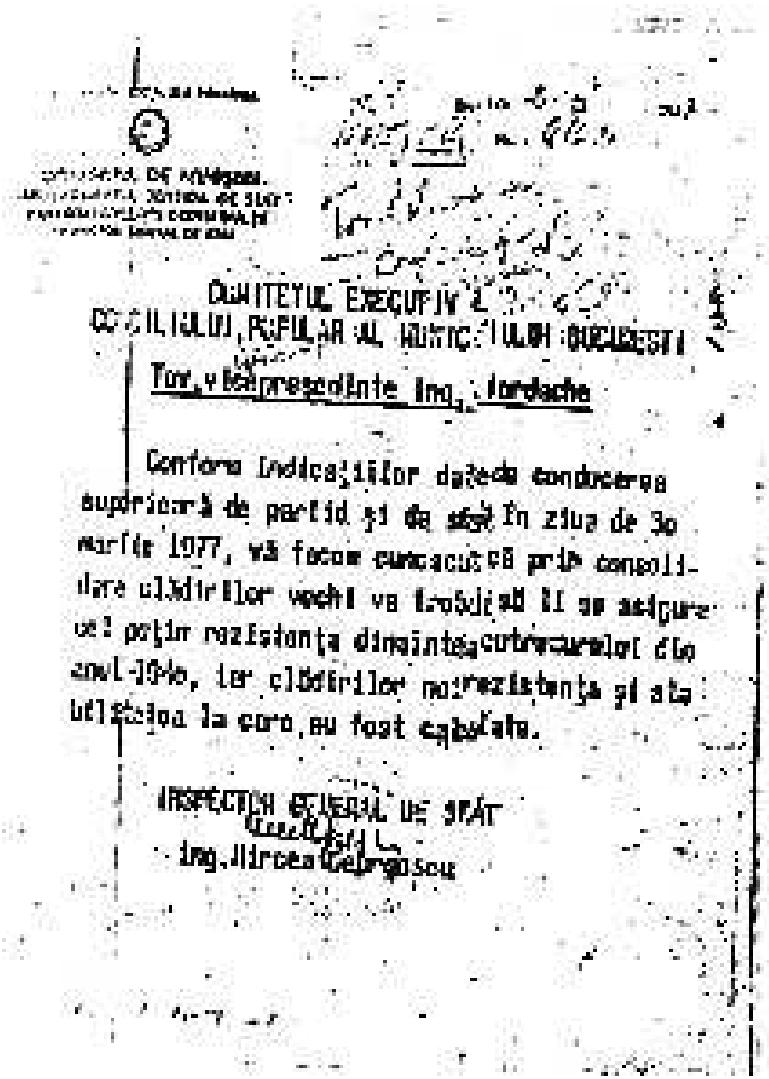
THE STRENGTHENING TARGETS:

After site visits of March 30, IGSIC (the General State Inspectorate for Investments and Constructions) have sent an official letter to all authorities, building design and research institutes, universities and construction companies, which stated the following:

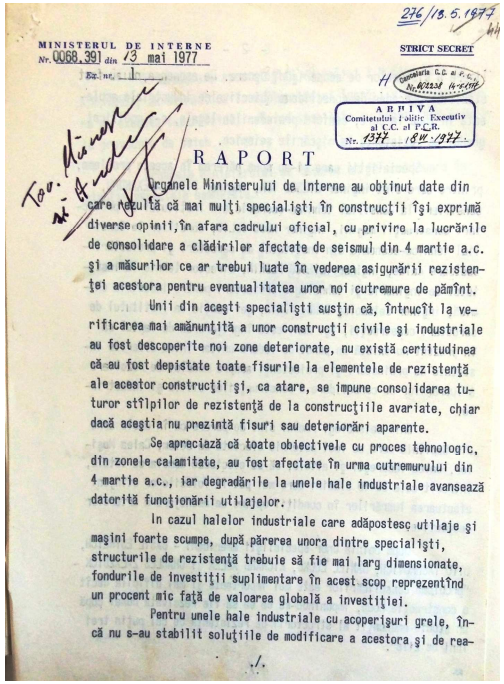
"According to the instructions given by the superior party and state leadership on March 30, 1977, we inform you that strengthening of old buildings shall provide at least the strength as before the 1940 earthquake, while for new buildings the strength and stability for which they were [initially] calculated"

(IGSIC instructions letter, 1977).

The term **"strengthening"** was used, although strictly speaking the intention was to bring a damaged building back to its pre-earthquake state and strength even if it had been constructed prior to the implementation of the first earthquake-resistant design code of Romania in 1963.



May 1977 – MI - Secret police surveillance of engineers – about assessment, repair and strengthening



MINISTERUL DE INTERNE
Nr. 0068.391 din 13 mai 1977
Ex. nr. 1

STRICT SECRET

ARHIVA Comitetului Executiv al C.C. al P.C.R. Nr. 1377 18.V.1977

RAPORT

Organele Ministerului de Interne au obţinut date din care rezultă că mai mulţi specialişti în construcţii îşi exprimă diverse opinii, în afara cadrului oficial, cu privire la lucrările de consolidare a clădirilor afectate de seismul din 4 martie a.c. şi a măsurilor ce ar trebui luate în vederea asigurării rezistenţei acestora pentru eventualitatea unor noi cutremure de pămînt.

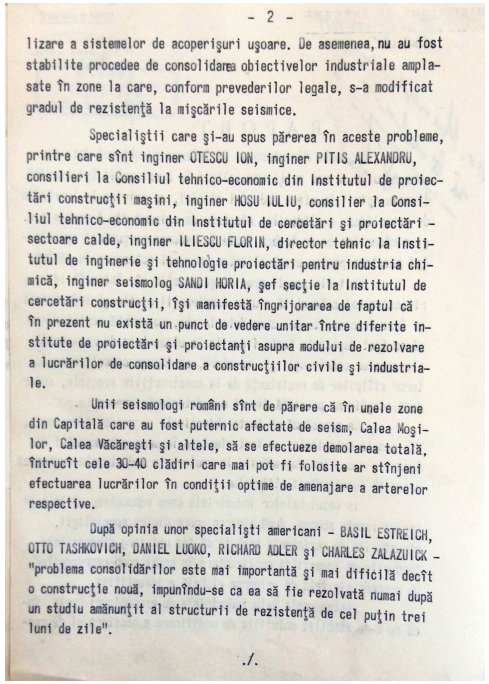
Unii din aceşti specialişti susţin că, întrucît la verificarea mai amănunţită a unor construcţii civile şi industriale au fost descoperite noi zone deteriorate, nu există certitudinea că au fost depistate toate fisurile la elementele de rezistenţă ale acestor construcţii şi, ca atare, se impune consolidarea tuturor stîlpilor de rezistenţă de la construcţiile avariate, chiar dacă aceştia nu prezintă fisuri sau deteriorări aparente.

Se apreciază că toate obiectivele cu proces tehnologic, din zonele calamitate, au fost afectate în urma cutremurului din 4 martie a.c., iar degradările la unele hale industriale avansează datorită funcţionării utilajelor.

In cazul halelor industriale care adăpostesc utilaje şi maşini foarte scumpe, după părerea unora dintre specialişti, structurile de rezistenţă trebuie să fie mai larg dimensionate, fondurile de investiţii suplimentare în acest scop reprezentînd un procent mic faţă de valoarea globală a investiţiei.

Pentru unele hale industriale cu acoperişuri grele, încă nu s-au stabilit soluţiile de modificare a acestora şi de rea-

./.



- 2 -

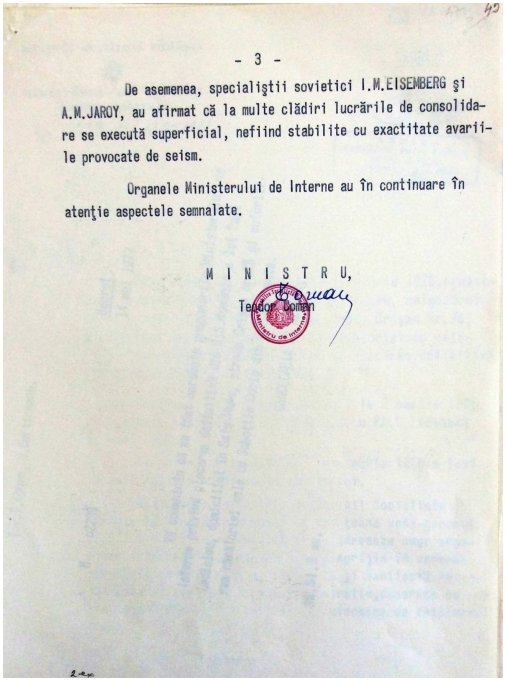
lizare a sistemelor de acoperişuri uşoare. De asemenea, nu au fost stabilite procedee de consolidarea obiectivelor industriale amplasate în zone la care, conform prevederilor legale, s-a modificat gradul de rezistenţă la mişcările seismice.

Specialiştii care şi-au spus părerea în aceste probleme, printre care sînt inginer OTESCU ION, inginer PITIS ALEXANDRU, consilieri la Consiliul tehnico-economic din Institutul de proiectări construcţii maşini, inginer HOSU IULIU, consilier la Consiliul tehnico-economic din Institutul de cercetări şi proiectări - sectoare calde, inginer ILIESCU FLORIN, director tehnic la Institutul de inginerie şi tehnologie proiectări pentru industria chimică, inginer seismolog SANDI HORIA, şef secţie la Institutul de cercetări construcţii, îşi manifestă îngrijorarea de faptul că în prezent nu există un punct de vedere unitar între diferite institute de proiectări şi proiectanţi asupra modului de rezolvare a lucrărilor de consolidare a construcţiilor civile şi industriale.

Unii seismologi români sînt de părere că în unele zone din Capitală care au fost puternic afectate de seism, Calea Moşilor, Calea Văcăreşti şi altele, să se efectueze demolarea totală, întrucît cele 30-40 clădiri care mai pot fi folosite ar stînjeni efectuarea lucrărilor în condiţii optime de amenajare a arterelor respective.

După opinia unor specialişti americani - BASIL ESTREICH, OTTO TASHKOVICH, DANIEL LUOKO, RICHARD ADLER şi CHARLES ZALAZUICK - "problema consolidărilor este mai importantă şi mai dificilă decît o construcţie nouă, impunîndu-se ca ea să fie rezolvată numai după un studiu amănunţit al structurii de rezistenţă de cel puţin trei luni de zile".

./.



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De asemenea, specialiştii sovietici I.M.EISEMBERG şi A.M.JAROV, au afirmat că la multe clădiri lucrările de consolidare se execută superficial, nefiind stabilite cu exactitate avariile provocate de seism.

Organele Ministerului de Interne au în continuare în atenţie aspectele semnalate.

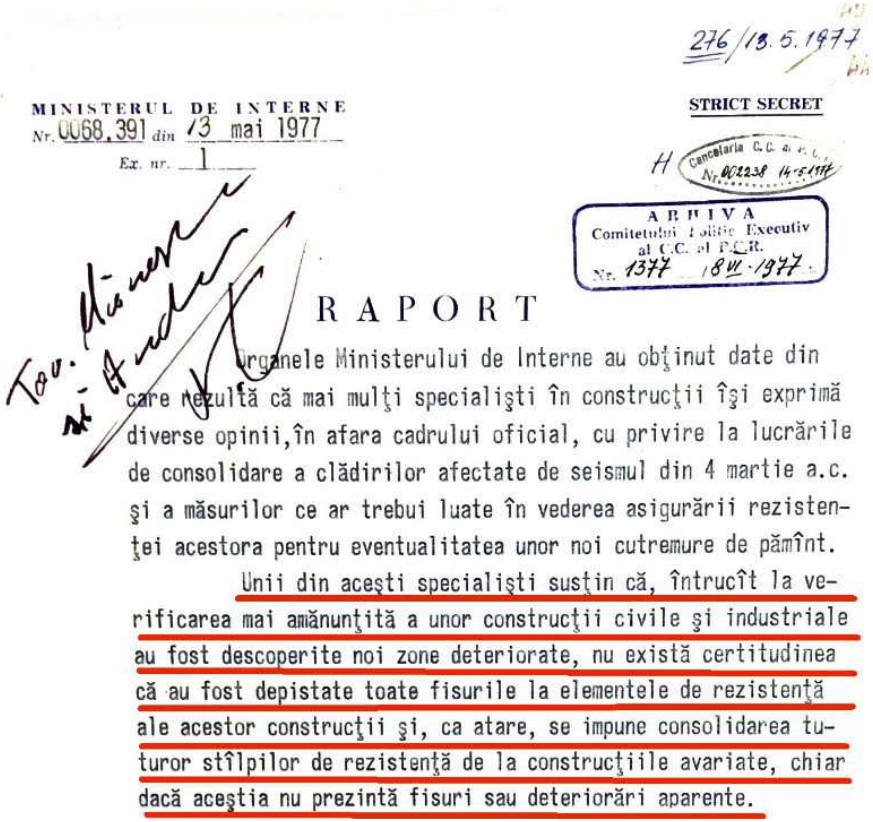
M I N I S T R U,
Tudor Postelnicu

MI Report of May 13, 1977 mentioning Eng. Ion Otescu, Alexandru Pitis and Iuliu Hosu of IPCM and Dr. Horea Sandi – INCERC - concerned about lack of unified viewpoint on strengthening solutions.

Some USA specialists mentioned the difficulty and time consuming of strengthening works.

USSR specialists Jakov Eisenberg and Alexandr Jarov are quoted as remarking superficial strengthening works in many cases.

NOTE: USA and USSR specialists have the same opinions with Romanian specialists !



276/13.5.1977

MINISTERUL DE INTERNE
Nr. 0068.391 din 13 mai 1977
Ex. nr. 1

STRICT SECRET

Cancelaria C.C. al P.C.R. Nr. 002238 14.5.1977

ARHIVA
Comitetului Politic Executiv
al C.C. al P.C.R.
Nr. 1377 18.V.1977

Tov. Manea
Tov. Andrei

RAPORT

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Unii din aceşti specialişti susţin că, întrucît la verificarea mai amănunţită a unor construcţii civile şi industriale au fost descoperite noi zone deteriorate, nu există certitudinea că au fost depistate toate fisurile la elementele de rezistenţă ale acestor construcţii şi, ca atare, se impune consolidarea tuturor stîlpilor de rezistenţă de la construcţiile avariate, chiar dacă aceştia nu prezintă fisuri sau deteriorări aparente.

The MI Report of May 13, 1977

STRICLTY SECRET

The key issue of SIGNIFICANCE OF KNOWN AND UNKNOWN CRACKS in damaged zones in structural members that leads to THE NEED TO STRENGTHEN ALL COLUMNS, NO MATTER THEY LOOK UNHARMED was sustained by specialists and Ceausescu was informed.

RCP AND GOVERNMENT ACTIVITY VS MASS-MEDIA COVERAGE, APRIL TO JUNE 1977

From April to June 1977 the RCP newspaper, Scînteia, reported continuously and positively about the on-going repair and strengthening works.

IN CAPITALĂ

Continuă în ritm susținut munca de consolidare și refacere a unor imobile și edificii avariate

În slujba mesaj p

Trei decenii de la in

Blocul „Romarta" : fără să piardă nici un moment, dulgherii pregătesc cofrajele necesare turnării betonului și rezistențe, a elementelor de construcție avariate

Se execută lucrări de consolidare la hotelul „Union"

Scinteia, May 26, 1977

In Capital, ***"The work of strengthening and recovery of damaged buildings continues in sustained rhythm"***

From the text we see how **the instructions of March 30 are applied.** The photos show overall jacketing of columns.

Romarta Block, Calea Victoriei No. 60

- a number of 94 from 102 ground-floor columns are strengthened with full jacketing in reinforced concrete
- existing members have a reduced strength
- in fact a new structure is built
- pre-1940 structures assessment is difficult
- some 2-3 design variants were necessary
- in Bucharest, from 2010 buildings, some 1500 are with heavy works and 600 with repairs.

UNION Block: shear-walls are cast at basements 1 and 2.

The Block Mantuleasa 22 was an example of how an apparently undamaged pre-1940 building may show in interior unrepairable damage, carbonated concrete, corroded reinforcement. This was demolished in the immediate period.

4.4 Minutes of the July 4, 1977 CPEx meeting and the July 6 IGSIC telex, # 11264 about damaged buildings' strengthening and repair

Bucharest RCP officials and specialists in charge of repair and strengthening of buildings damaged by the earthquake attended the July 4th meeting.

SITUATION AT JULY 4, 1977 IN BUCHAREST – THE BIG CHANGE

Bucharest's Mayor Dincă presented a report on the impressive number of assessments, repairs, and strengthening completed. He accepted the blame that the work took too long **(**ANR, CCRCP Economics 78/1977, pp. 1-10).

- **14,063 buildings in need of structural repairs**
- **3,616 structures with repair works already finished**
- **351 buildings to be repaired and strengthened, out of which 114 were in process of execution.**

- **Ceauşescu was irritated and complained to the meeting members that they and the city's leaders, relinquished decisions about the repair efforts to "professors" and that the responsibility for what happened in Bucharest was left in "the hands of specialists"** (ANR, CCRCP Economics 78/1977, p.28).
- **He expressed anger with the engineering assessment commissions and the degree of strengthening work, saying that they produced more damage than the earthquake itself.**
- It is again confirmed his disbelief in the mind of engineers and professors about seismic risk.

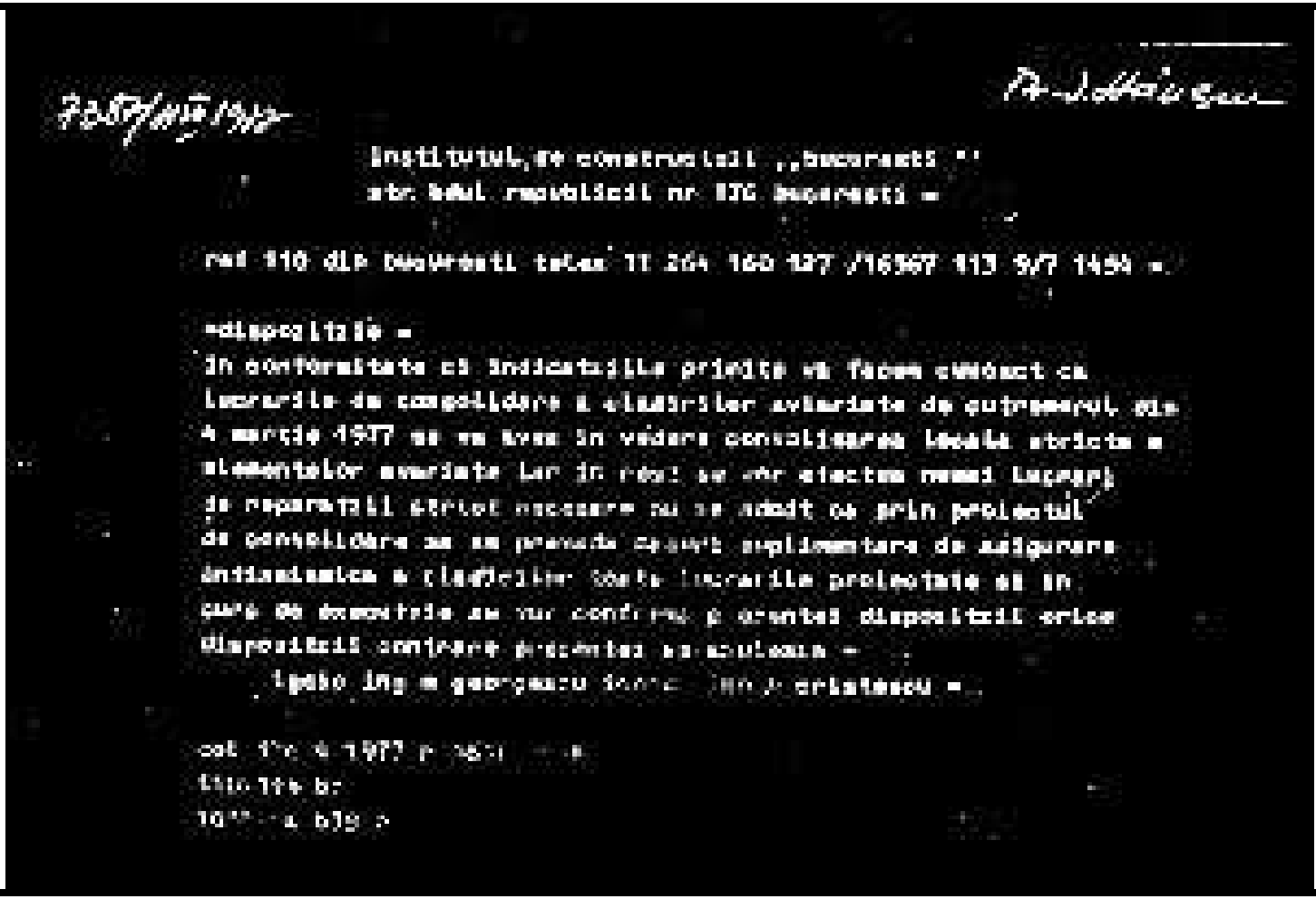
- On July 4, the engineers were taken as enemies, and blamed, after **he discovered they want to "destroy" Bucharest under cover of strengthening works !**
- In fact, ***the professionals of that time, including most of those attending the meeting, are put in excellent light, as their work was huge, so many commissions and buildings, and they were able to convince and "corrupt" all the levels of Party and administration to start extensive works for safety of living, and to speak in their way.***
- **After the fear of first days, now he was not afraid of vulnerability in front of a future earthquake.**
- He repeatedly **rejected overall works**, while **demolitions were not accepted at all** (at that time). This is further pointed out at p. 54: ***"...you do not learn architecture and engineering to destroy a block. Those who came with proposal of demolition must be sent at home and not to enter in such commission".***
- He believed that **what he cannot see as a big crack, that one must be plastered.**
- On July 4, he was completely against any advisory boards (CTS – Scientific and Technical Councils or CTE – Technical - Economic Councils) of institutes (as it was legal and usual with any project), as well as against any decision of engineers, professors etc.
- Almost all participants depended their actions with the March 30 decisions i.e., the aim of bringing back the repaired structure's resistance as prior to the earthquake.
- **Some of the speakers referred to the initial degree of 8.5 MSK provided for Bucharest** (as in the immediate new zoning map - Decree no. 66 -1977) as being a source of their understanding to increase the resistance of old buildings. Ceausescu denied he knew about it and how it was changed afterwards…or about common understanding of March 30.

- The crucial outcome of the July 4 meeting was that ***only local repairs were to be done from then onwards***. This reflected Ceauşescu's level of understanding… **Or it was a maverick motion?**

- He ordered that no apartment building be demolished or have a column repaired without special approval (ANR, CCRCP Economics 78/1977, p. 25).
- The new deadline for ending most of the repair work was August 23, the National Day.

On **July 6, the IGSIC telex No. 11264** was sent to the relevant authorities stating:

"Working Order: According to the received instructions, we let you know that for the strengthening work for buildings damaged by the March 4, 1977, earthquake one will take into account strictly the local strengthening of damaged members while for the remaining ones, one shall make only repairs that are strictly necessary…the strengthening project is not permitted to introduce supplementary measures for earthquake safety of buildings…all designed and ongoing works will be in conformity with the present working order…any working orders that are contrary to the present one will be cancelled" . (IGSIC Telex No.11264 / 1977).



This order given as Telex No. 11264 is the root of current seismic risk problems in Bucharest and other cities, since it removed entirely reference to a damaged building's seismic resistance and ordered only localized repairs.

Therefore, ***the regime's July the 4th, 1977, decision to put an end to large-scale strengthening projects was consistent with the grand plans for a new Bucharest stated in March 22 and eventually to the razing of some 450 hectares to make way for Ceauşescu's Civic Center in the 1980's*** (ANR, CCRCP Economics 78/1977, Steinbrueck, 2017).

- **This crucial decision was not endorsed by any CC RCP Decision, Government Act or Decree** and strongly conflicted with Law No. 8 on Constructions Safety, passed a week before, on July 1, which put all **responsibility** and legal liability for building safety **on IGSIC and ICCPDC, as well as on designers and engineers** (Georgescu, 2003).
- **There was no press coverage of the July 4 meeting, but on July 8, a CPEx meeting reiterated these orders.**
- A new deadline for all repair works was set for the end of 1977.
- As Steinbrueck (2017) pointed-out, ***"The July 1977 order that stopped the structural assessments and hastened repairs has implications to this day…This danger is directly linked to the Ceauşescu regime's July 1977 policy to end assessments and significant repairs and exacerbated by the post-1989 governments' limited actions to support repairs or relocate residents".***

The cracks visibility – repair issue

After July 4, some pressure is presumed to have been exerted on ICCPDC - INCERC to make compatible the new rules with technical constraints.

Therefore, within INCERC Instructions C 183/1977 on epoxy resin injections / 12.07.1977 extended the width of repairable cracks from 3 to 5 mm.

FROM FEARS TO DECISIONS AFTER MARCH 4, 1977 EARTHQUAKE

We may conclude the following mental process: the way of thinking was associated with contradictory double way of acting along of these four months:

FEAR ABOUT DAMAGE OF OFFICIAL BUILDINGS → NEED OF A NEW CIVIC CENTER

- **DEALING WITH ARCHITECTS** → *TASK OF NEW CIVIC CENTER → URBANISTIC PLANS AND NEW "ROMANIAN" ARCHITECTURE → FEW CRITICISM → MUTUALLY LAUDATIVE* → ***SMOOTH ATTITUDE*** → *TASK ACCEPTED → 8 YEARS TERM →* ***DEMOLITIONS ALMOST NECESSARY*** → **TASK ACHIEVED.**

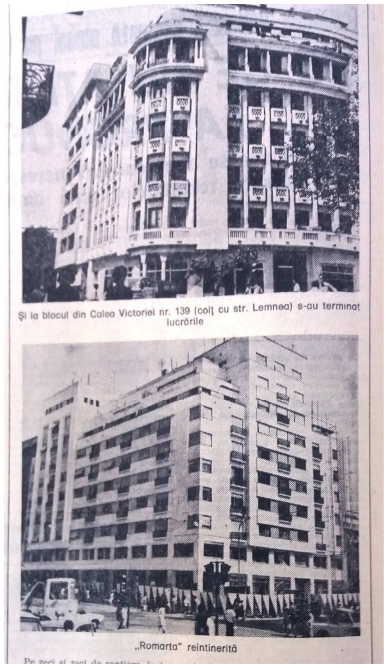
FEAR ABOUT DAMAGE OF RESIDENTIAL HOUSES: → ORDER OF EVACUATION → URGING SPEEDY REPAIR → SELF-REPAIR OF TRADITIONAL HOUSES → DENYING THE DANGER OF FINE CRACKS IN CONCRETE → **FORCING USE OF BUILDINGS WITH CRACKS, AFTER "LOCAL" REPAIRS**

- **DEALING WITH ENGINEERS** → *TASK OF MAKING HOUSES SUITABLE FOR "SLEEPING" → AFTER* ***MARCH 30 INDICATIONS*** *ACCEPTANCE, ENGINEERS CONVINCED THE PARTY STAFF TO RESPECT PROFESSIONAL APPROACH →* ***JULY 4, 1977 STOP !*** → ***TOUGH ATTITUDE*** → *PRESSURE → BLAME → DESPISE →* ***ENGINEERS DEFEND THEIR WORK → IGSIC ORDER TELEX 11264*** → *LOCAL REPAIR →* ***DEMOLITIONS FORBIDDEN*** → **TASK OF REASONABLE SAFETY** */ RESISTANCE* **NOT ACHIEVED** → ***INCREASED VULNERABILITY AND RISK AT FUTURE EARTHQUAKES.***

Soon after July 4, 1977 there was a shifting of Scinteia key-words, from recovery and strengthening towards the new style in architecture, leading also to the future Civic Center

Scinteia, August 11, 1977
Reporting the end of some strengthening works

Calea Victoriei 139, Calea Victoriei 60, Romarta Block



Și la blocul din Calea Victoriei nr. 139 (colț cu str. Lemnea) s-au terminat lucrările

„Romarta" reîntinerită

Scinteia, August 18, 1977
Reporting about the visit of Ceausescu on August 17 on strengthening sites and for modernization and making Bucharest beautiful !

PROLETARI DIN TOATE ȚĂRILE, UNIȚI-VĂ!

Scînteia

ORGAN AL COMITETULUI CENTRAL AL PARTIDULUI COMUNIST ROMÂN

Anul XLVII Nr. 10 885 | Joi 18 august 1977 | 6 PAGINI — 30 BANI

TOVARĂȘUL NICOLAE CEAUȘESCU

a făcut o vizită de lucru în Capitală

A fost analizat modul în care se acționează în continuare pentru încheierea vastei acțiuni de refacere și consolidare a imobilelor afectate de cutremur, pentru modernizarea și înfrumusețarea Bucureștiului

Scinteia, September 30, 1977
Reporting on the visit of Ceausescu in Bucharest, to see the new architectonic style, specific and original

PROLETARI DIN TOATE ȚĂRILE, UNIȚI-VĂ!

Scînteia

ORGAN AL COMITETULUI CENTRAL AL PARTIDULUI COMUNIST ROMÂN

Anul XLVII Nr. 10 921 | Vineri 30 septembrie 1977 | 6 PAGINI — 30 BANI

TOVARĂȘUL NICOLAE CEAUȘESCU

a făcut ieri o vizită de lucru în Capitală

Secretarul general al partidului a analizat, împreună cu specialiști, cu cadre de răspundere modul în care se aplică măsurile stabilite de conducerea partidului pentru realizarea construcțiilor edilitare într-un stil arhitectonic specific, original

Tovarășul Nicolae Ceaușescu, secretarul general al Partidului Comunist Român, președintele Republicii Socialiste România, a examinat, joi dimineață, în cadrul unei vizite de lucru în Capitală, modul în care se aplică măsurile stabilite de conducerea partidului pentru realizarea construcțiilor edilitare într-un stil arhitectonic specific, original, demn de tradițiile artistice ale poporului nostru, de societatea noastră socialistă.

În această vizită secretarul general al partidului a fost însoțit de tovarășa Elena Ceaușescu, de tovarășii Ion Dincă, Iosif Uglar, Ștefan Andrei, Vasile Patilineț.

And the first step supposed to be the Great Rally and Meeting of 33-rd Anniversary of National Day, August 23 !


Sub semnul unității indestructibile a întregului popor în jurul partidului, al secretarului său general, tovarășul Nicolae Ceaușescu, sub semnul voinței nestrămutate de a transpune în viață hotărîrile Congresului al XI-lea al P. C. R.,

Scînteia

PROLETARI DIN TOATE ȚĂRILE, UNIȚI-VĂ!

ORGAN AL COMITETULUI CENTRAL AL PARTIDULUI COMUNIST ROMÂN

Anul XLVII Nr. 10 890 | Joi 25 august 1977 | 6 PAGINI — 30 BANI

ROMÂNIA SOCIALISTĂ A SĂRBĂTORIT, ÎNTR-O ATMOSFERĂ DE BUCURIE, DE ÎNSUFLEȚIRE REVOLUȚIONARĂ, A XXXIII-A ANIVERSARE A ELIBERĂRII

1944 1977

TRAIASCA 23 AUGUST ZIUA ELIBERARII PATRIEI DE SUB DOMINATIA FASCISTA SARBATOAREA NATIONALA A POPORULUI ROMÂN !

On December 7, Ceausescu reported to the The National Conference of Romanian Communist Party that March 4, 1977 **earthquake losses were of over two Billion Dollars of damage**, but the rapid recovery is a proof of superiority of Romania's socialist society.

The comment of a US analyst (US Embassy cables, 1977) was: "President's tone implied entire earthquake episode is now history and is no longer a consideration in Romanian forward planning".

Looking retrospectively, this is why all were pushed to cut actual strengthening?

5. Conclusions

- New archival evidence and data allowed the authors to recover yet unpublished official data on building damage and human casualties in the 1977 Vrancea earthquake. The latter are highly relevant to preparedness and risk management in the present day.
- It was also possible to track the contradictory path of politically driven decisions, from March 5 to July 4, 1977, which concluded with the cessation of strengthening of the damaged buildings.
- Sound technical arguments were replaced by Ceauşescu's allegations as they seemed to be a threat to his "systematization of Romania" and "new Civic Center" vision that he was to implement in the 1980s.
- Misguided orders left Bucharest with the unenviable legacy of a very large number of high-occupancy residential buildings that have been damaged by the 1977 (and possibly the 1940) Vrancea earthquake that were mostly built prior to 1940 without any seismic design principles. Most of them are at risk from future Vrancea earthquakes.
- **Engineers must find adequate language to convey their knowledge to political and administrative leaders, especially in matters that refers to public safety. Also to individual or corporate owners of buildings, contractors, mass-media and population.**

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Further reading:

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