

## ICGEE-2020: International Conference on Geosciences and Earthquake Engineering, Challenges for Balkan Region (ICGEE)

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**IoT (Internet of Things) for structures: the challenge for the civil engineers to develop permanent and affordable structural monitoring system**

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**Moni2BSafe**  
Project



**Pictures from the damage caused by the L'Aquila earthquake, 2009, Italy**



**Durazzo, 26 Novembre 2019**





The "*aftershock*" work of the structural engineer. Quick and insufficient surveying with the aim to judge good building from bad building, the safe one from the dangerous one.  
How much reliable is the result?



Collapse of the belltower in S. Marco square, in Venice, on July 14 1902, at 9:46.



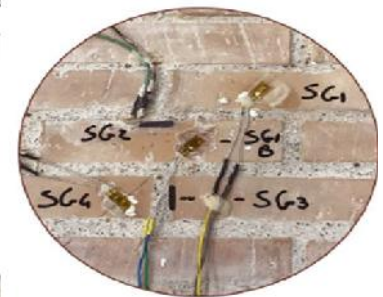
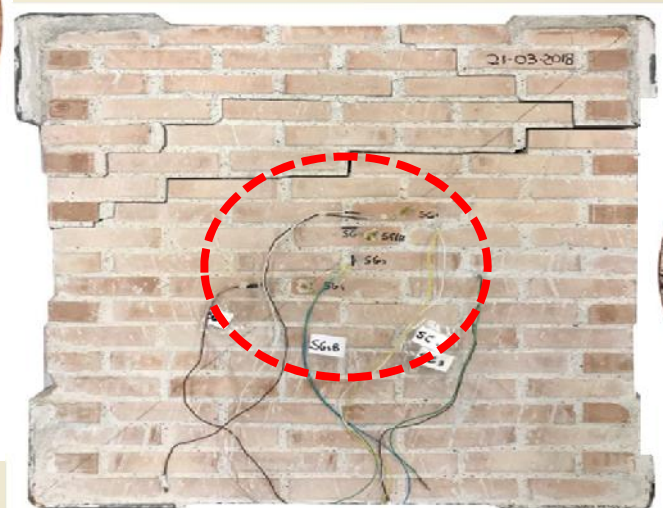
Rubble and debris after the collapse of the belltower in S. Marco square in Venice



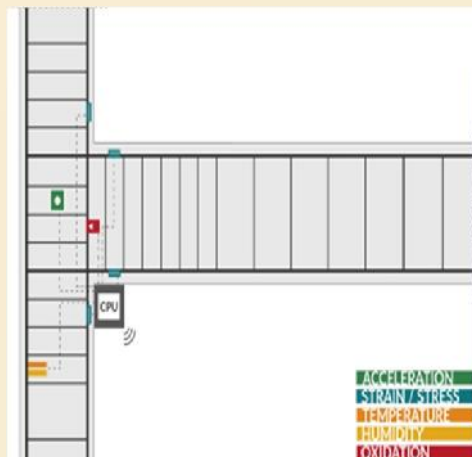
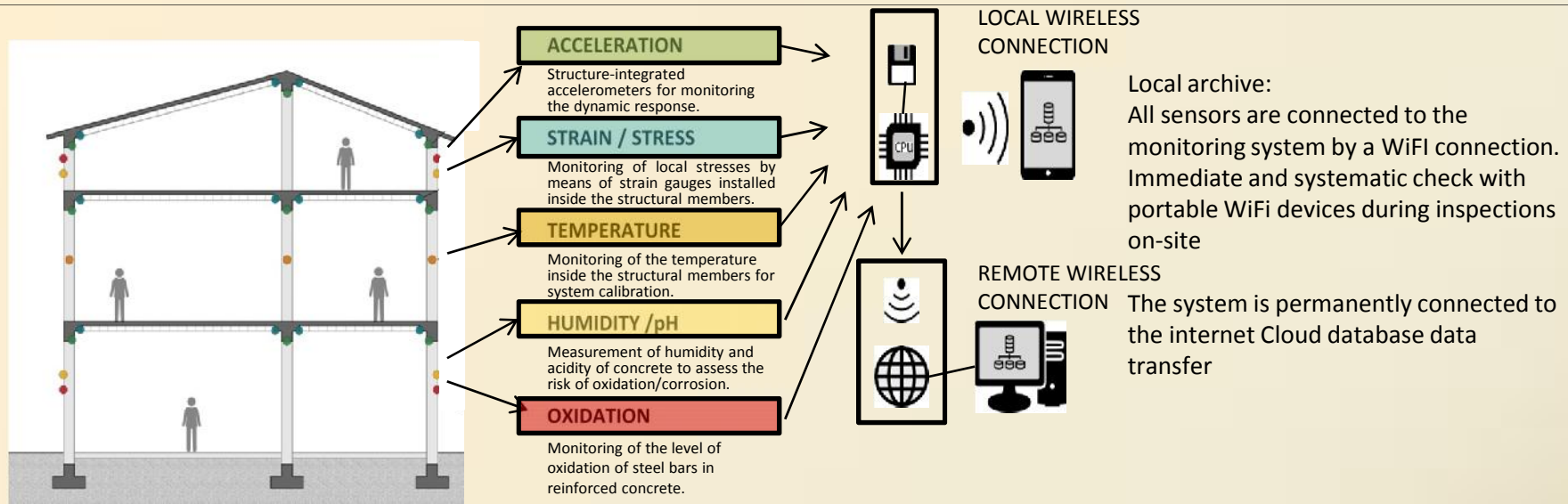
# Protecting and monitoring also Cultural Heritage Monument



The bell tower now is standing again in the S.Marco square, but my opinion is that if we do not want an other sudden collapse we should monitor the monument.

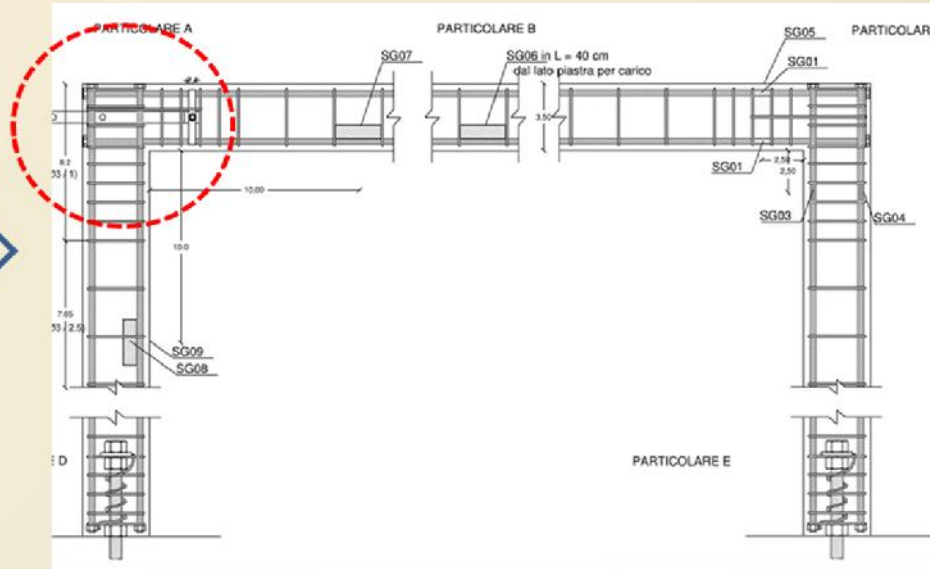


The buildings' structural safety today is for save money (maintenance, durability, efficiency) and to save life in the extreme environmental or anthropic actions



**Permanent monitoring**

at critical points of the structure, in order to give a continuous information of the stress level due to the acting loads and of the behaviour of the structure to the external events.

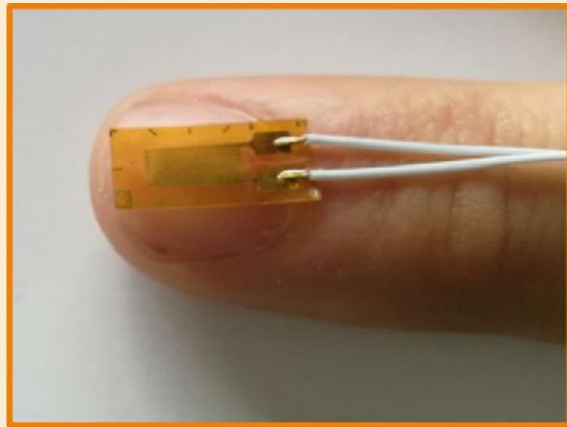


# ELECTRONIC MINIATURIZED COMPONENT AVAILABLE AND CHEAP (\$\$)

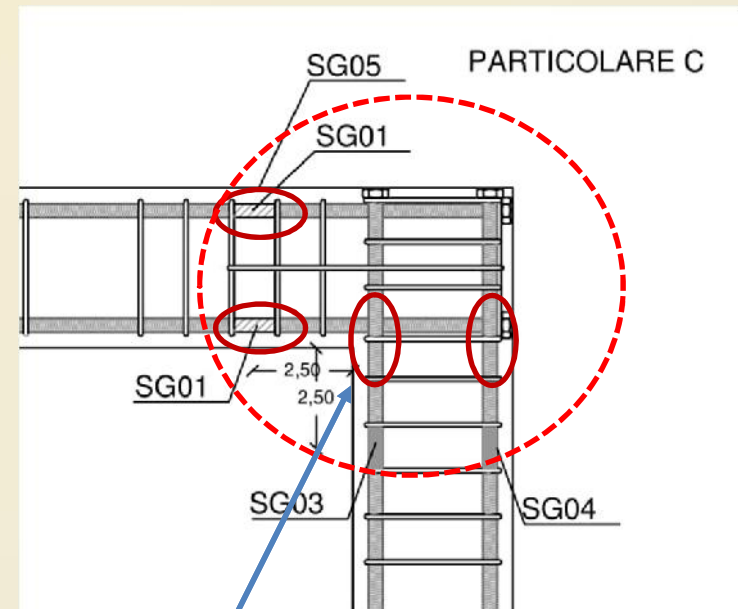




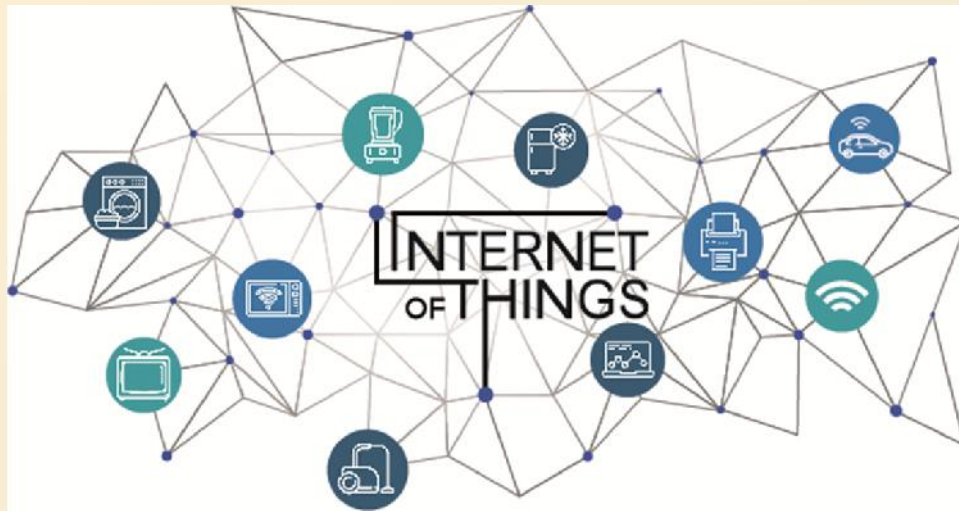
# PERMANENT MONITORING



I o T - *Internet of (every)Thing*



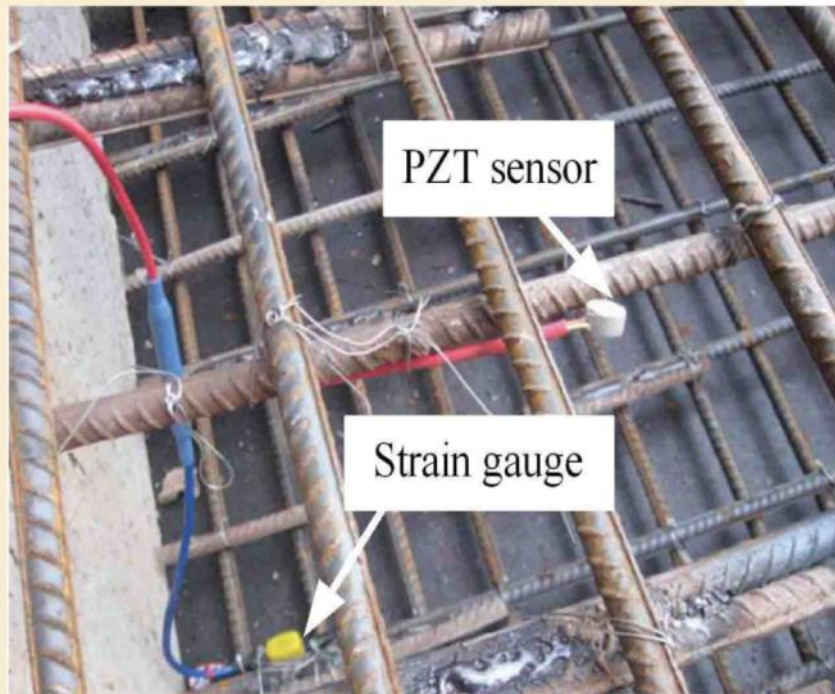
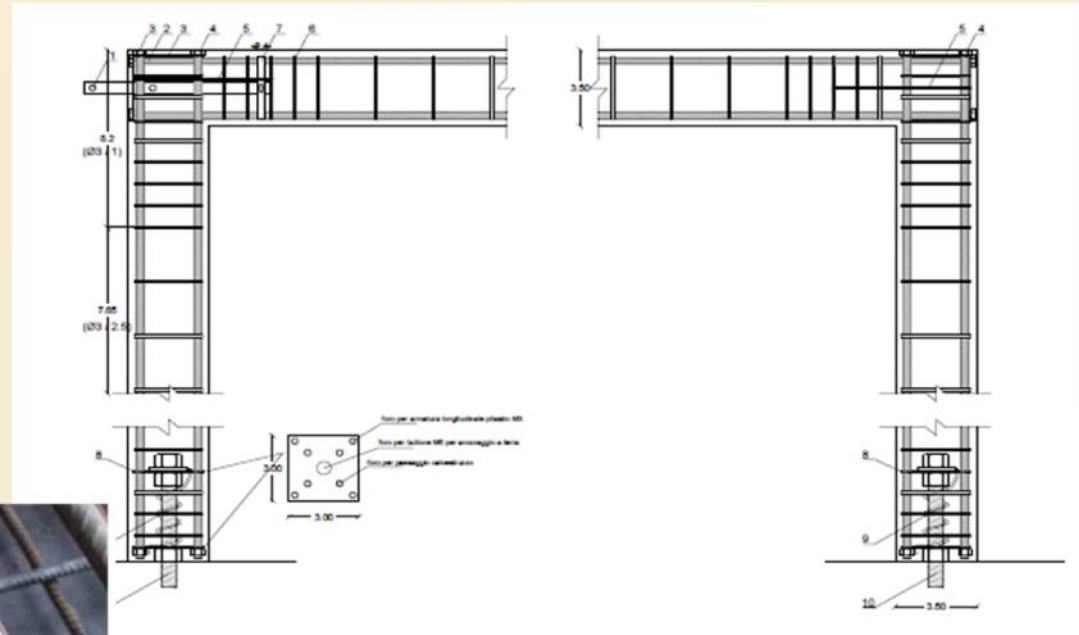
Embedded sensors



## IoT «Internet of Things»

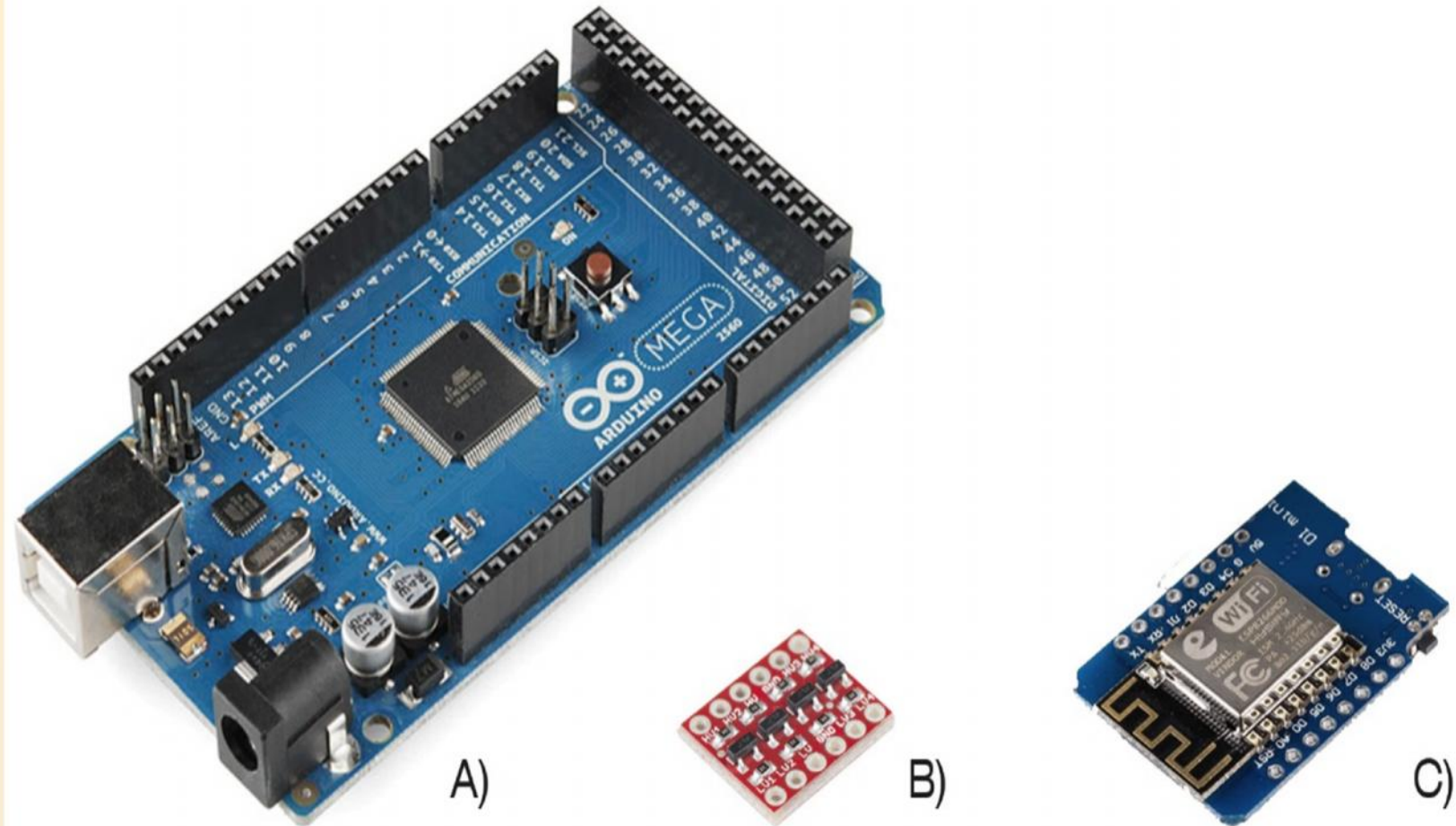
To bring into the digital networks the things surrounding us during our life. To bring some objects in order to make them communicate between themselves and then with us. .

- The IoT approach and platform allows us to access any moment and from every where to the structure, and the structure transfer to us the information collected with sensors
- The control is facilitated. No need to be just on site to know what is happening
- It is possible also to connect the «Smart Building» functions;
- It is possible to plan more efficiently maintenance and recover in advance situation that could become worst.



Diffused embedded sensors in order to check the local stress in most critical zones





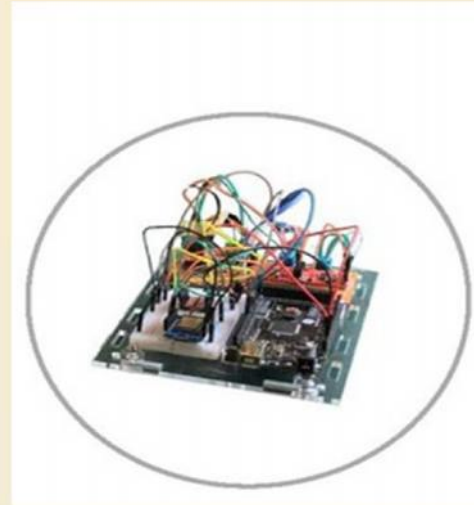
Arduino's like platform  
(Arduino, invented and designed by italian electronic engineers at Ivrea, Italy)

# What we have done until now?



Old, traditional, expensive control box for laboratory

Cost: 12.000-15.000 €

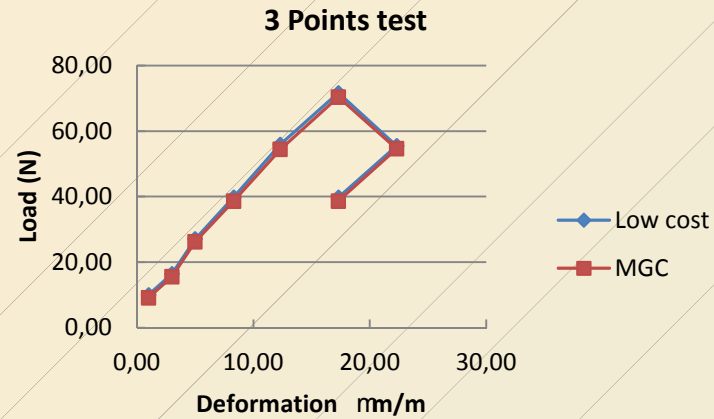


New, Arduino platform, compact, portable, very cheap, reliable device, battery powered

Cost: 300-500 €

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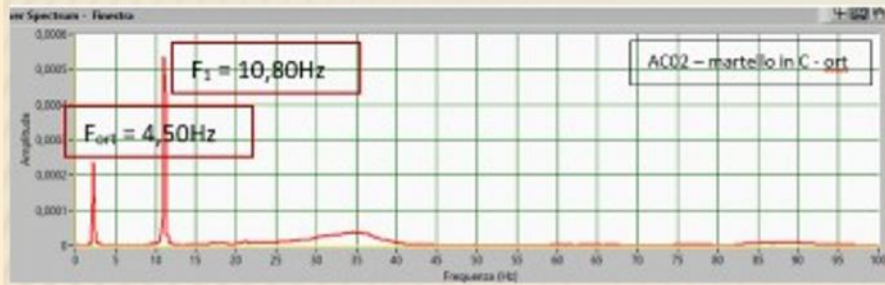
Comparison between the MGC-Plus-HBM and Low cost device.  
Deformation for a simple supported beam with a increasing load in the middle

Load (N)	L-C device $\mu\text{m/m}$	MGCPLUS $\mu\text{m/m}$	% difference	Nominal value $\mu\text{m/m}$
1.00	3.36	2.76	-18.0%	2.976
3.00	10.02	9.15	-8.7%	8.929
5.00	16.44	15.55	-5.4%	14.881
8.31	27.06	26.26	-3.0%	24.732
12.31	39.83	38.66	-2.9%	36.637
17.31	55.94	54.39	-2.8%	51.518
22.31	71.62	70.35	-1.8%	66.399
17.31	55.49	54.62	-1.6%	51.518
12.31	39.76	38.66	-2.8%	36.637
8.31	27.36	26.10	-4.6%	24.732
24.31	77.33	77.36	0.0%	72.351

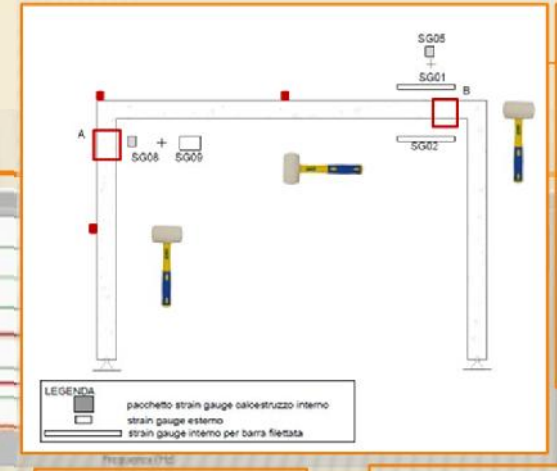
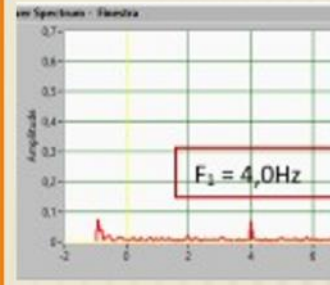


# Dynamic test comparing accelerometers and strain gauges

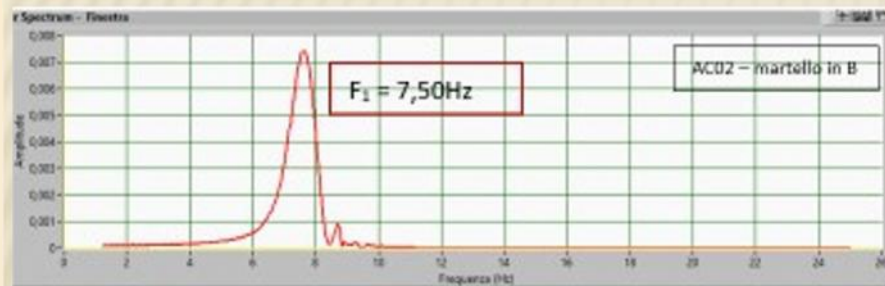
F=0 Accelerometri



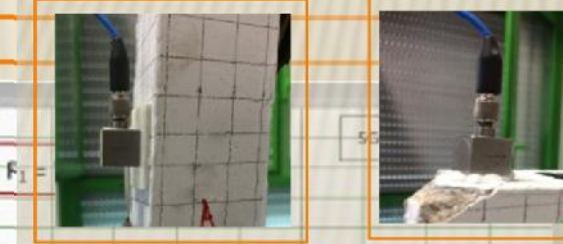
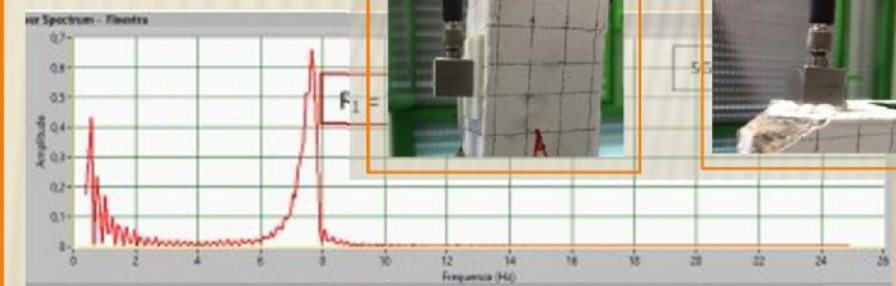
F=0 Strain gauge



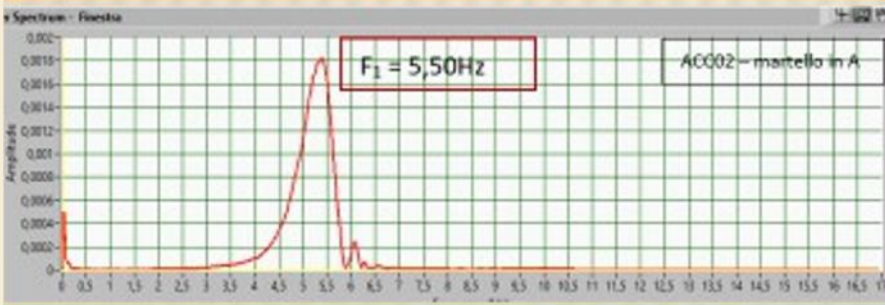
F=400N Accelerometri



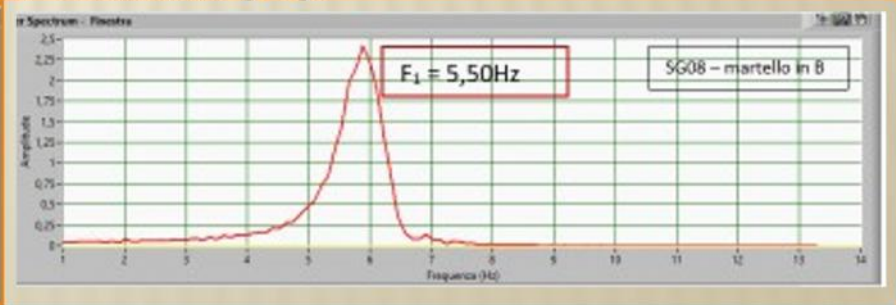
F=400N Strain gauge

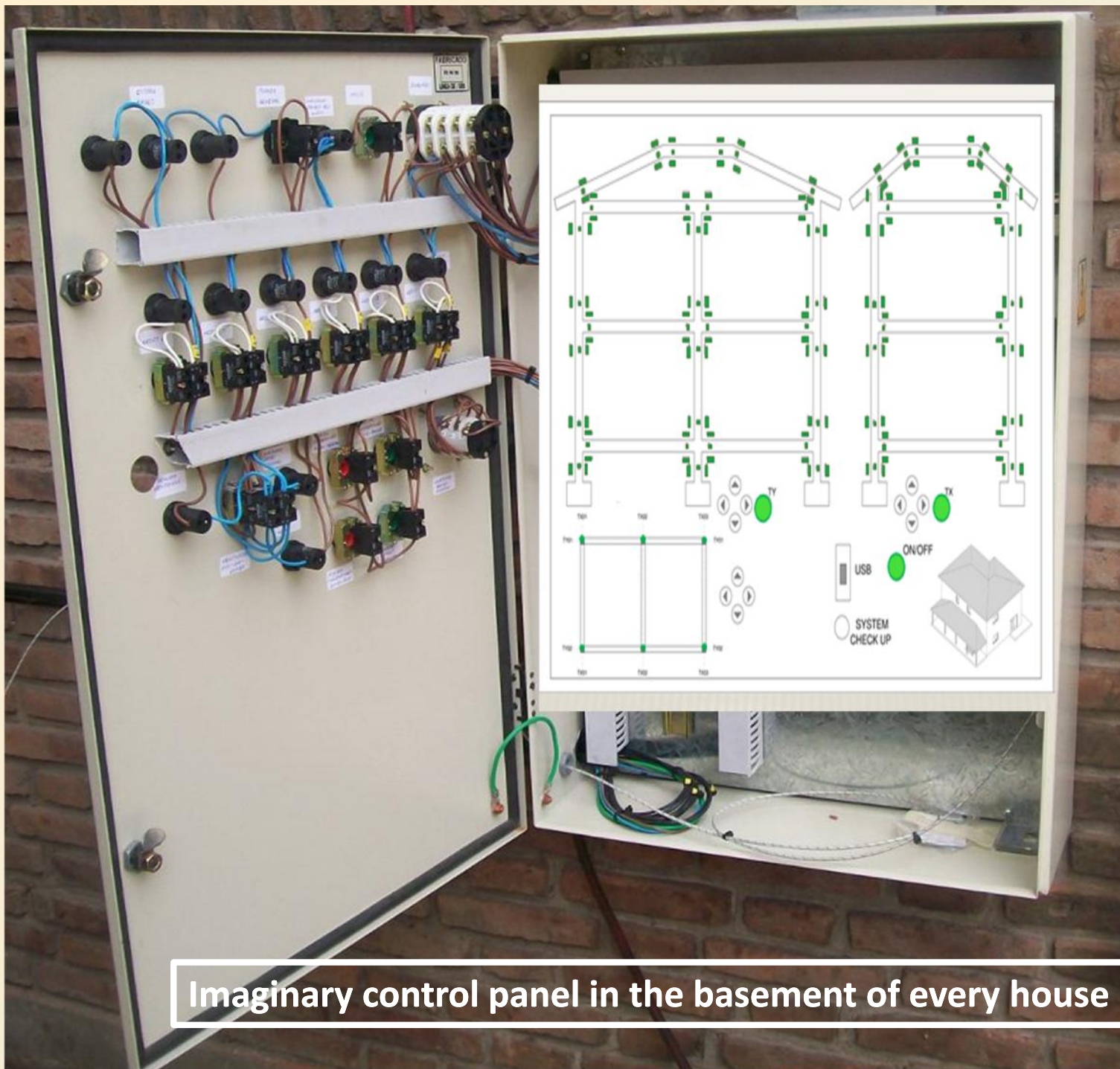


F=850N Accelerometri

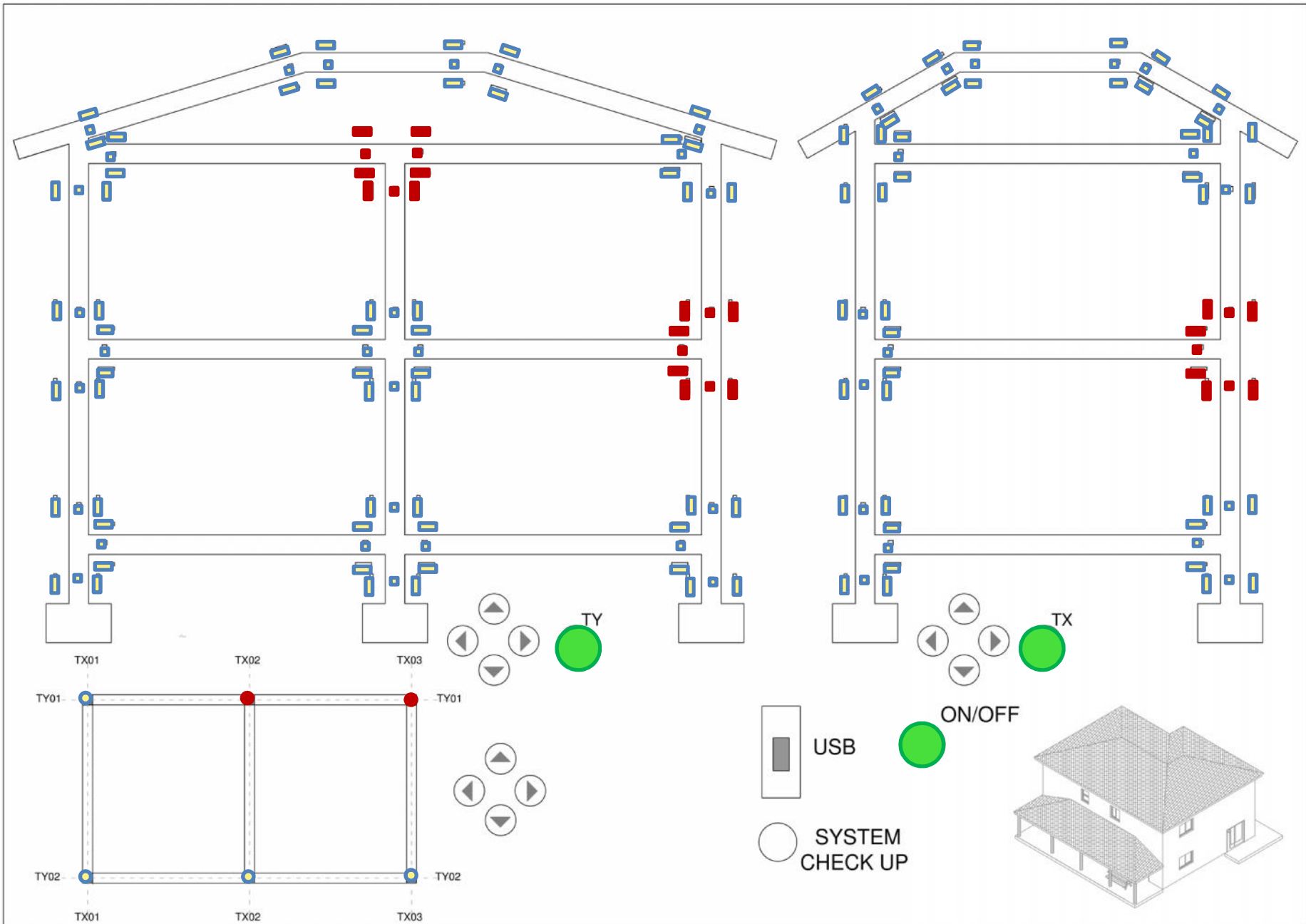


F=850N Strain gauge





Imaginary control panel in the basement of every house





## The Aim of the Research

### IoT technology for Structural Health Monitoring

- Objectives:
  - to permanently assess the health of the structure through embedded monitoring
  - to define and realize affordable devices in order to achieve a lifelong health of the structure
  - to realize a tailored network in order to collect all these data and elaborate them
- Expected results
  - to identify the right family of sensors able to deliver the desired performances and fulfil the predetermined objectives
  - to apply the monitoring system to some new building to be built and verify the results as case study



To control the building as we control our car  
**SMART BUILDING -> SAFE BUILDING**



# ! Acknowledgment to the happy research team !

