

Pan-EU CoP Forum meeting

3rd of June 2021

Please introduce yourself in the chat, we have already done so



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IM-SAFE^{.EU}

www.IM-safe-project.eu

<https://www.linkedin.com/company/im-safe-project/>

<https://cordis.europa.eu/project/id/958171>

IM-SAFE (ref. 958171)



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Pan-EU CoP Forum meeting: Welcome!

Please introduce yourself in the chat, we have already done so

The meeting will be recorded, the chat will be saved. Only for internal project purposes, it won't be published! If you have problems with this, let's us know. We will stop recording!



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Workshop agenda

The presentation will be shared after the meeting by E-mail and will be uploaded to our website

12:30	Welcome and introduction to the IM-SAFE project
12:10	Summary of results of national / regional CoP's
12:40	Analysis of trends, best practices, PEST barriers: preliminary results
13:30	Break
13:45	Preliminary definition of the scope of the mandate to CEN
14:15	Discussion on the scope of the mandate to CEN
14:45	Follow-up on engagement of Pan-EU CoP
14:50	Closure



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SPEAKERS



Dr. Diego Allaix

- **IM-SAFE WP Leader (Standardization)**
- TNO Department of Structural Reliability
- Senior Scientist Structural Reliability
- Visiting Professor University of Gent
- Member of CEN/TC 250 WG3 "Safety formats for non-linear problems"
- Member of *fib* TG3.1 "Reliability and safety evaluation"



Jos Wessels MSc, MBA

- **IM-SAFE WP Leader (Stakeholder Engagement)**
- CROW
- Senior project manager
- Coordinator platform Inner City Quay Walls
- Coordinator platform Geotechnics
- Project manager CROW Program Advisory Board Hydraulics and Geotechnics
- Involved in establishing NL platform Bridges & NL platform Inspections



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SPEAKERS



Prof. Dr. Jochen Kohler

- **IM-SAFE WP Taskleader (Trends, best practices and barriers)**
- Norwegian University of Science and Technology, Trondheim
- Professor in Structural Engineering
- Member CEN TC250 WG2 (Assessment of Existing Structures), SC10 WG1 (Reliability Based Calibration)
- Active in IABSE and *fib*



Sara Cuerva Navas MSc, PMP

- **IM-SAFE WP Leader (Trends, best practices and barriers)**
- Ferrovial Construction
- Innovation project manager
- Seven years' experience in design and construction of infrastructures including railways and thermal power plants



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H2020 CSA IM-SAFE (Grant agreement ID: 958171)

Harmonised Transport Infrastructure Monitoring in Europe for Optimal Maintenance and Safety



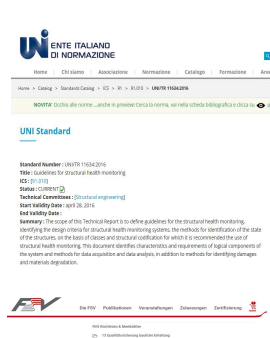
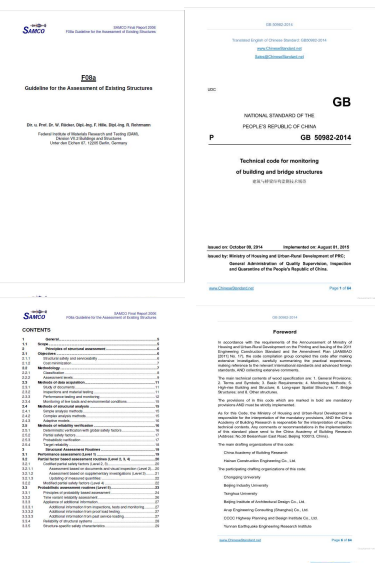
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H2020 CSA IM-SAFE context


Safety risks have become critical in the recent years and manifested in major disasters caused a.o. by structural failures due to maintenance deficiencies.

Optimal maintenance is only possible with the right policies and decisions enabled by timely and accurate information from monitoring.

Standardisation in monitoring is a key enabler for optimal maintenance strategies, strengthening or retrofitting measures to be applied for ensuring the safety of the infrastructure.

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H2020 CSA IM-SAFE scope

- IM-SAFE covers **bridges, tunnels and other large infrastructures on the road and railway networks.**

H2020 CSA IM-SAFE aim

- **To support the European Commission and the European Committee for Standardization (CEN) in preparing new standards in monitoring for optimal maintenance and safety of transport infrastructure based on a comprehensive insight into :**
 - trends & challenges,
 - PEST barriers,
 - best practices,
 - technology & knowledge developments
- **To achieve broad acceptance for new standardization**
- **To enable public authorities and industries to contribute to standardization, roll-out, and implementation**



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H2020 CSA IM-SAFE results

- **Input for mandate for CEN incl.:**
 - **new standard for condition-based and risk-based maintenance of transport infrastructures**
 - **further amendment to the existing EU standards** on safety assessment taking into account inspections, monitoring and testing
 - **new standard on structural monitoring**
- **Background for provisions :**
 - review of national guidelines and standards in all EU and international research activities related to monitoring, data-informed safety assessment and condition- and risk-based maintenance
 - evaluation of the PEST barriers & state-of-practice in inspection, monitoring, testing, diagnostics, data-informed safety assessment, risk management and decision-making with regard to maintenance
 - evaluation of the needs of standardization for enabling digital solutions for monitoring and data analytics
 - technical background to the mandate
- Plan of **approach for the execution** of the mandate by CEN






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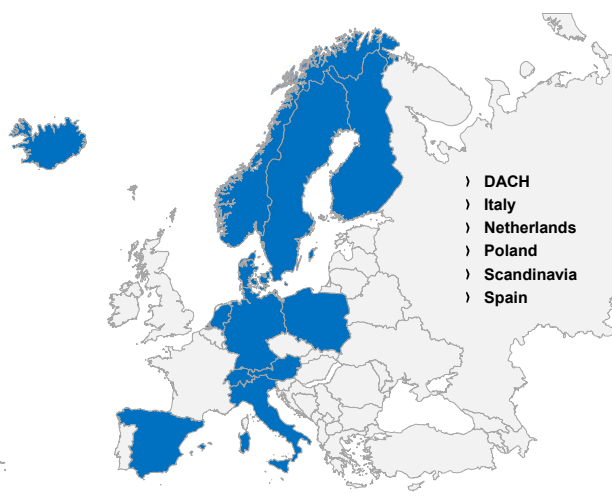
Summary results national / regional CoP meetings

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OVERVIEW





- › DACH
- › Italy
- › Netherlands
- › Poland
- › Scandinavia
- › Spain

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MEETINGS

12
COUNTRIES

>120
ATTENDEES

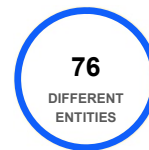



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ATTENDEES

- › Public entities
- › Government agencies
- › Infrastructure owners
- › Engineering companies
- › Consulting companies
- › Construction companies
- › Construction software developers
- › Technology providers
- › Research centers
- › Universities
- ›



INFORMATION SHARED

Overview and analysis of current state of standardization

Topics:

- › Structural monitoring
- › Asset management and maintenance
- › Data-informed safety assessment

Standards and guidelines adopted by:

- › European countries
- › Countries outside Europe (e.g. China)
- › International standards (e.g. CEN and ISO standards)



ROUND TABLE DISCUSSIONS

Monitoring

- › What is the reason to **monitor bridges**? How important is **monitoring** in assessing structural safety?
- › Which aspects of **monitoring** could be **standardised**? How important is standardisation of procedures / solutions for monitoring?
- › Which additional adjustments to the 2nd generation of the Eurocodes are necessary to be able to use monitoring data / information?



ROUND TABLE DISCUSSIONS

Monitoring

- › Inspections are the main source of information (classification of damage and intervention urgency)
- › Methodologies differ from operators
- › Methodologies differ in the railway sector partially from the road sector
 - › temporary monitoring
 - › monitoring systems already implemented
- › Continuous monitoring is advantageous
 - › real time warning system
 - › move towards preventive or ideally predictive maintenance
 - › Identification of the structure's reference behavior
- › Proposal of a guideline to harmonise monitoring plans: local and global variables
- › Monitoring system of a new structure as part of the design and life cycle of the structure

ROUND TABLE DISCUSSIONS

Monitoring standardisation

- › How to make data of different nature or origin compatible, comparable, storable?
- › How to guarantee data reliability, traceability? What accuracy?
- › Standardisation challenge: huge variety of structural characteristics. Potential aspects to be covered:
 - › objectives of monitoring
 - › choice of suitable monitoring techniques
 - › additional physical quantities to be measured (e.g. temperature)
 - › measurement frequency
 - › sensor layout to reach the prescribed accuracy
 - › data quality
 - › data reporting
- › General guideline for the choice of a monitoring system (already existing)
 - › Set the parameters to be monitored rather than the instrumentation



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ROUND TABLE DISCUSSIONS

Maintenance

- › What is the importance of monitoring for **maintenance** decisions?
- › What is needed to fruitfully **use monitoring data/information**?
- › How important is standardisation of procedures / solutions for condition and risk-based maintenance?



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ROUND TABLE DISCUSSIONS

Maintenance

- › Based on the inspections, maintenance activities are planned: monitoring is mainly problem-driven
- › Monitoring and inspection are complementary techniques
 - › Change from inspections with fixed frequency to condition-based interventions
- › Permanent monitoring has been identified as a priority line of work
- › Adequate data governance is needed. Use of a standard technological architecture for data acquisition and data transferring
 - › Standardisation should also leave enough freedom (types of structures, asset managers, etc.)
- › Need for digitalisation
- › Relationship between safety, threshold levels according to the damage scenarios and corresponding maintenance interventions
- › Standards could raise awareness on the costs of monitoring and maintenance -> helpful for funds allocation



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AN INFRASTRUCTURE MONITORING PLATFORM

The Spanish Road Directorate (MITMA) has released a real-time monitoring and analysis platform for infrastructures

Plataforma **celosia.es** de monitorización de estructuras



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AN INFRASTRUCTURE MONITORING PLATFORM

CELOSIA allows:

- › Automating data transmission in real time
- › Standardising the presentation of information regardless of the technology
- › Centralising the management of monitored structures, controlling content and access
- › Saving the information through a single database, preserving the content beyond the life of the monitoring system

Potential uses of data:

- › Short-term: construction monitoring
- › Medium-term: pathologies monitoring
- › Long-term: patterns identification



Improve understanding of infrastructures

OC 2/2021

- › All monitoring data should be integrated
- › Protocol for the integration
 - › Data format standardised
 - › Static data (5 minutes)
 - › Dynamic data (0.01 seconds)

AN INFRASTRUCTURE MONITORING PLATFORM

www.celosia.com

plataforma **celosia.es** de monitorización de estructuras

31/05/2021 15:49:08 UTC ✓ Red completa Estructuras Estadística Mapa 10 20 50 100 Plataforma 11 Grupos 11 Vistas 11

Estructura	Foto	Mapa	Base de datos	Canales	Registros	Valores	Primer registro	Último registro	Vida	
Puente del Centenario Servicio: Tránsito		📍	centenario2	309	198 371	61 296 639	27/06/2019 19:15:00	31/05/2021 17:45:00	1 año y 11 meses	🟢
Viaducto de Montabiz Servicio: (2)		📍	montabiz3	100	226 378	22 637 800	15/02/2019 12:30:00	31/05/2021 17:45:00	2 años y 3 meses	🟢
Puente del Vinalopó Construcción y servicio		📍	vinalopó	13	482 832	6 276 816	25/02/2015 18:20:00	31/05/2021 17:45:00	6 años y 3 meses	🟢
Talud de Trabadelo Servicio: (2)		📍	trabadelo2	37	279 840	10 354 080	09/05/2011 14:50:00	31/05/2021 13:00:00	10 años y 21 días	🟡
Viaducto del Genil Construcción		📍	genil	120	32 774	3 932 880	18/03/2020 14:55:00	28/07/2020 12:30:00	4 meses y 9 días	🟡
Puente de Fernando Reig Servicio: Tránsito		📍	freig	19	156 441	2 972 379	06/04/2018 12:10:00	15/03/2020 01:05:00	1 año y 11 meses	🟡
Puente de la Gatzata Construcción		📍	gatzata	30	158 932	4 767 960	25/09/2018 18:20:00	21/10/2019 07:40:00	1 año y 25 días	🟡
Puente del Centenario Servicio: Juntas		📍	centenario1	13	177 089	2 302 157	28/09/2016 17:20:00	26/06/2018 12:35:00	1 año y 8 meses	🟡
Talud de Trabadelo Servicio: Juntas		📍	trabadelo1	29	60 168	1 744 872	20/11/2009 12:00:00	27/07/2011 09:00:00	1 año y 8 meses	🟡
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AN INFRASTRUCTURE MONITORING PLATFORM

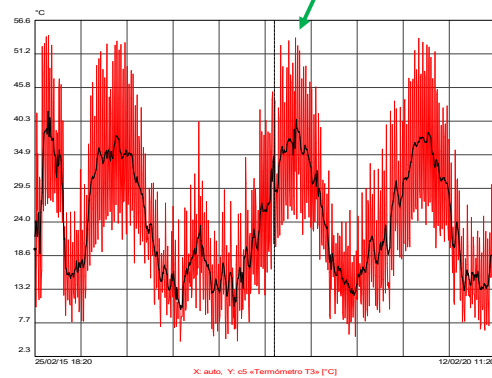
VINALOPÓ BRIDGE – Thermal monitoring



Vinalopó Steel bridge in Elche

- › There is little information on the thermal behavior of this type of decks
- › Monitored since 2015

Steel deck – Max. Temperature
54,5 °C (August 2018)



AN INFRASTRUCTURE MONITORING PLATFORM

VINALOPÓ BRIDGE – Thermal monitoring



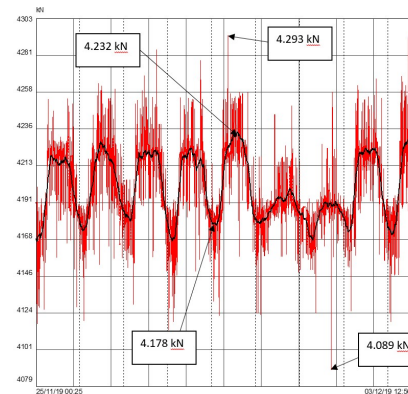
AN INFRASTRUCTURE MONITORING PLATFORM

CENTENARIO BRIDGE – Stay cables monitoring



Centenario bridge in Seville

- › Signs of corrosion in the anchors in 2018
- › 88 stay cables monitored since June 2019

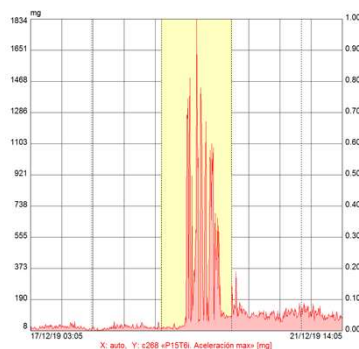


Daily fluctuations caused by traffic

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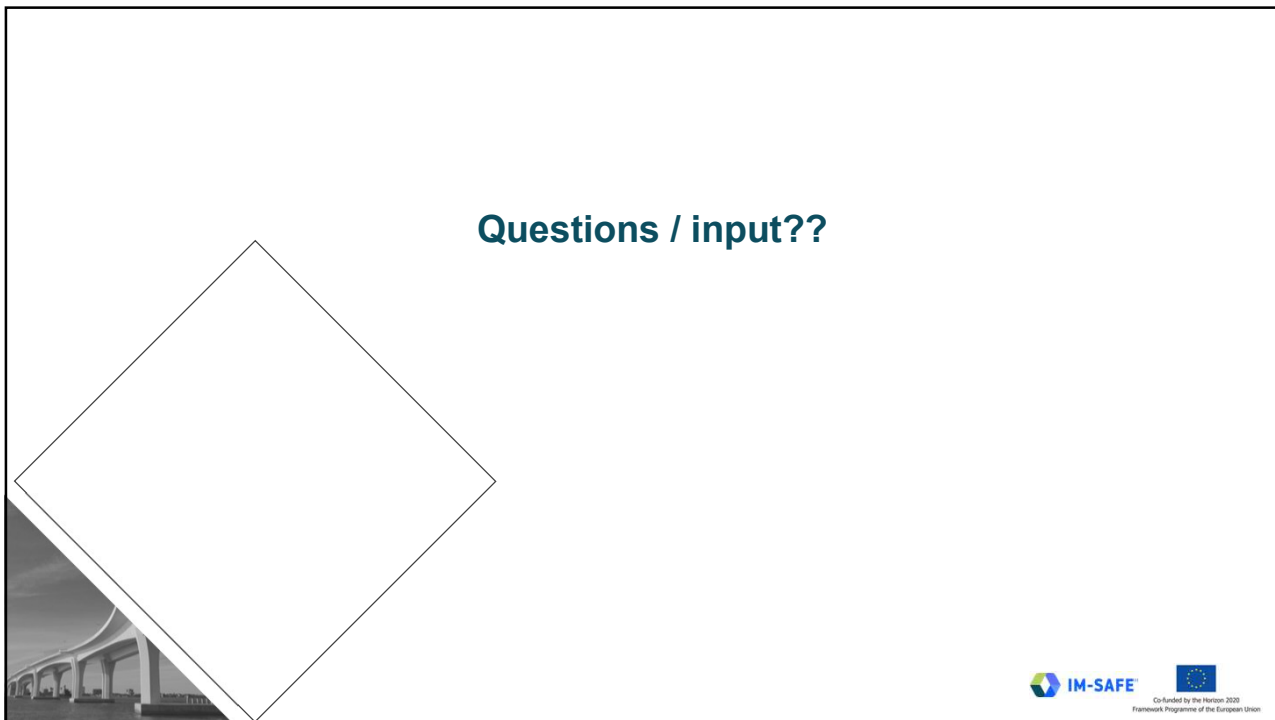
AN INFRASTRUCTURE MONITORING PLATFORM

CENTENARIO BRIDGE – Stay cables monitoring





- › Significant increase in the level of vibrations produced in one of the stay cables because of the by the storm of wind Fabien

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Questions / input??



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Best practices, Trends, Barriers: summary of findings



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Best Practices

Safety evaluation

- ✓ Explicit criteria for new structures
- ✓ Service life period considered in design
- Assessment of structures at occasion
 - Based on inspection and monitoring
 - Identification and representation of limit states
 - Qualitative or Quantitative analysis of safety

Following doubts or end of projected service-life.


Selection of measurable properties that relate to the origin of the doubts.

Design of the monitoring / inspection campaign based on expert judgement

Formal relation between measurement and structural property of interest not known

In the absence of better knowledge qualitative of based on proxy states

Important and expensive decisions based on poor information.



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Trends

Safety evaluation

- ✓ Explicit criteria for new structures
- ✓ Service life period considered in design
- Assessment of structures at occasion
 - Based on inspection and monitoring
 - Identification and representation of limit states
 - Qualitative or Quantitative analysis of safety

Risk based inspection and maintenance plan from age 0.

Set of inspection and monitoring technologies per structural type

Design of the monitoring / inspection campaign based on information optimization


Known relation between measurement and property of interest (likelihood)

In the absence of better

Quantification of reliability and risk

Important and expensive

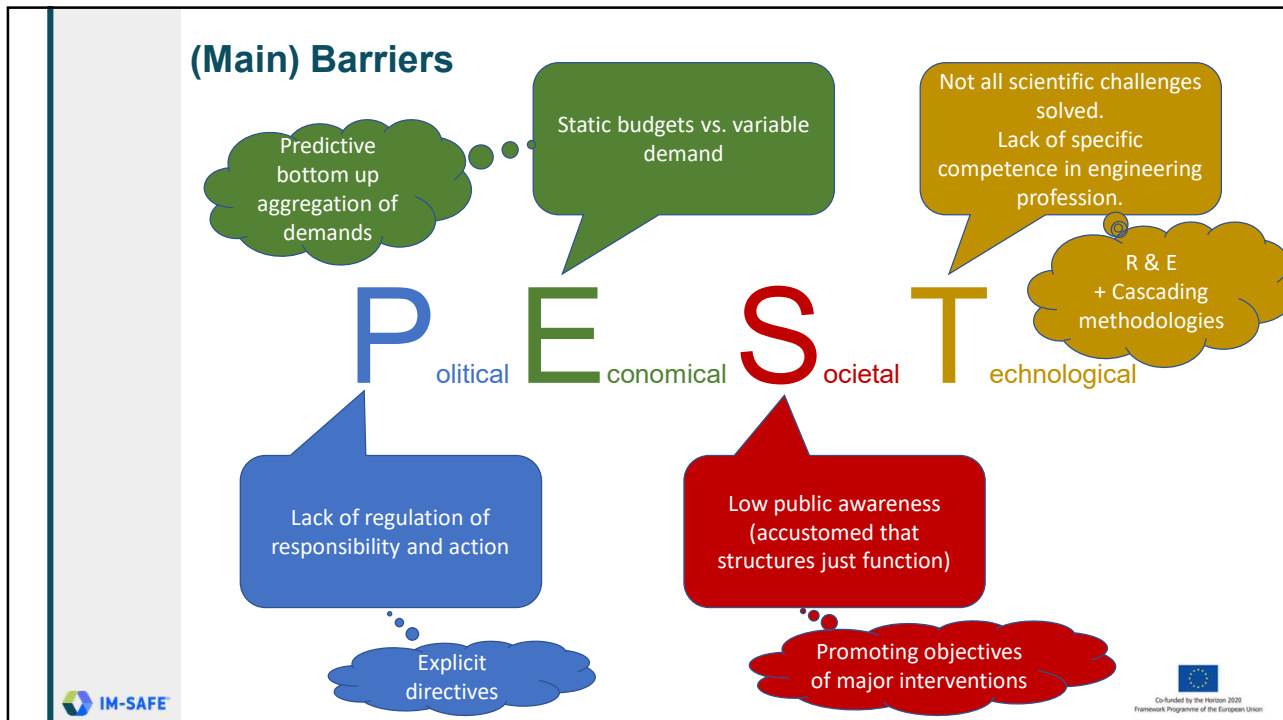
Optimal decisions on measures and future I&M planning



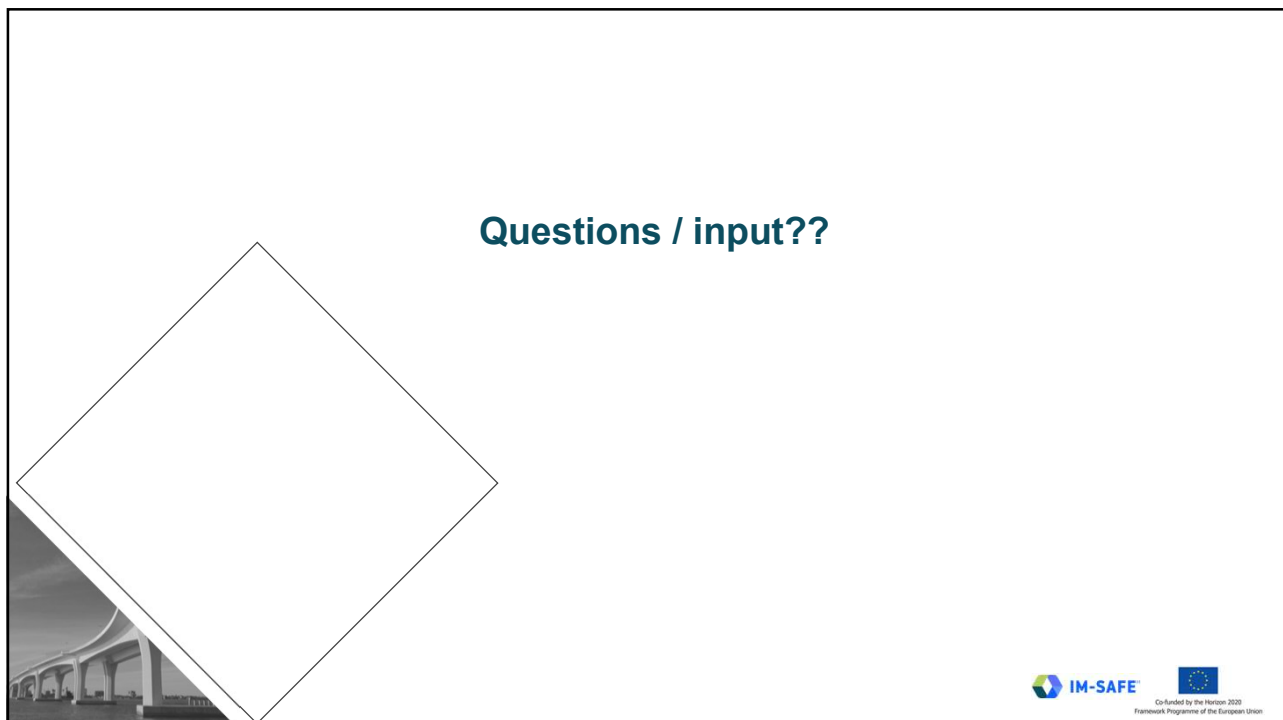
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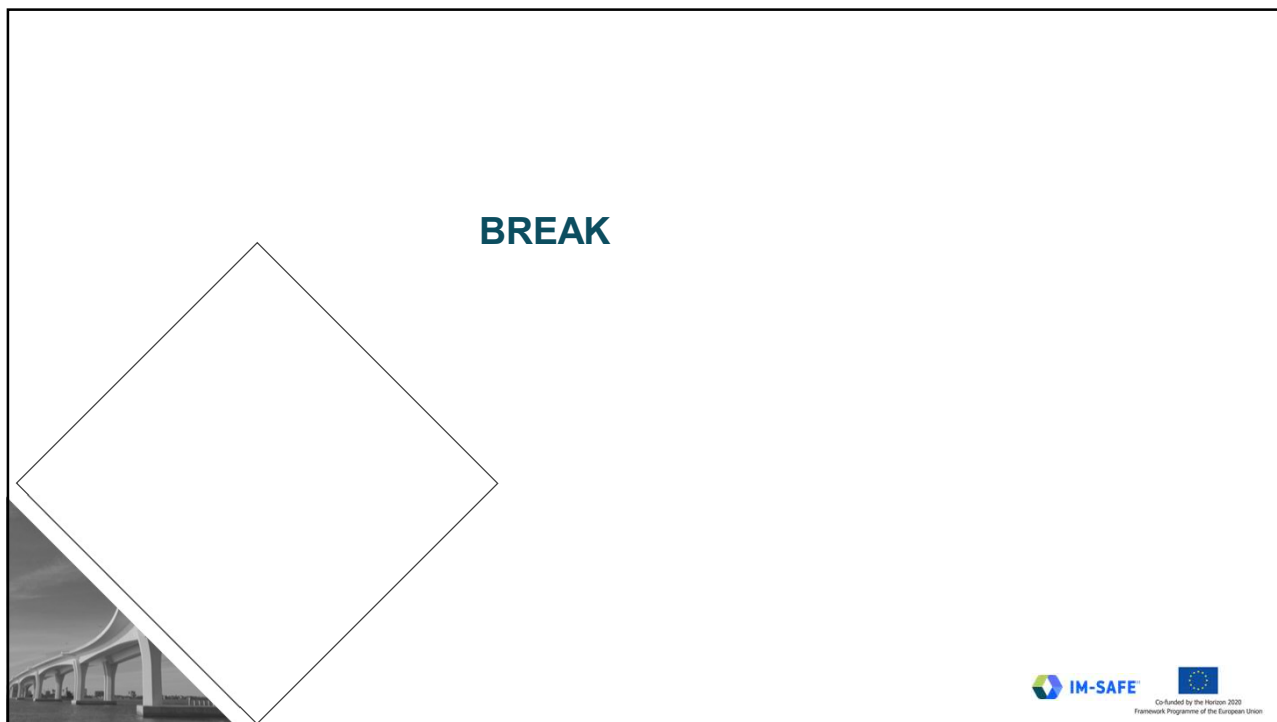
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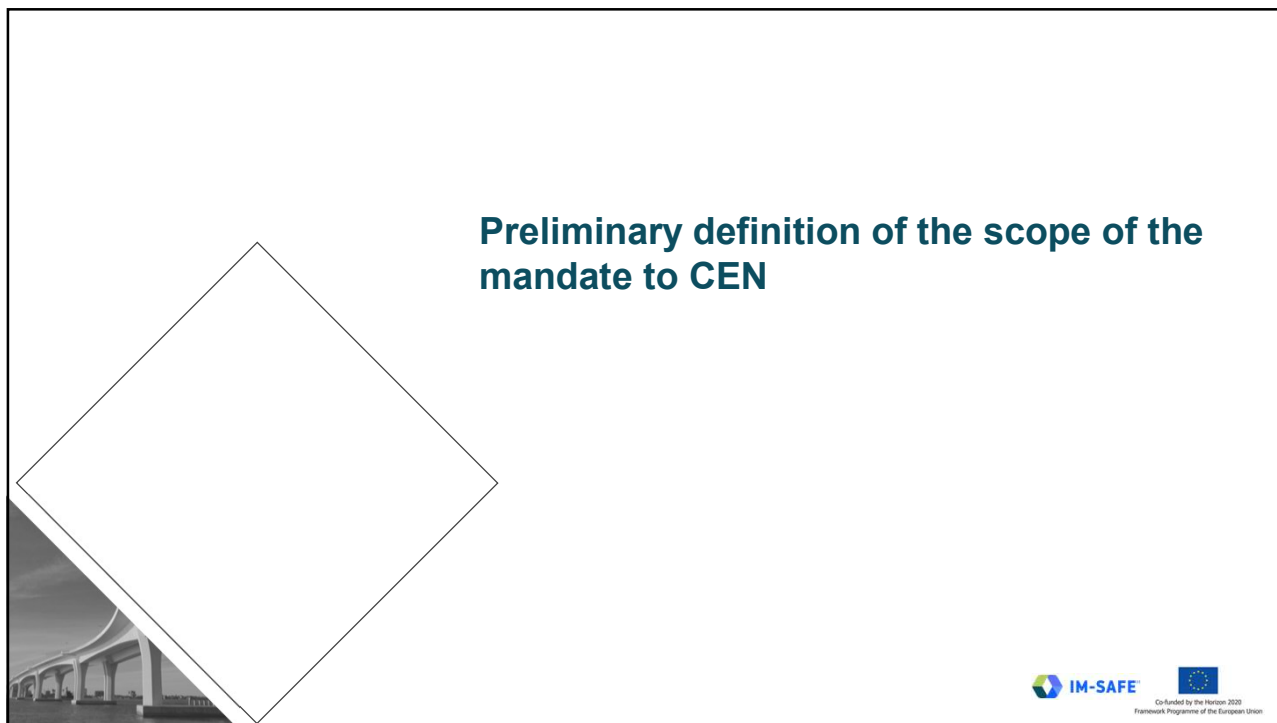
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New standard for condition-based and risk-based maintenance of transport infrastructures

Objectives:

- to promote transition from corrective and time-based approaches towards risk-based predictive approaches to maintenance
- to formulate the principles of the condition-based and risk-based approaches
- to provide principles and requirements for data-informed (inspection, monitoring and testing) decision-making

Preliminary definition of the scope of the mandate:

- classification of hazards and vulnerable elements of bridges and tunnels
- condition-based decision process regarding condition survey (inspections, testing and monitoring) and maintenance:
 - the principles for formulating key-performance indicators (KPIs) and condition indices and for updating them based on inspection, testing and monitoring
 - the principles of condition-based planning of condition survey and maintenance
- risk-based decision process regarding condition survey (inspections, testing and monitoring) and maintenance
 - the rigorous risk-based approach based on explicit evaluation of risks
 - the principles for developing simplified risk-based approaches based on condition and performance indicators
 - the principles updating risks based on inspection, testing and monitoring
 - the principles for risk-based classification of structures
- performance assessment of the transport infrastructure network (KPIs for network management and the corresponding performance targets)
- through-life management documentation



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Further amendment to the existing Eurocodes on safety assessment taking into account inspections, monitoring and testing

Objectives:

- to enable the **use of structure-specific data** in the safety assessment of existing structures
- to formulate the **framework for including information from diagnostics** of structures based on data from inspection, monitoring and testing
- to provide **background material to CEN** for translating the framework into practical clauses for the assessment at the semi-probabilistic level

Preliminary definition of the scope of the mandate:

- minimum reliability requirements (and corresponding reference period)
- use of monitoring of the structural response in combination with threshold values for assessing safety during operation
- consideration of deterioration and damage in the safety assessment
- use of structure-specific indirect information in the safety assessment
- Eurocodes to:
 - EN 1990 "Eurocode - Basis of structural design"
 - EN 1991-2 "Eurocode 1: Actions on structures - Part 2: Traffic loads on bridges"
 - EN 1992 "Eurocode 2: Design of concrete structures"
 - EN 1993 "Eurocode 3: Design of steel structures"



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New standard on structural monitoring

Objectives:

- to formulate the principles of setting the objectives of structural monitoring
- to formulate essential principles of setting the design of the monitoring system incl. requirements related to the reliability of sensor systems
- to provide essential requirements related to the methodologies used for translating data into useful and **meaningful information** relevant for diagnostics of structures, safety assessment and maintenance approaches
- to promote best practices for transport infrastructure
- to maintain the openness to innovations (i.e. in sensing technology and data analysis methods)

Preliminary definition of the scope of the mandate:

- framework for **decision making** regarding the monitoring strategy:
 - definition of the objectives of the monitoring activities
 - choice of the monitoring type (e.g. periodic / continuous)
 - choice of the measured quantities
 - definition of the required measurement accuracy
 - selection of the monitoring technologies
 - design of the monitoring system, including amount and placement of the monitoring devices
 - evaluation of alternative monitoring strategies
- requirements for **data acquisition** (calibration, post-installation verification, management and maintenance of the acquisition system)
- requirements for **data pre-processing** (identification of outliers, removal of the environmental effects from the raw data, data validation, etc.)
- requirements for **data analysis** (updating of structural models, identification of damage and deterioration processes, quantification of actions)
- requirements for **data storage and management** (in relation to through-life information management systems)
- requirements for **data security and ownership**

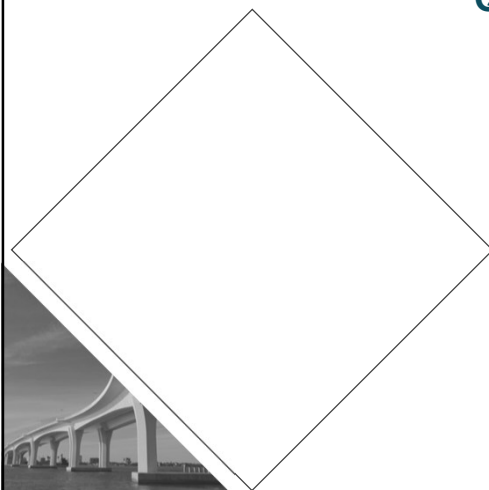


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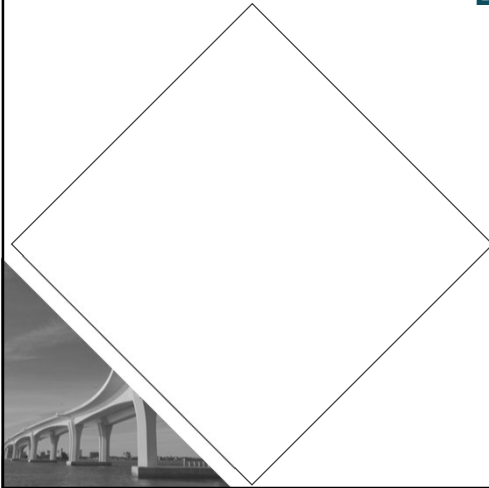
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Questions??



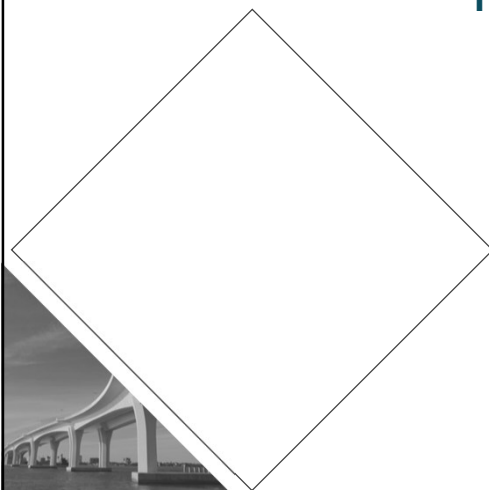
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Discussion on the scope of the mandate

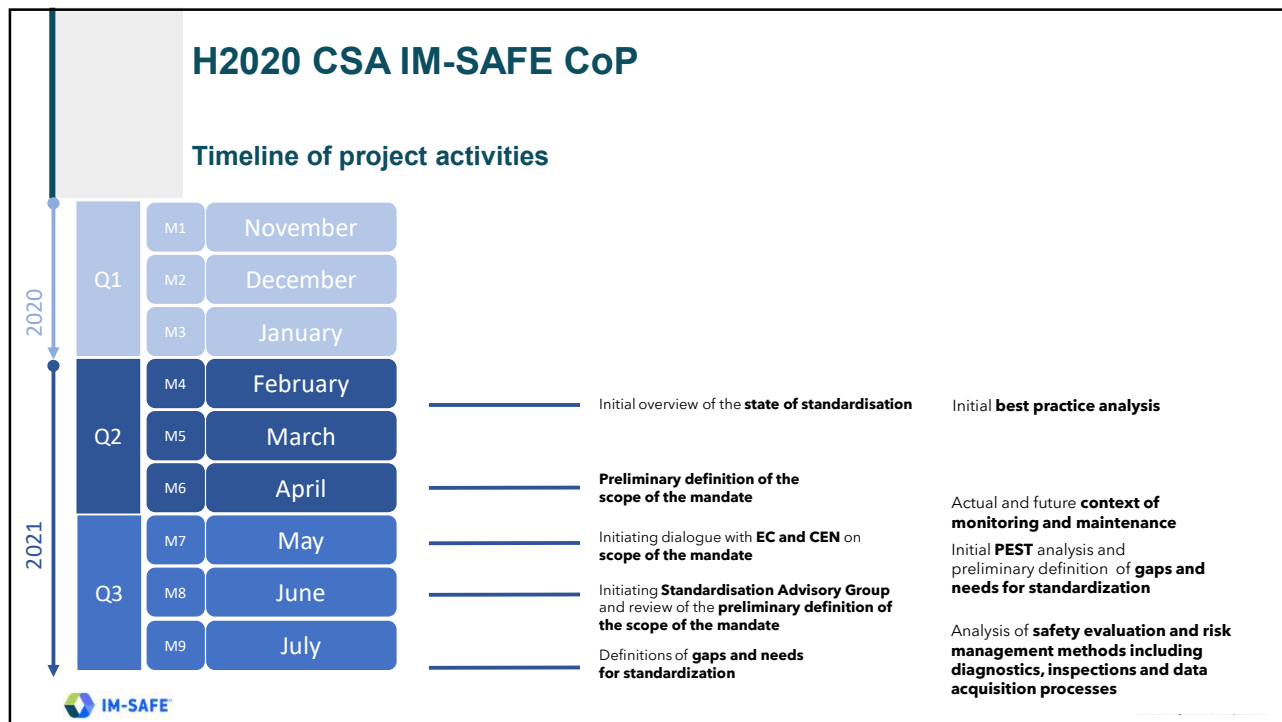


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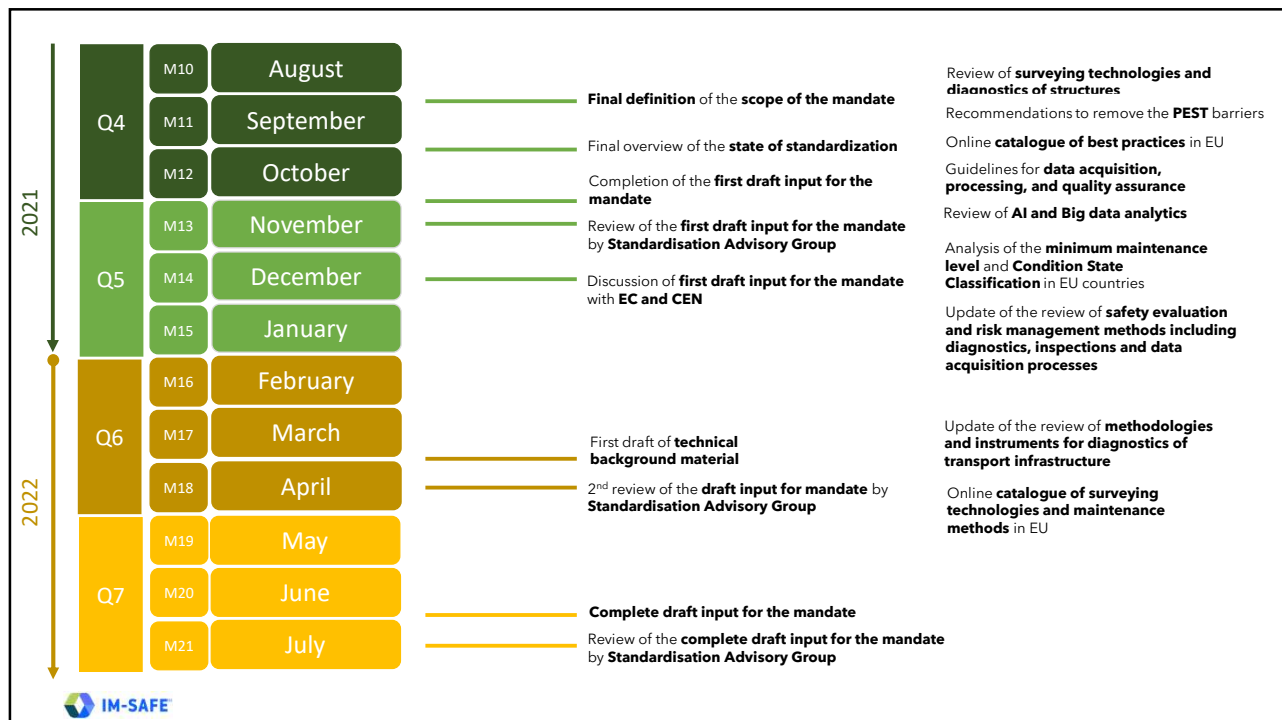
Follow-up on the engagement of CoP



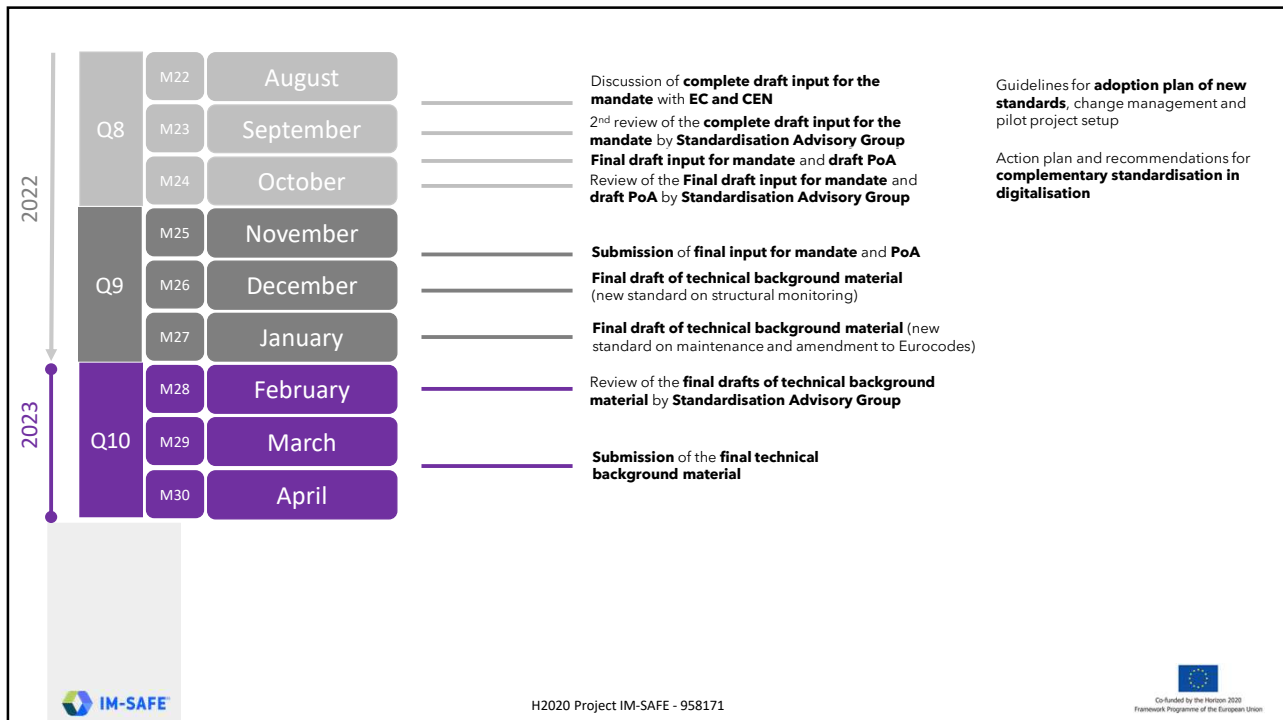
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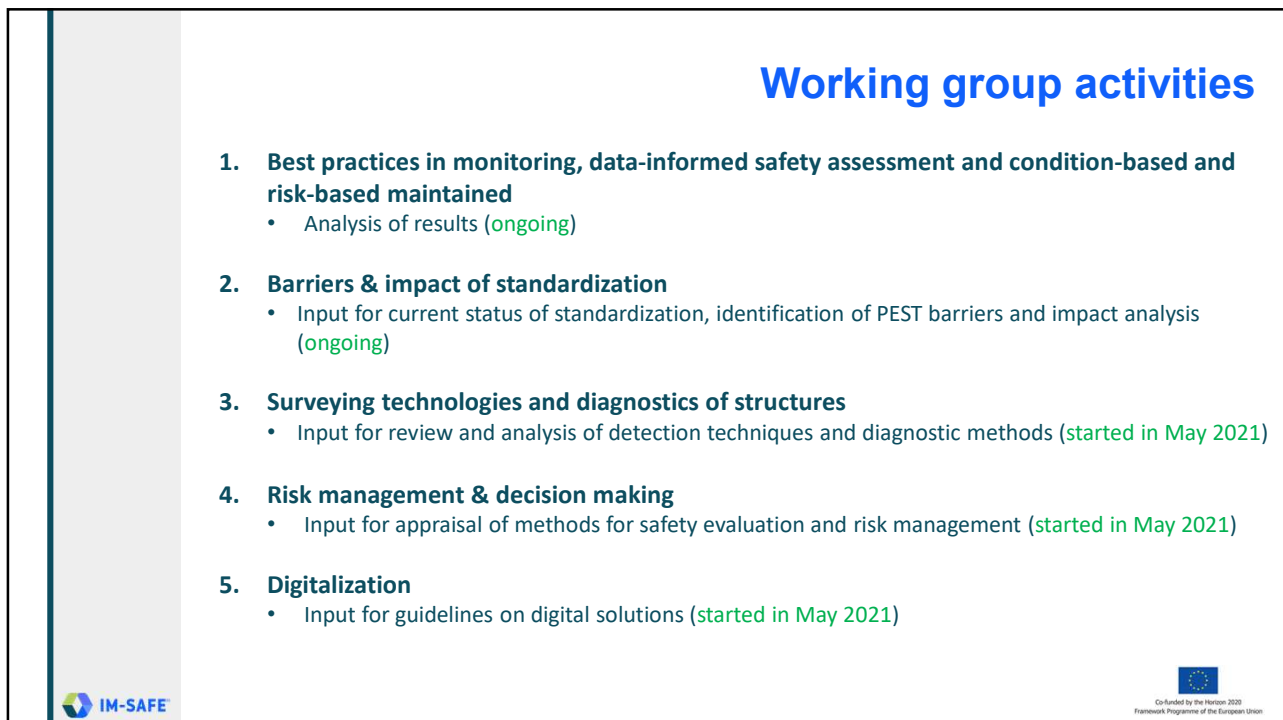
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Pan-European CoP Forum

Organized in January / February 2022

Online workshop, followed by a round table discussion:

UPDATE ON THE MANDATE TO CEN AND DIALOGUES WITH THE EUROPEAN COMMISSION AND CEN

Participants to the workshop will receive up-to-date information on the first draft of the mandate to CEN:

- new standard for condition-based and risk-based maintenance of infrastructures
- amendment to the existing EU standards on data-informed safety assessment of infrastructure
- new standard on structural monitoring of infrastructure

Information and viewpoints shared by the participants of the workshop will be taken into consideration in preparing the next draft of the mandate to CEN.



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Outlook

2021

1. July: IM-SAFE Newsletter
2. Questionnaire to (selected) CoP members, in preparation.
3. October Pan-EU CoP Forum meeting (preliminary results, input on specific concerns requested)
 - Surveying technologies
 - Data and digitalization
4. September: EuroStruct 2021 conference
5. December: (to be confirmed) Presentation in annual ECTP conference
6. Q4: 3 conferences in Poland


2022

1. January: IM-SAFE Newsletter
2. Februari: Pan-EU CoP Forum meeting



This presentation will be shared after the meeting by E-mail and will be uploaded to our website!



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Questions?





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Closure



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Communication

1. Website: www.IM-SAFE-project.eu, www.IM-SAFE.eu
 2. LinkedIn: <https://www.linkedin.com/company/im-safe-project/>
 3. IM-SAFE general information: info@im-safe-project.eu
 4. National CoP => IM-SAFE country representative
 5. National steering committee => IM-SAFE country representative
 6. Pan-EU CoP Forum => CROW (responsible IM-SAFE consortium partner),
Jos Wessels Jos.Wessels@crow.nl
- IM-SAFE Pan-EU Forum membership managed by CROW, to be "appointed" by country representative
 - Presentations of this Meeting will be sent to you by CROW



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Country representatives

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Thank you all for
attending, questions,
input, etc.



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