



"Seeing is believing" - DIC-overvågning af Storebælts- og Vejlefjordbroen

BRODAGEN 2022



Drift og vedligehold af infrastruktur - Udfordringer

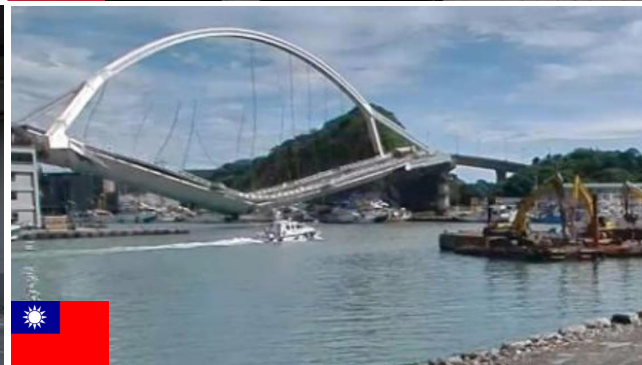
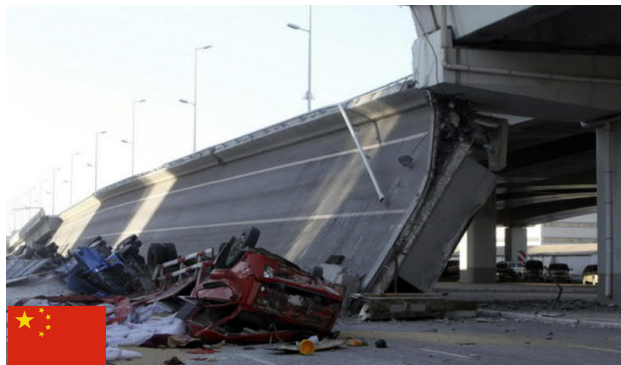


70 milliarder US \$
D&V omkostninger



HVORFOR kollapser broer? 2018 - 2022 !!!

USA (02/2022), Frankrig (11/2019), Italien (08/2018), Taiwan (10/2019), Colombia (01/2018), Kina (10/2019), Indien (03/2019)



Registrering på papir



Overvågning for dyrt



Overvågning resultater for kompliceret

Bro Asset Management i verden

Nuværende "bedste praksis"



Risiko
Arbejde i højden
Natarbejde



Traffikgener
Sporspærringer
Vejspærringer

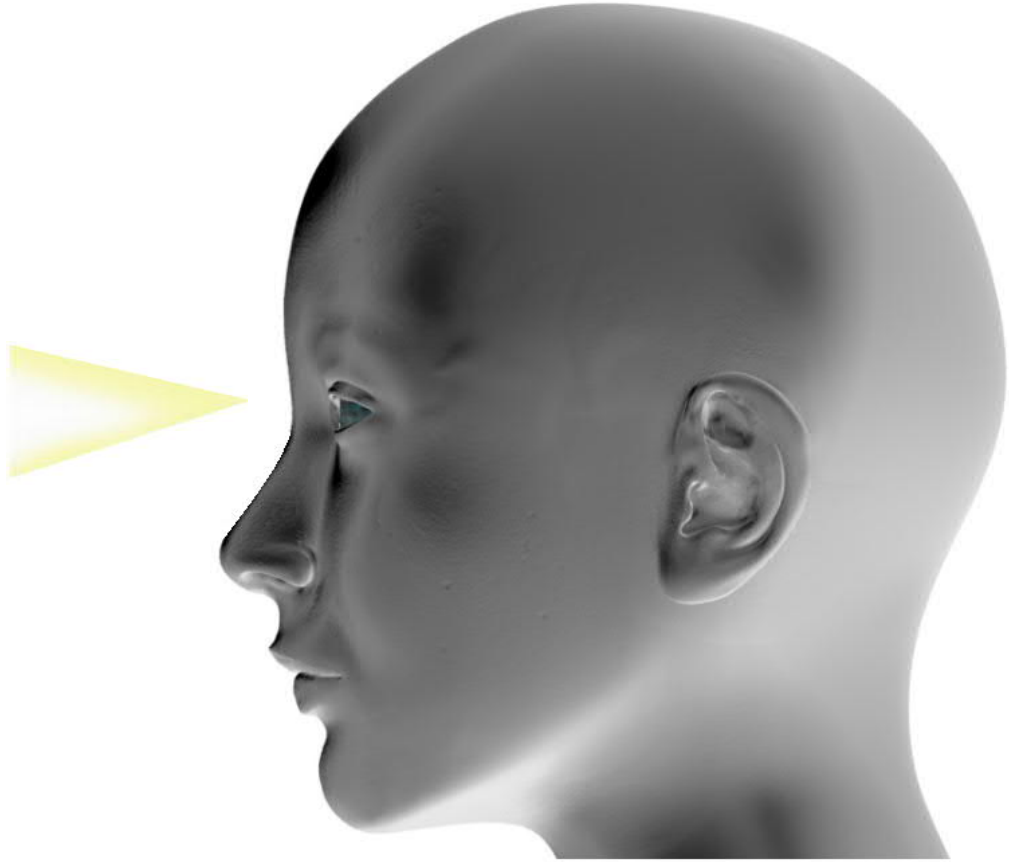
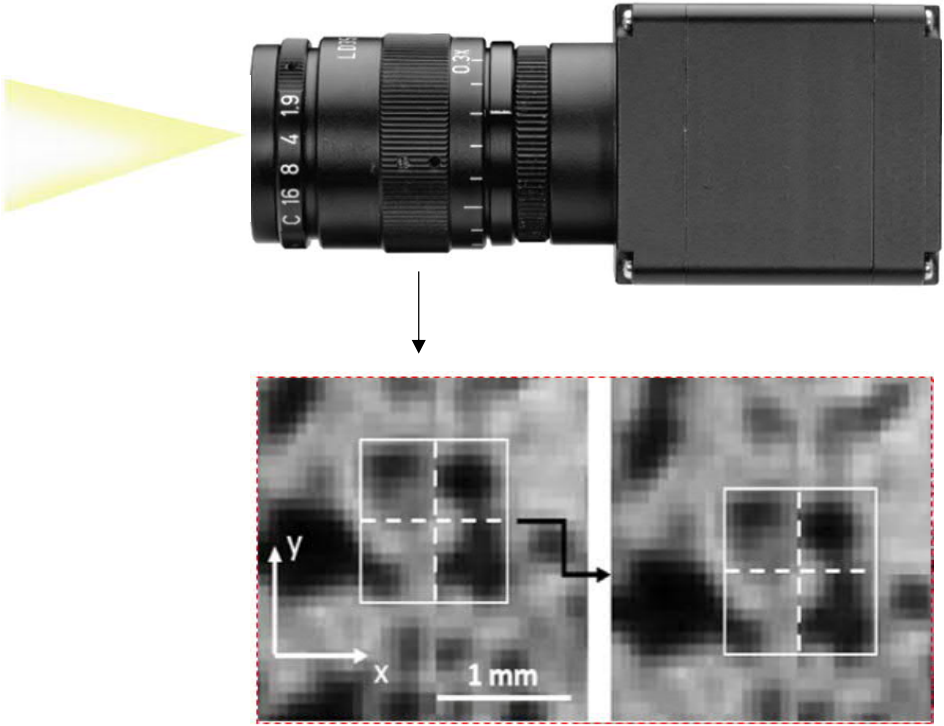


Effektivitet
Midlertidige arbejder (stilladser)
Strømforsyning & Dataadgang

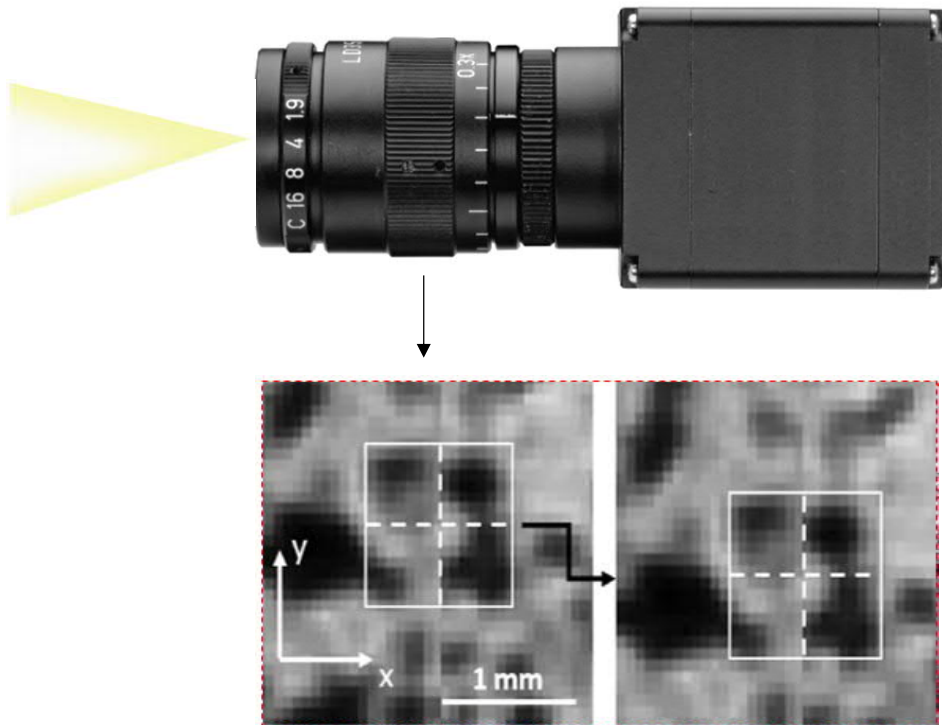


Fysiske sensorer

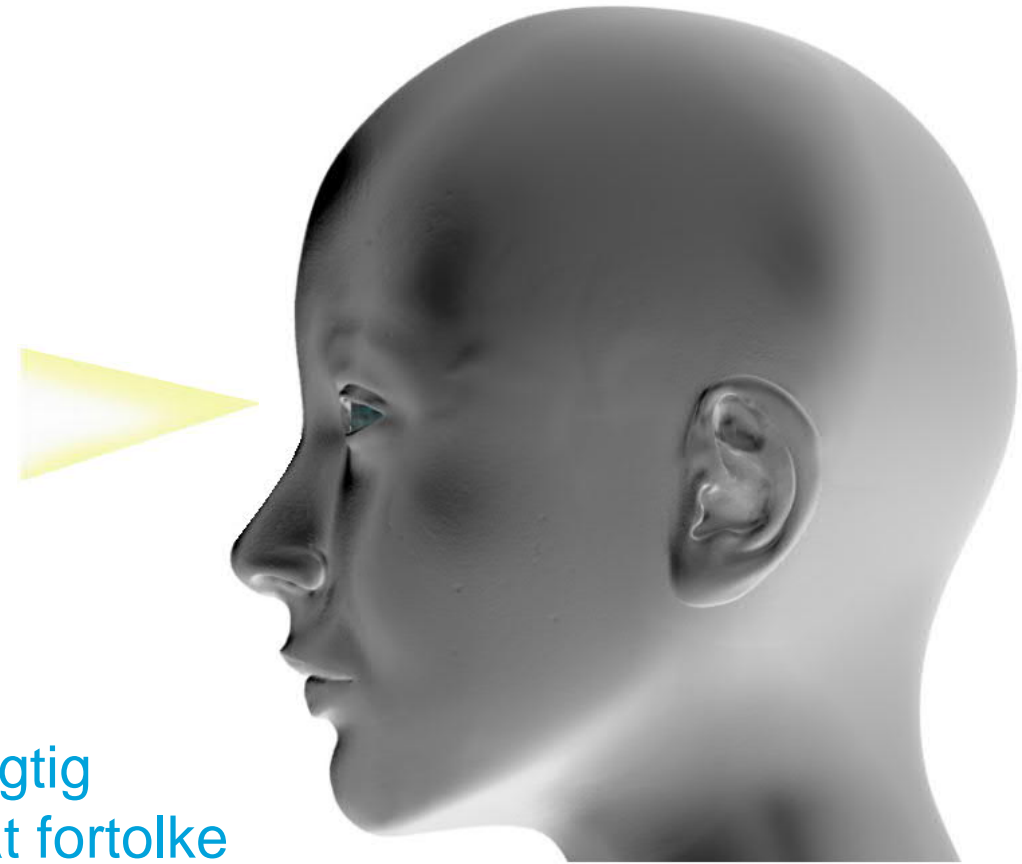
HVORFOR DIC ? - Seeing is believing !



HVORFOR DIC ? - Seeing is believing !



- Nøjagtig
- Let at fortolke
- Ingen trafikforstyrrelser
- Billig



HVORFOR DIC ?

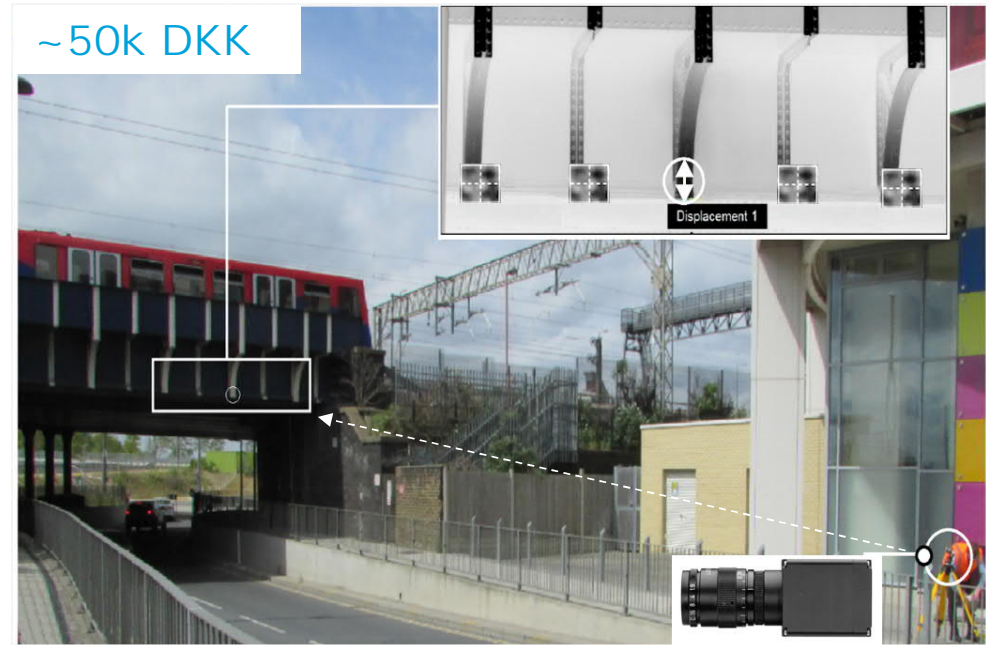
TRADITIONELLE TEKNIKKER



- Lukning af vej / jernbane
- Fysiske sensorer er nødvendige

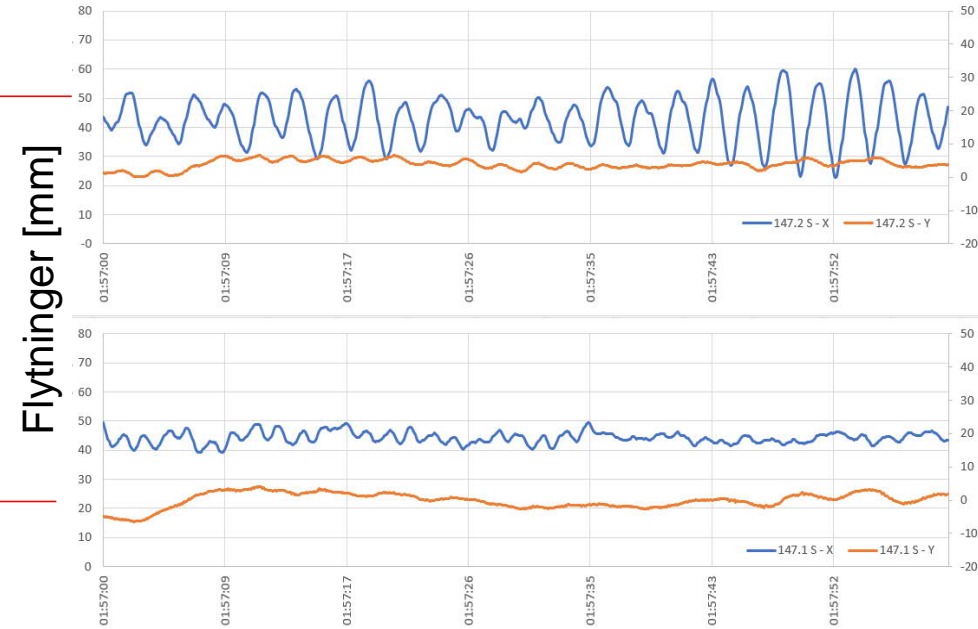
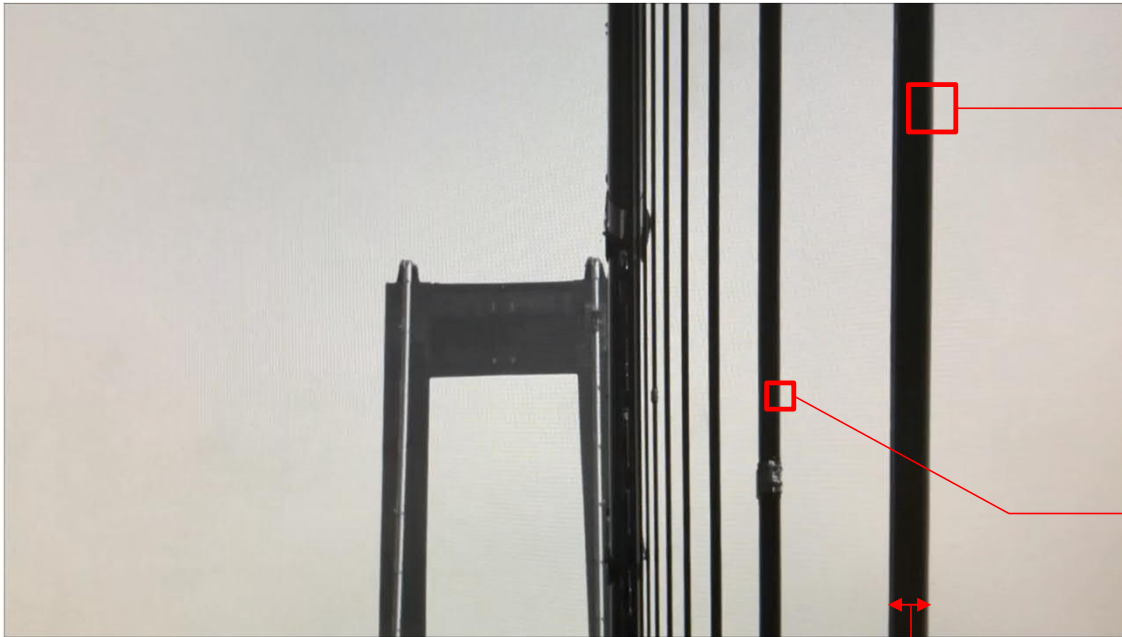
VS.

DIC



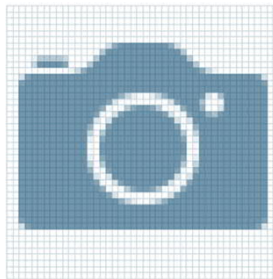
- Ingen trafikforstyrrelser = kontaktløs
- Ingen lukning nødvendig
- Kameraopsætning 30 m væk fra broen

Digital Image Correlation (DIC) – HVORDAN?

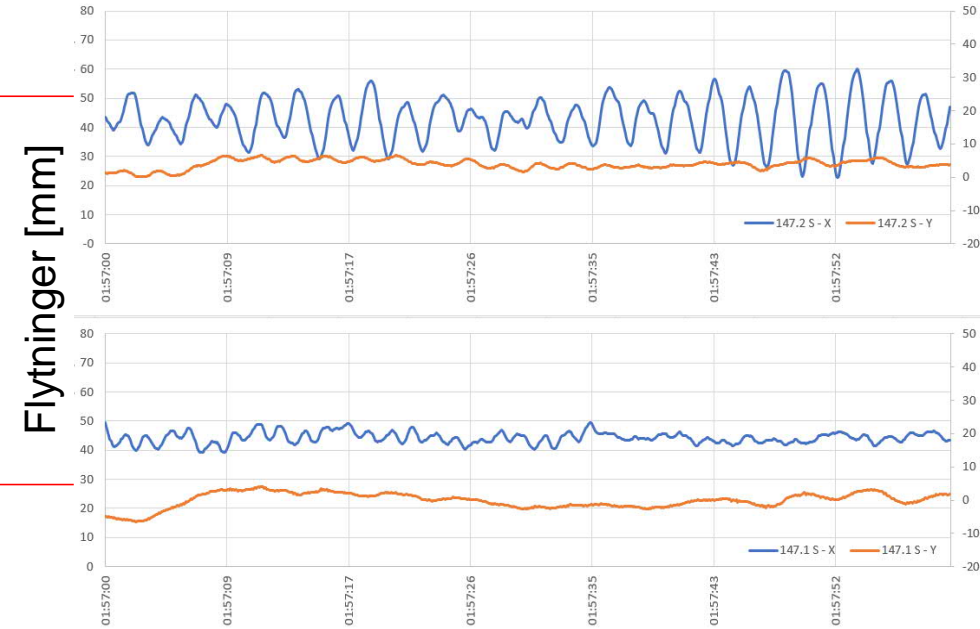


UTC Time	147.2 S - X	147.2 S - Y	147.1 S - X	147.1 S - Y
01:57:00	43,5543389	1,267785	49,3636852	-4,83784
01:57:00	43,1687589	1,214195	48,1808852	-4,94172
01:57:00	42,3838389	1,084785	47,3009302	-5,20219
01:57:00	41,7327189	1,251165	46,0311762	-5,1004
01:57:00	41,3206889	1,452765	44,9826352	-4,86578
01:57:00	40,7660389	1,311405	43,7079052	-5,18747
01:57:00	40,0711889	1,217875	42,9859352	-5,28734
01:57:00	39,5649889	1,273485	42,1279952	-5,21305
01:57:01	39,1709889	1,293395	41,5871252	-5,29767
01:57:01	39,1079889	1,394415	41,1826752	-5,26355
01:57:01	39,5359889	1,399915	41,3567752	-5,37568
01:57:01	40,0036889	1,379635	41,4268352	-5,55782

110 mm = 45 pixels

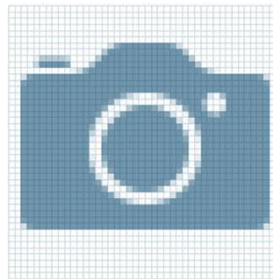


Digital Image Correlation (DIC) – HVORDAN?



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Kunden:

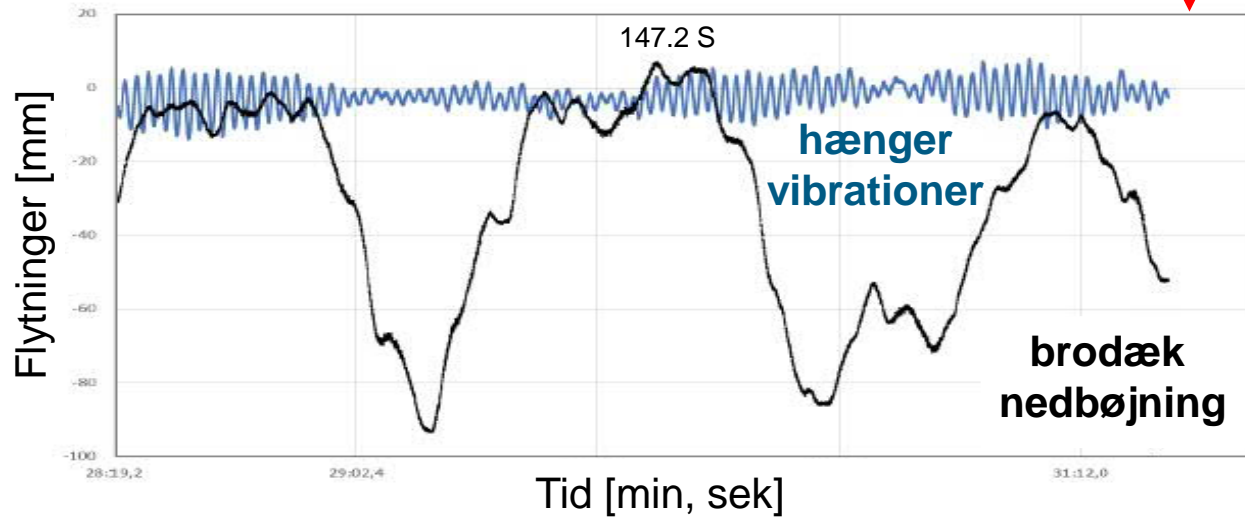
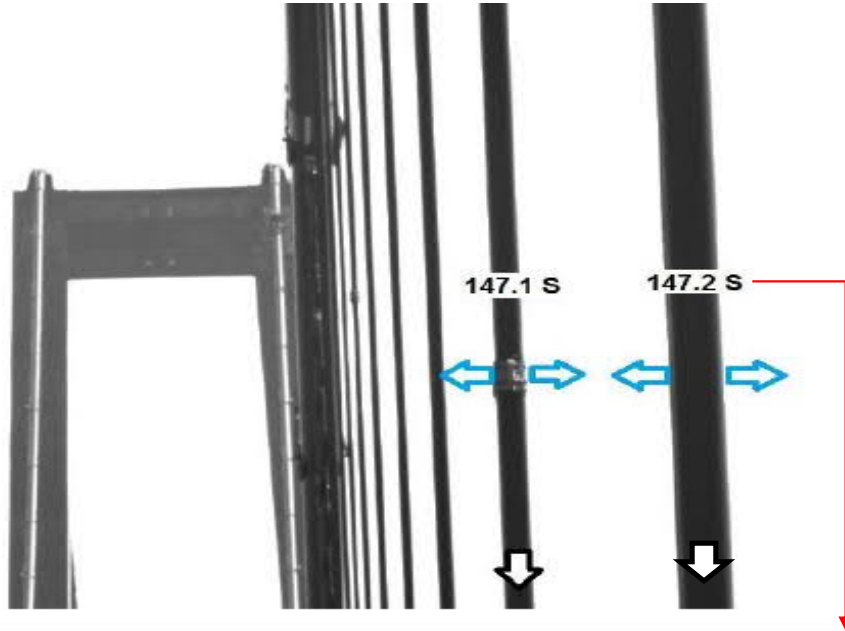
Sund ≈ Bælt
Sund ≈ Bælt

Storebæltsbroen

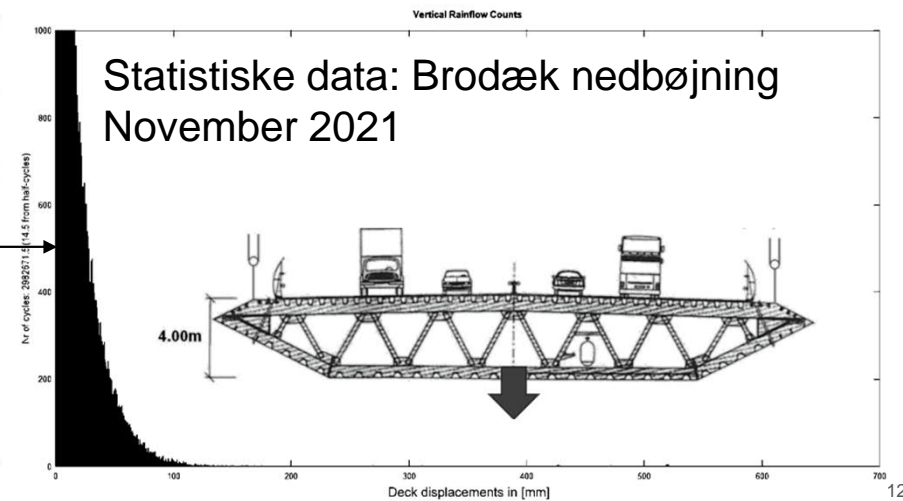
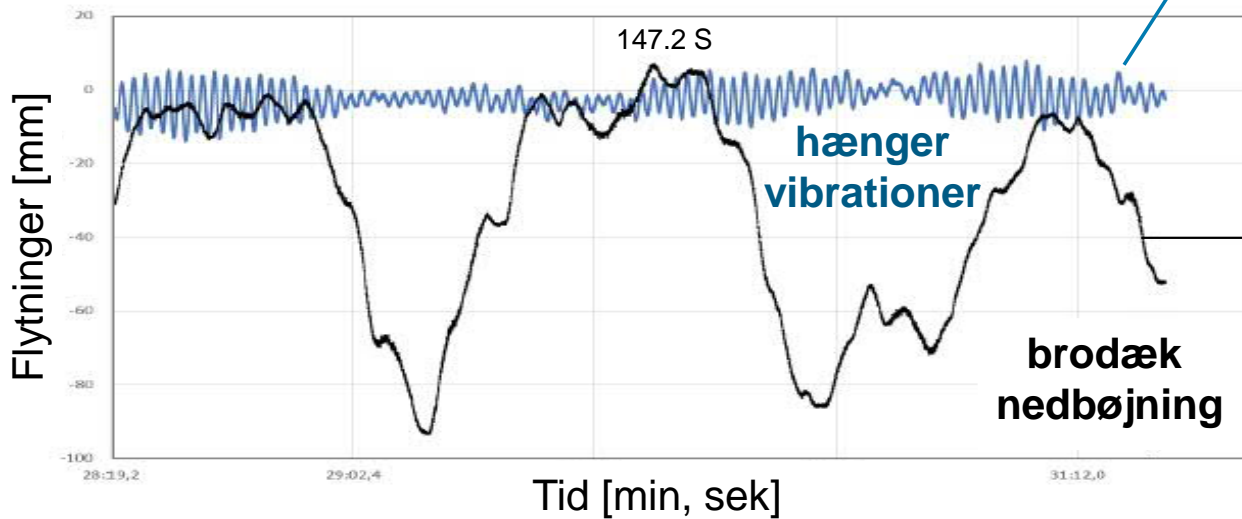
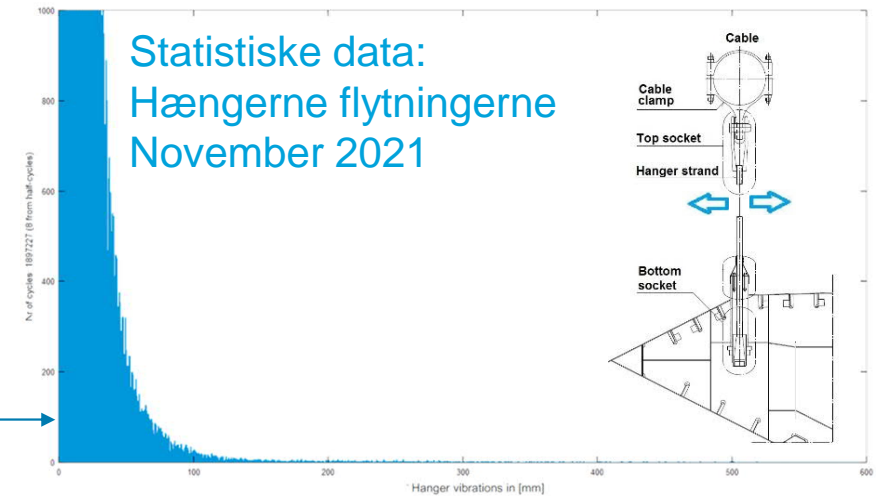
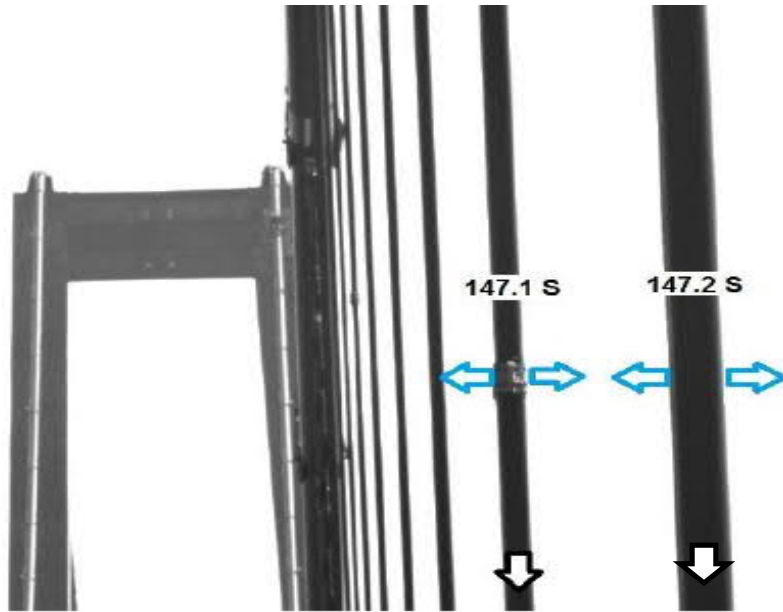
Danmark

◆ DIC-teamet designede, installerede og vedligeholder permanent kamerabaseret overvågningssystem til langtidsovervågning af kabler, dæk og ekspansionsfuge.

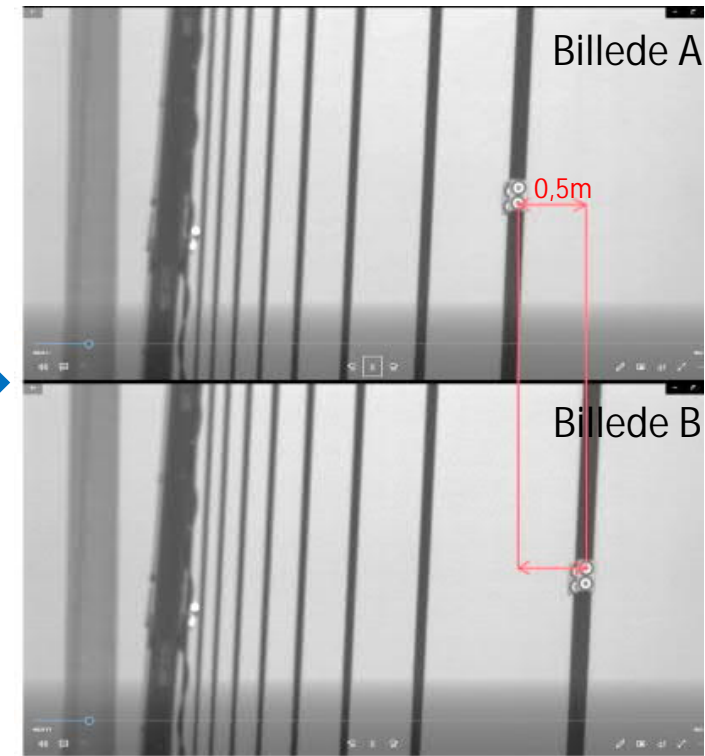
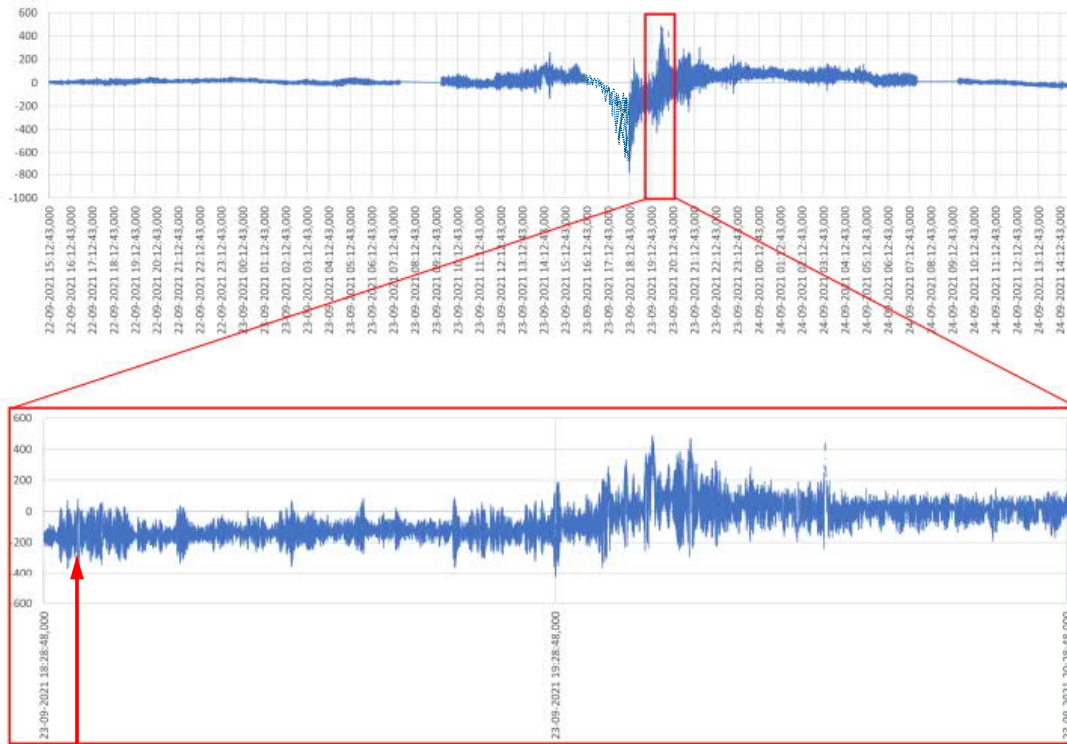
Storebæltsbroen – overvågning af hængerne & brodæk



Storebæltsbroen – overvågning af hængerne & brodæk

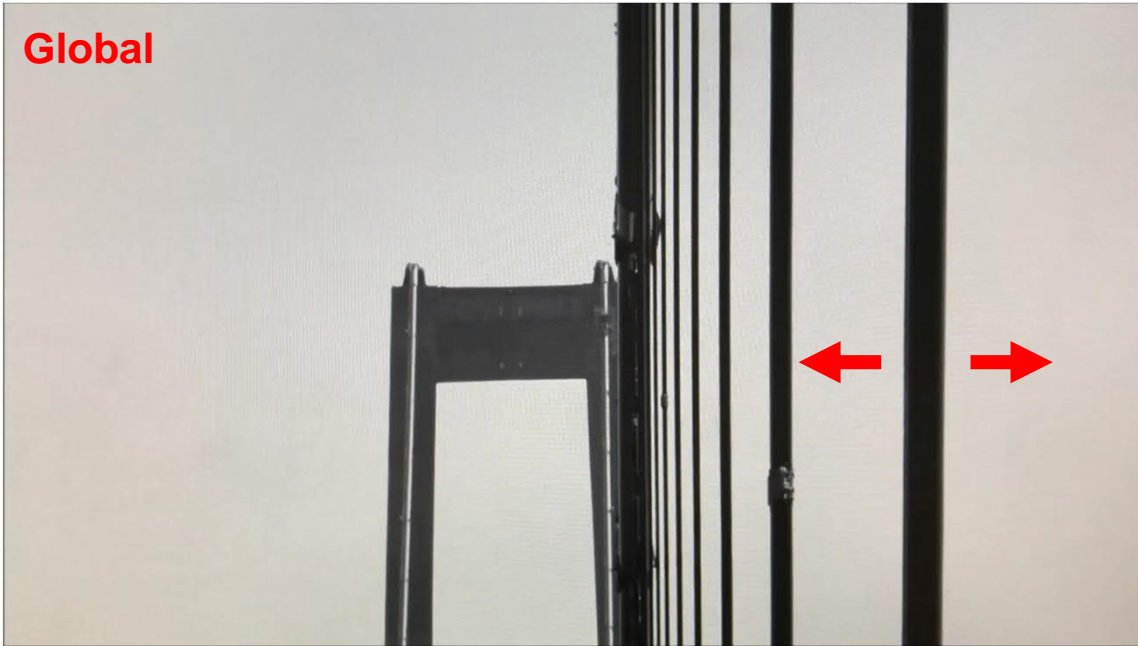


Storebæltsbroen – overvågning af hængerne & brodæk

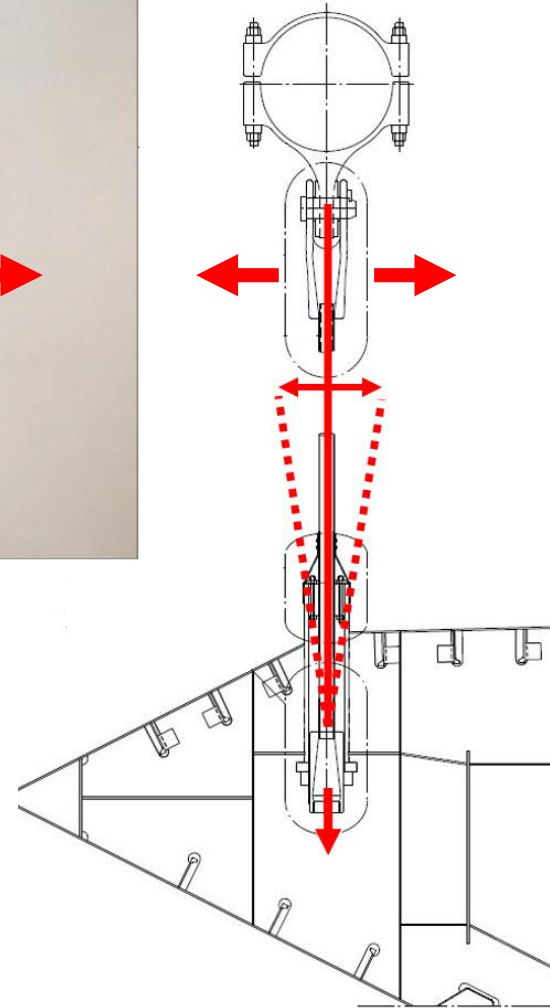


Storebæltsbroen – overvågning af hængerne & brodæk

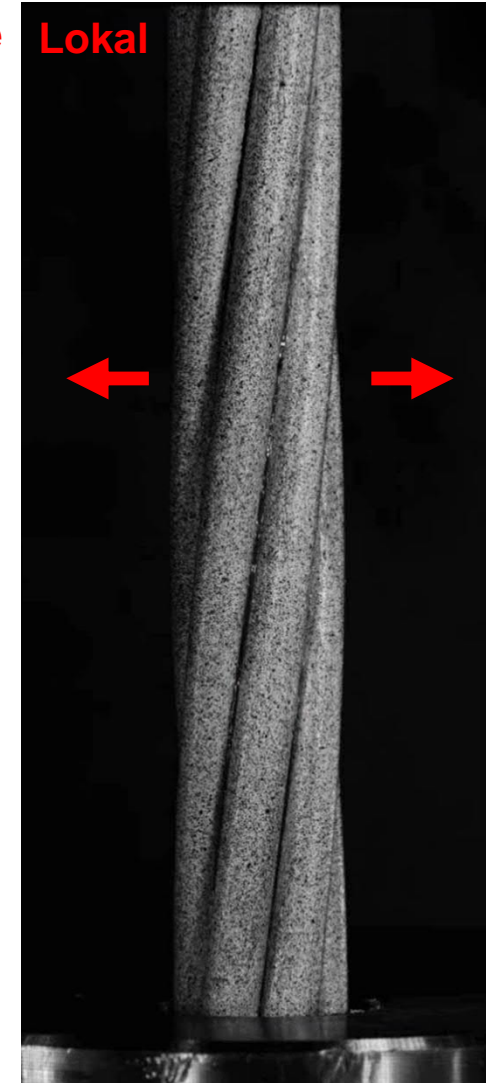
Global



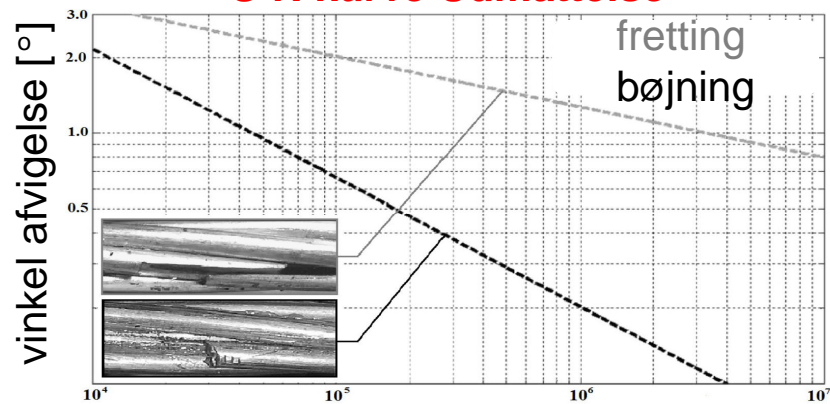
Hængerne flytningerne



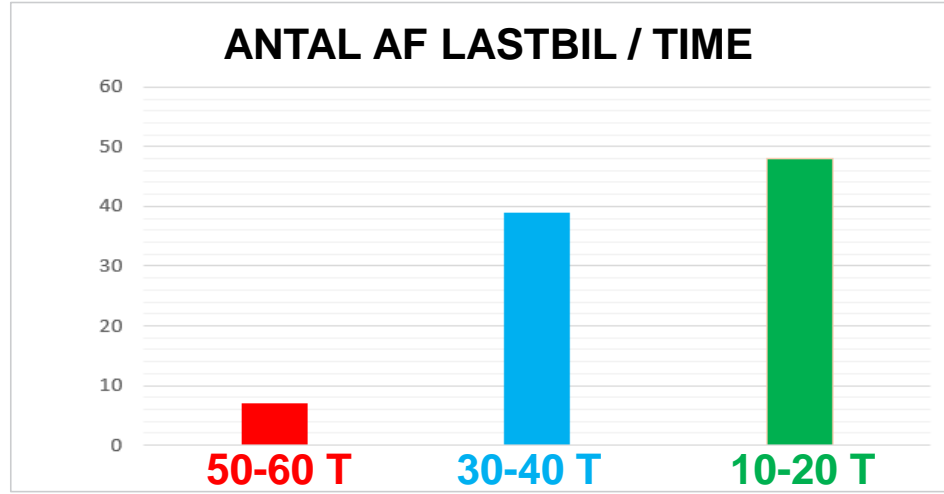
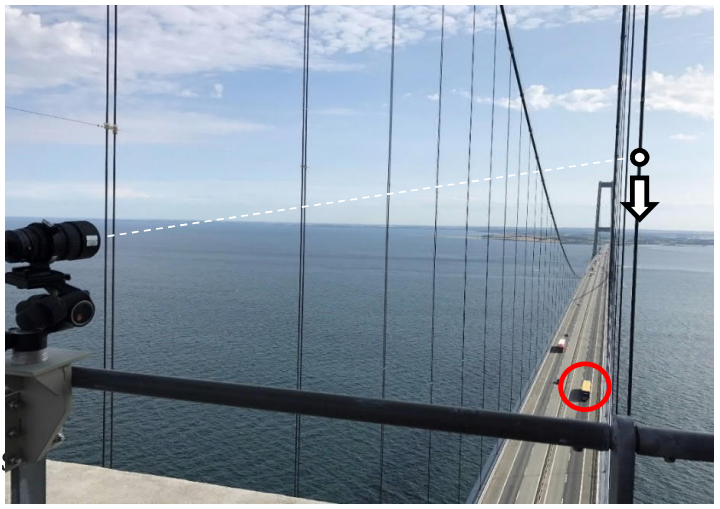
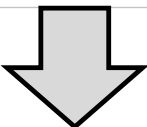
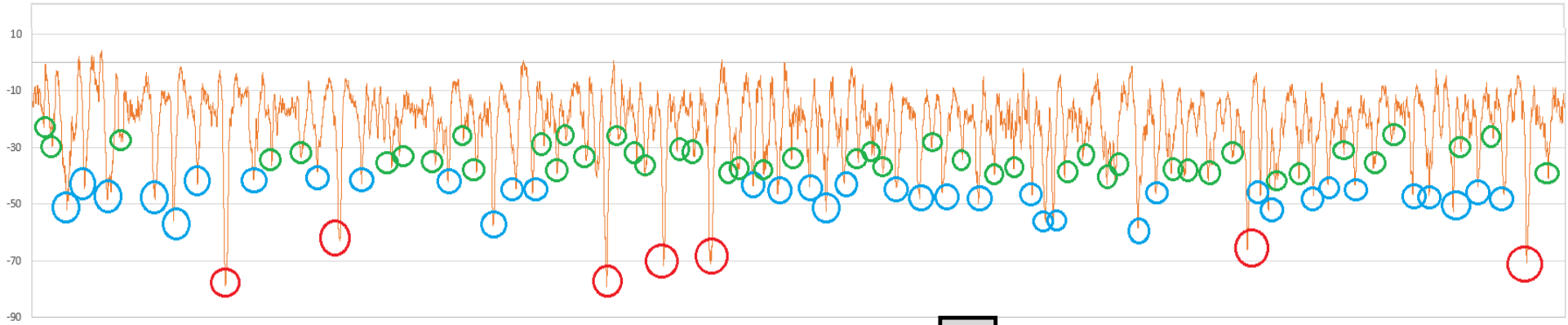
Lokal



S-N kurve Udmattelse



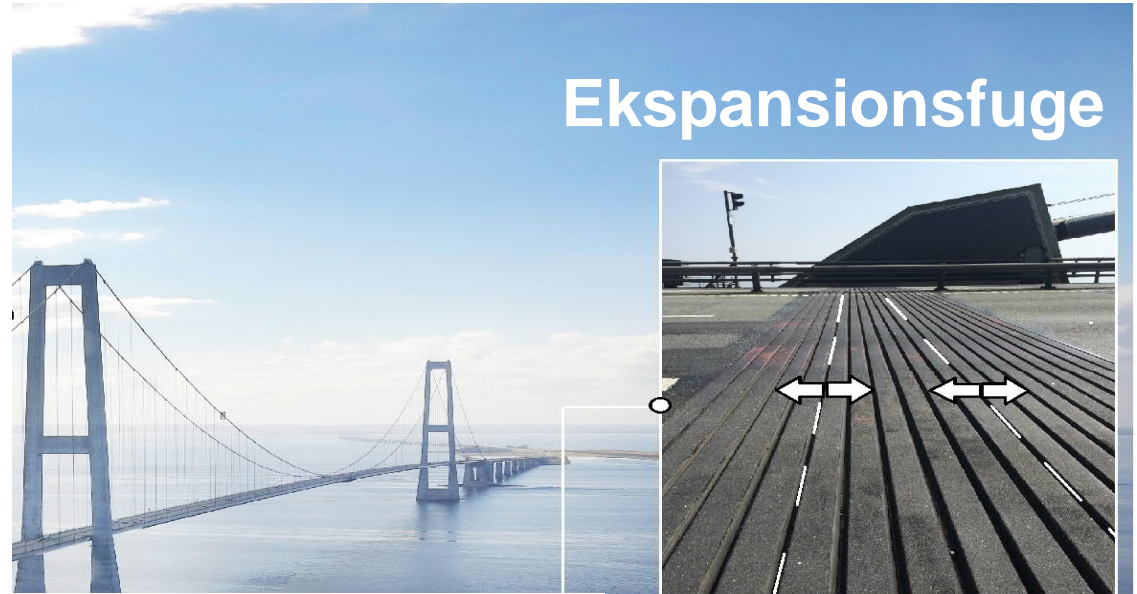
Storebæltsbroen – overvågning af trafikbelastning



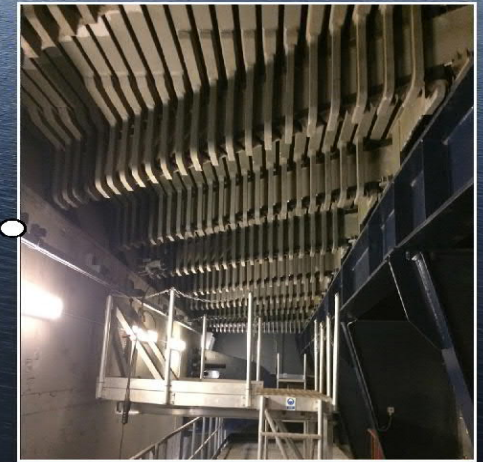
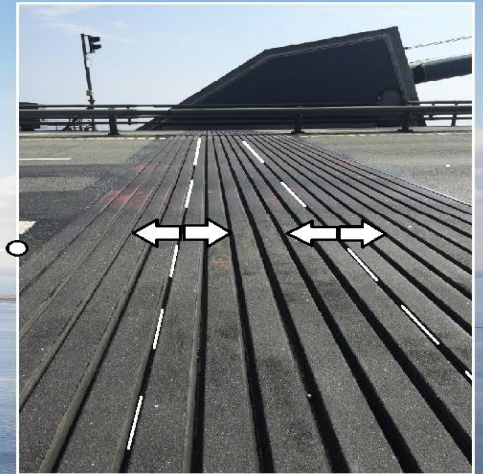
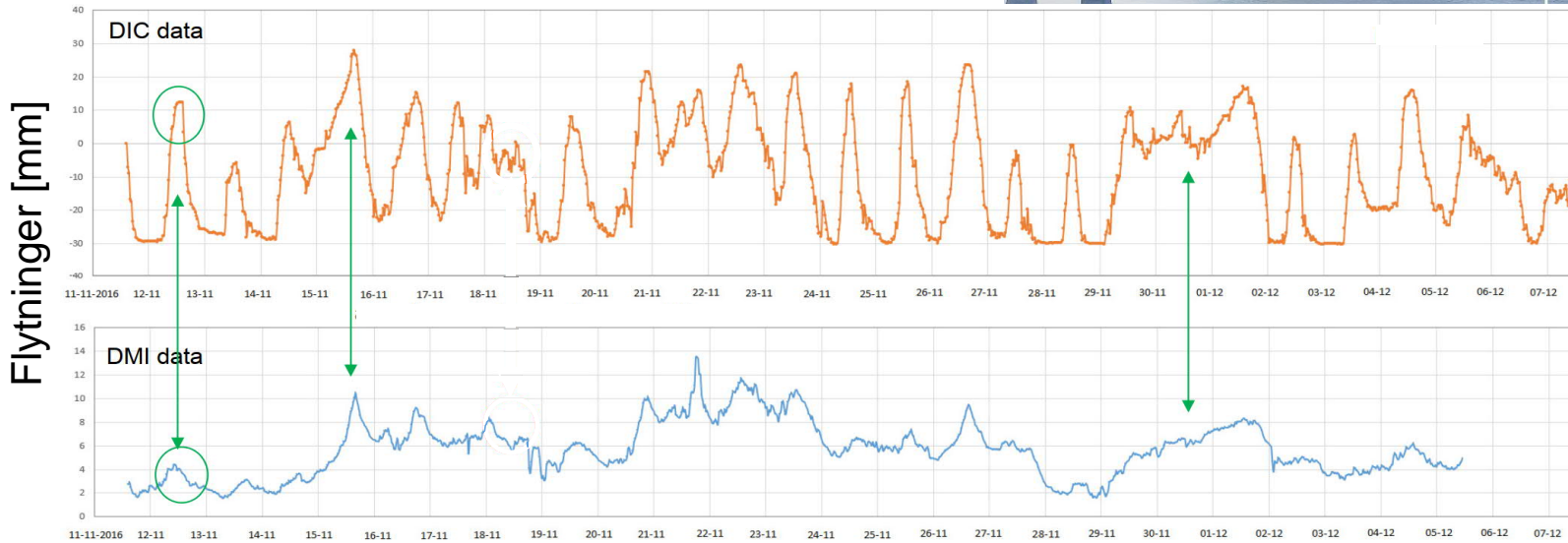
Storebæltsbroen – overvågning af ekspansionsfuge



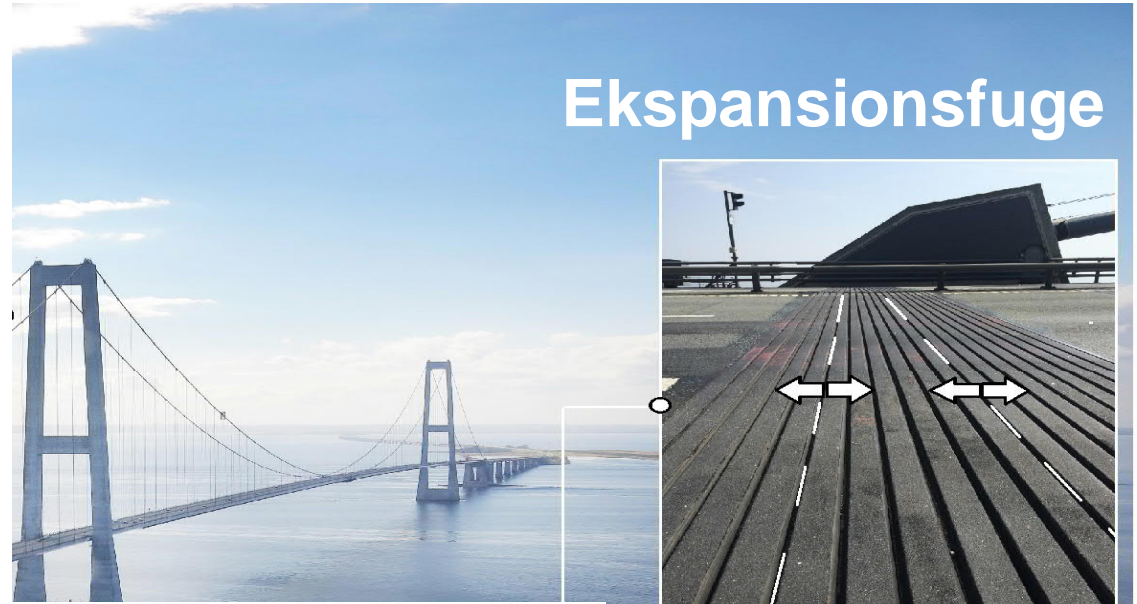
Storebæltsbroen – overvågning af ekspansionsfuge



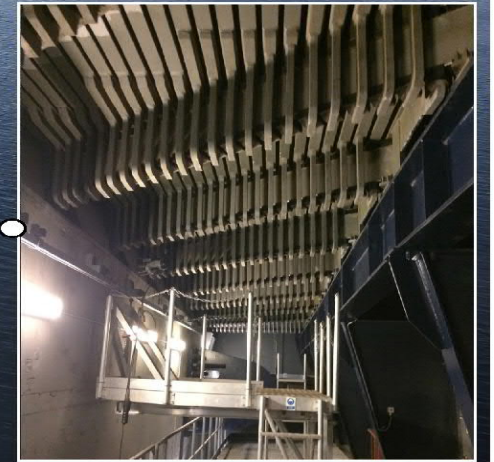
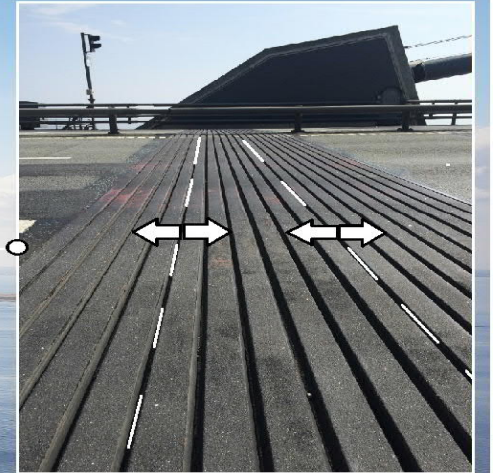
Temperatur-induceret bevægelse



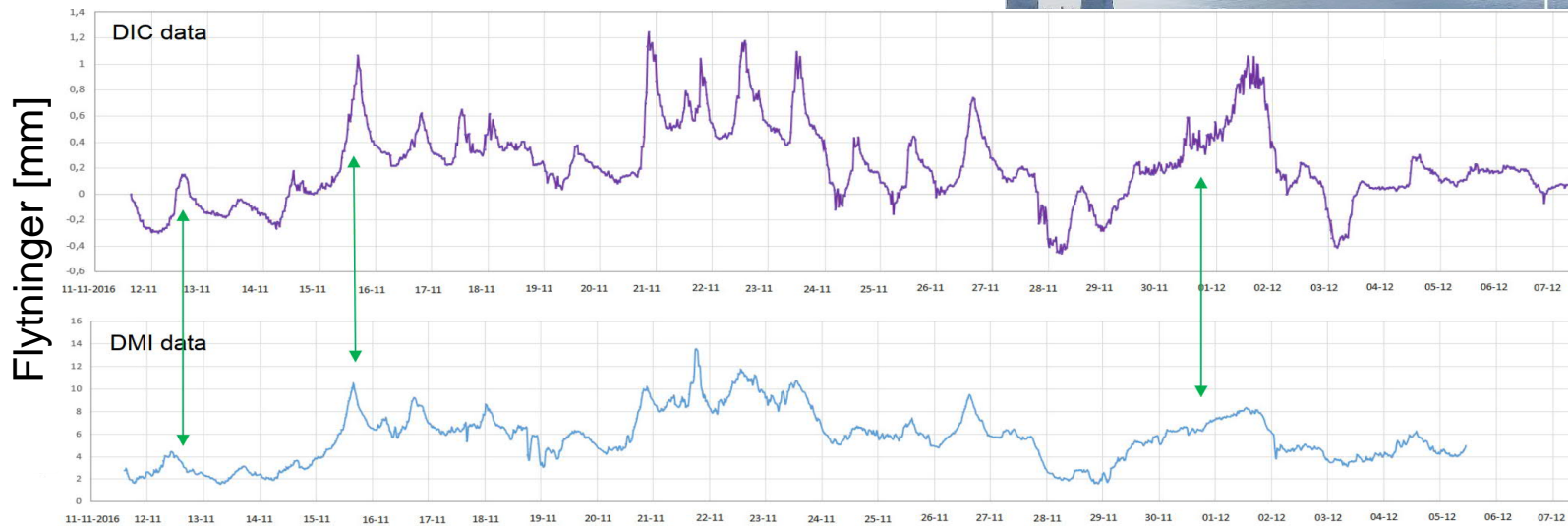
Storebæltsbroen – overvågning af ekspansionsfuge



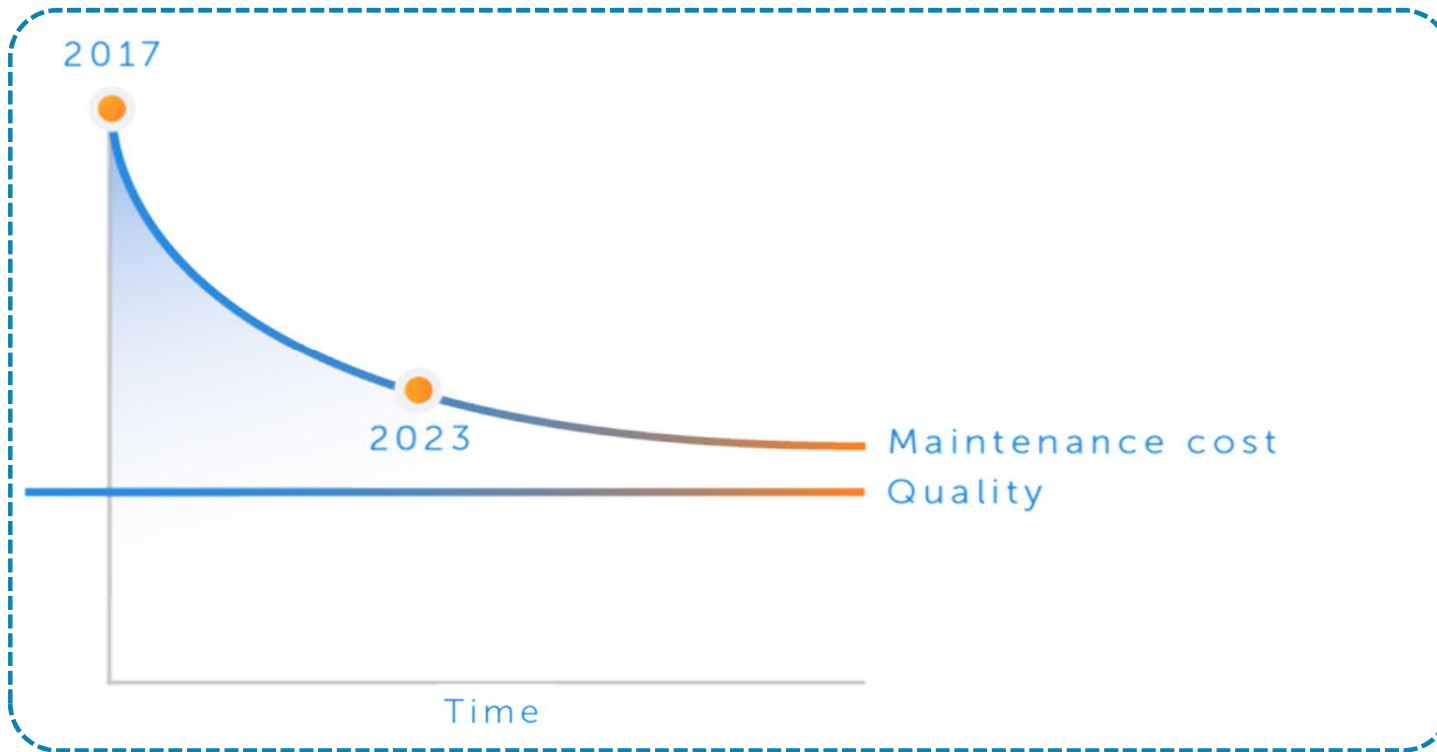
Ekspansionsfuge



Temperatur-induceret rotationer



DIC hjælper kunder med at nå mål for Asset Management



Sund Bealt A/S Mål:

- Reducer driftsomkostningerne med 2 % om året frem til 2023
- Hold konstant omkostningsniveau efter 2023 på trods af aldrende anlægsmasse
- Fastholde kvalitet og tilgængelighed

D
I
C

This collage illustrates the application of DIC (Digital Image Correlation) in structural analysis. It includes:

- Photographs of bridge hangers and deck structures.
- Graphs showing 'DIC data' and 'DMI data' with amplitude and time axes.
- Structural diagrams of a hanger system with labels for 'Cable collar', 'Top socket', 'Hanger strand', and 'Bottom socket'.
- Text labels for 'Global' and 'Local' vibration analysis.
- Text labels for 'Hanger vibration' and 'deck deck'.

Vejlefjordbroen - Overvågning af brotrafikbelastning

ATKINS
Member of the SNC-Lavalin Group

Kunden:



Vejlefjordbroen

Danmark

◆ DIC-undersøgelsen blev udført for at bestemme spændingsvariationerne under påvirkning af trafiklast.

Vejlefjordbroen - Overvågning af brotrafikbelastning



Vejlefjordbroen - Overvågning af brotrafikbelastning

Tankvogn (T)



Lastbil (L)



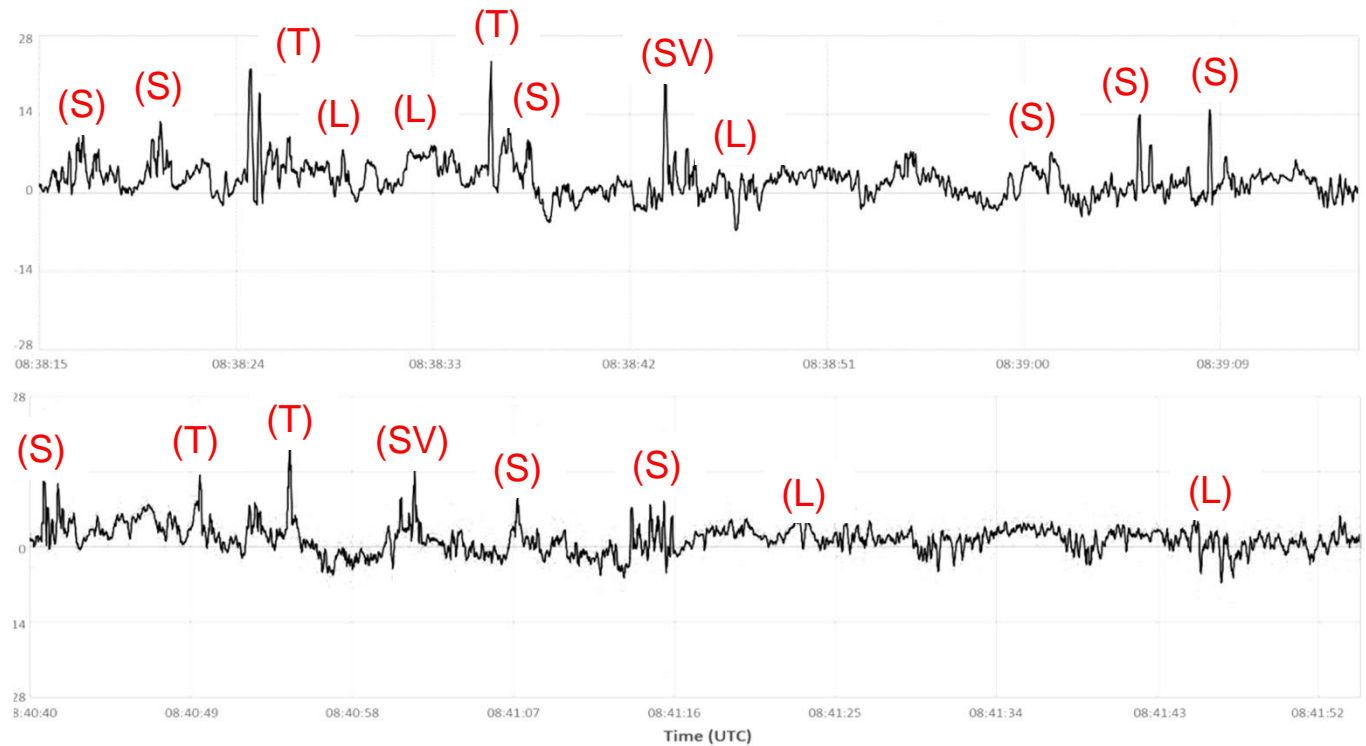
Sættevogn m. trækker (S)



Specialkøretøj (SV)



Spændingsvariationerne under påvirkning af trafiklast



Vejlefjordbroen - Overvågning af brotrafikbelastning

Tankvogn (T)



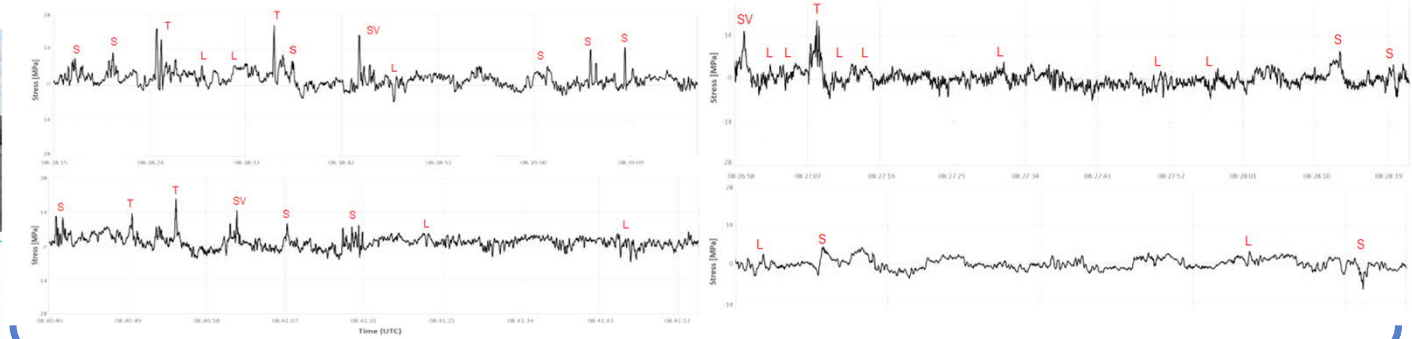
Lastbil (L)



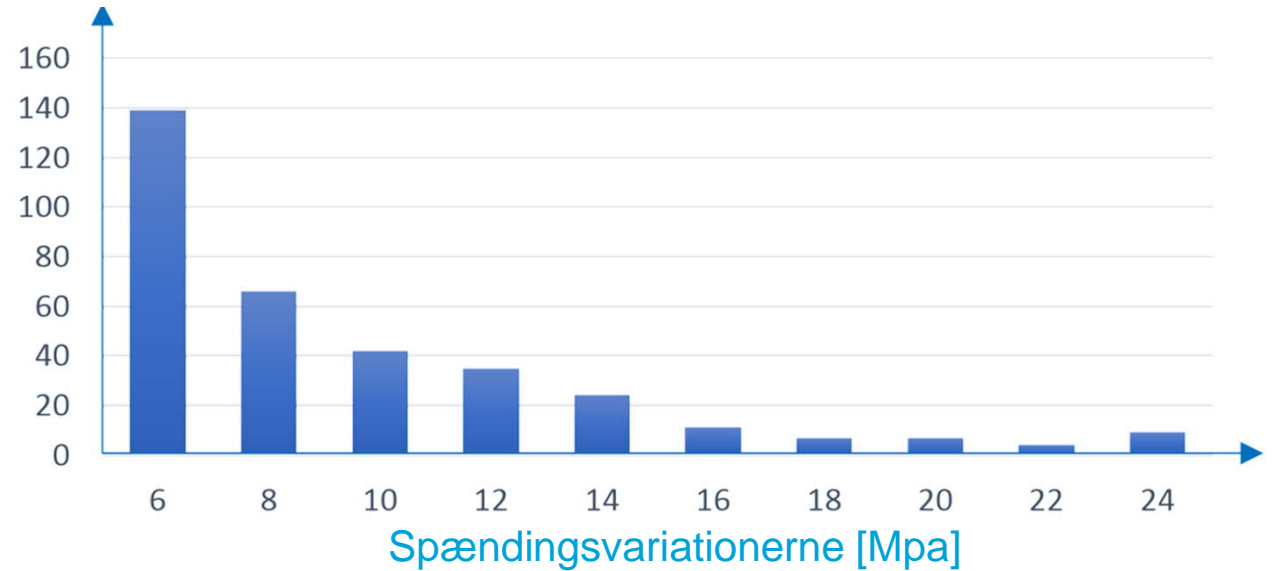
Sættevogn m. trækker (S)



Specialkøretøj (SV)



Antal / time

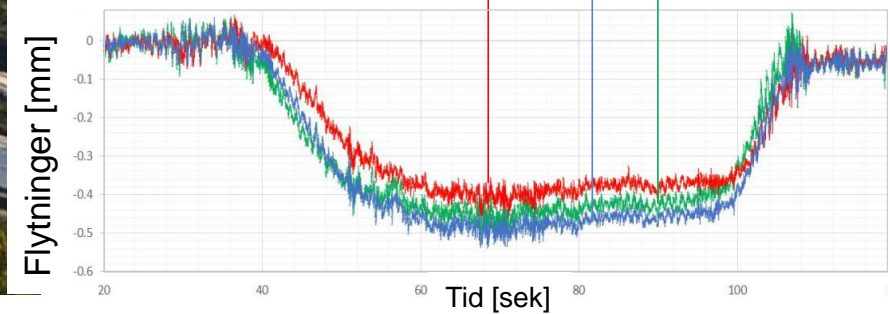
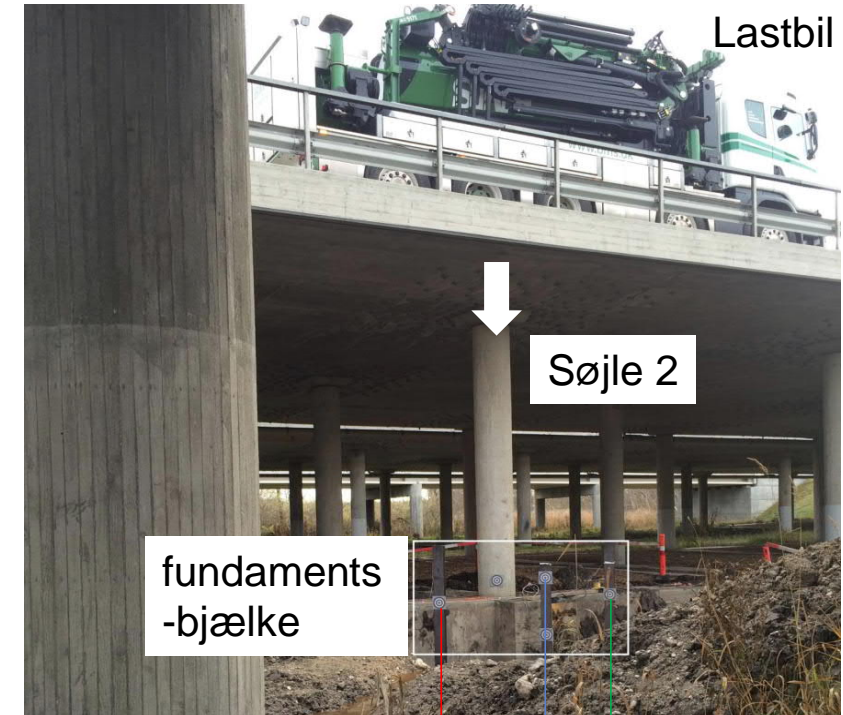


Køge Bugt Broer – Forstærkningsprojekt



Køge Bugt Broer – Forstærkningsprojekt

DIC målinger af fundamentsbjælke deformationer - Karlslunde



Oversigt - Digital Image Correlation

- Undgå unødvendig og kostbar forstærkning
- Forlæng infrastrukturens levetid (besparelser på offentlige budgetter)
- Undgå trafikforstyrrelser (lukninger og arbejde i højden)
- Flere transporttjenester for det samme CO2-fodaftryk

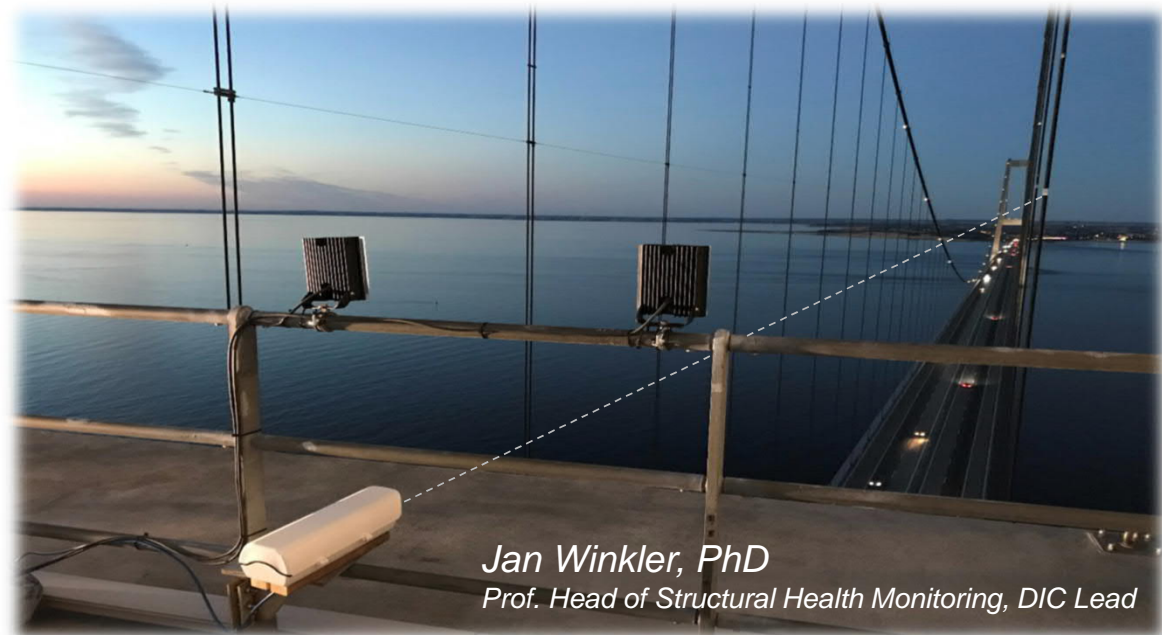
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BRODAGEN 2022



*Jan Winkler, PhD
Prof. Head of Structural Health Monitoring, DIC Lead*