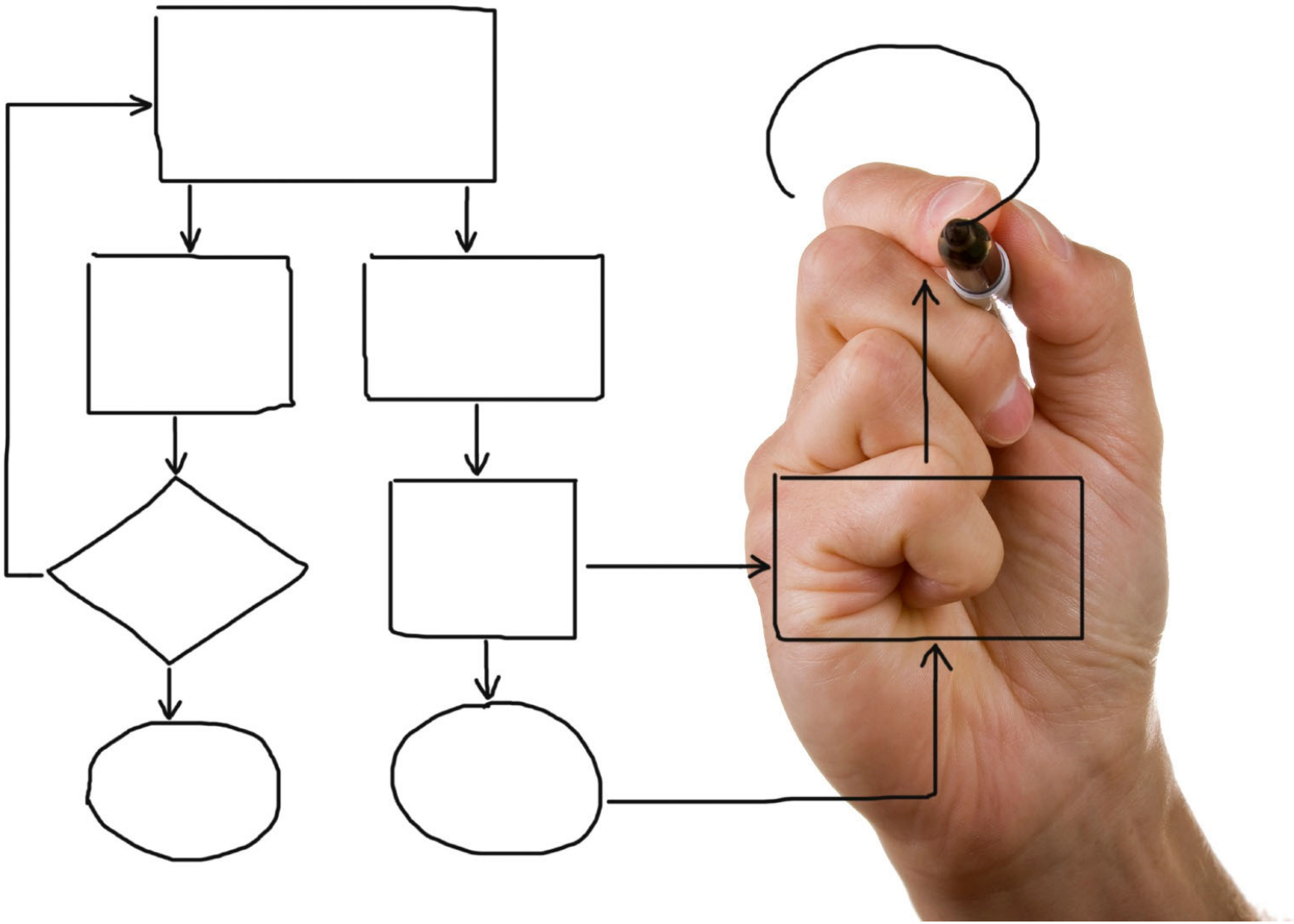
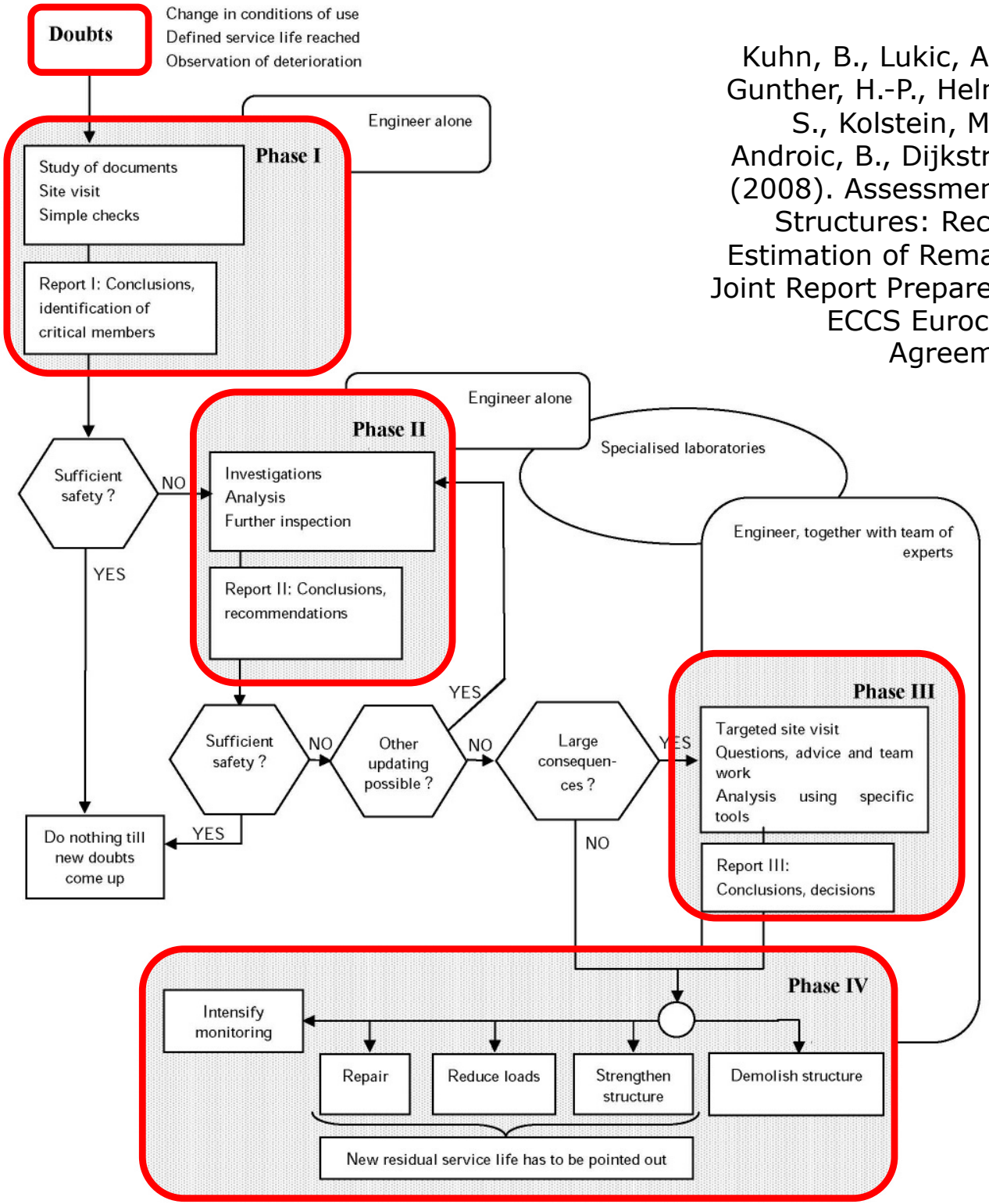
Lecture 1C – Key Messages

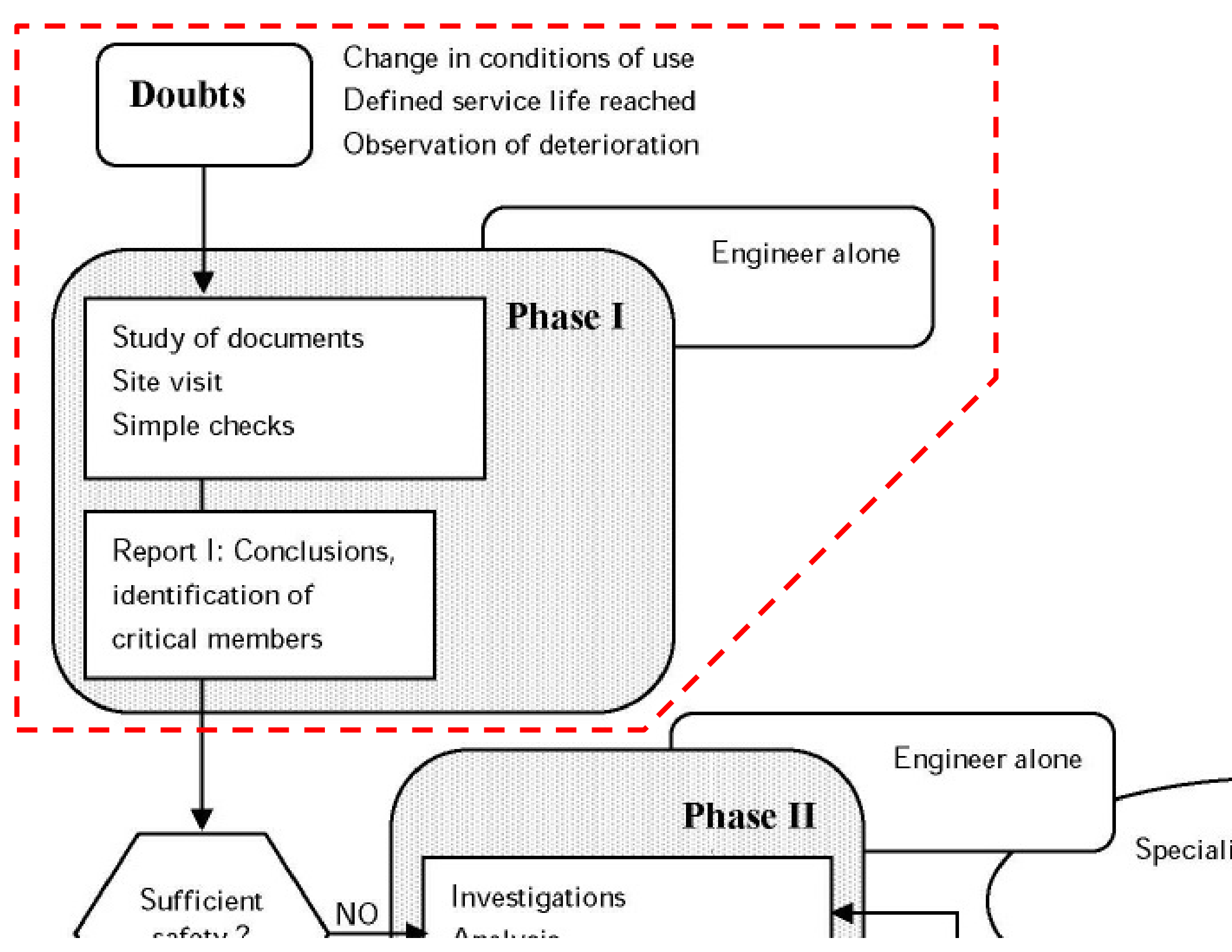
- The process of structural assessment is best and most cost-effectively performed using iterations with increasing complexity and cost brought to bear as necessary.
- Effective repair of structures occurs after: 1) an effect is seen, 2) a cause is determined, and 3) a repair method is identified, which addresses the cause of the observed damage or gradual deterioration.

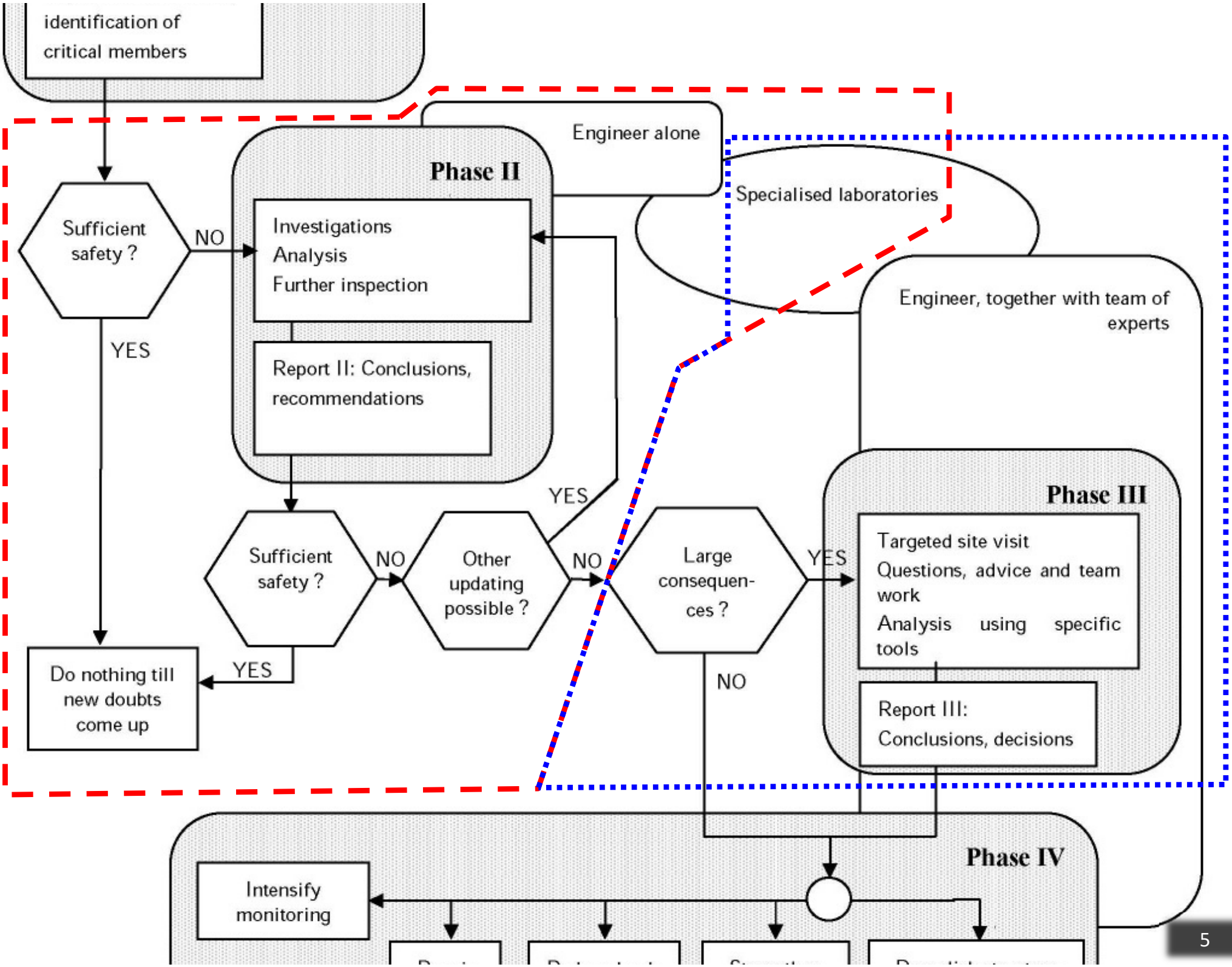
Assessment and rehabilitation: what process to follow?

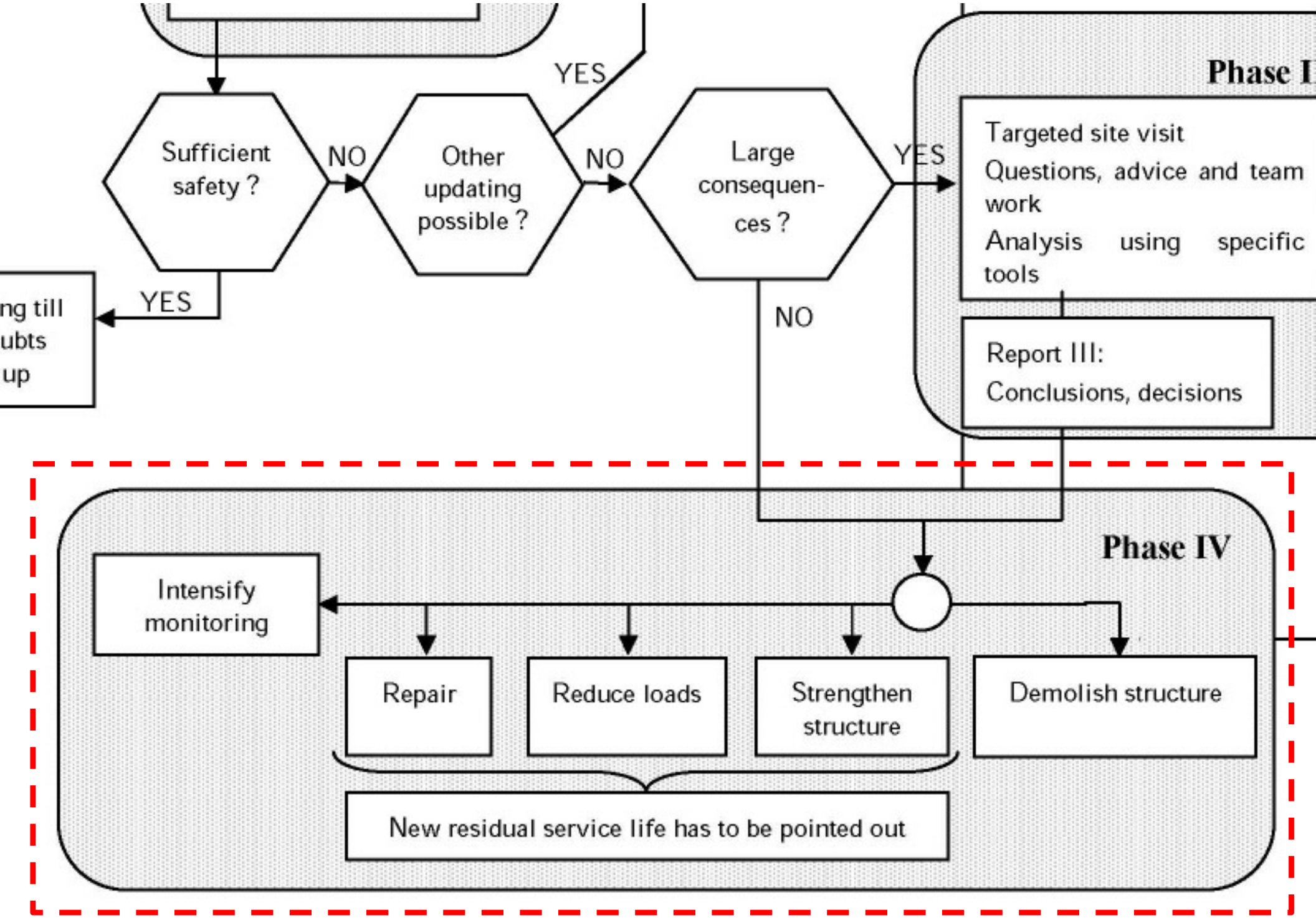




Kuhn, B., Lukic, A., Nussbaumer, A., Gunther, H.-P., Helmerich, R., Herion, S., Kolstein, M.H., Walbridge, S., Androic, B., Dijkstra, O., & Bucak, O. (2008). Assessment of Existing Steel Structures: Recommendations for Estimation of Remaining Fatigue Life, Joint Report Prepared under the JRC – ECCS Eurocode 3 Cooperation Agreement, Luxembourg.


Doubts
Change in conditions of use
Defined service life reached
Observation of deterioration
Engineer alone
Phase I
Study of documents
Site visit
Simple checks
Report I: Conclusions, identification of critical members
Engineer alone
Phase II
Speciali
Sufficient
NO
Investigations


identification of critical members
Engineer alone
Phase II
Specialised laboratories
Sufficient safety ?
NO
Investigations
Analysis
Further inspection
YES
Report II: Conclusions, recommendations
Engineer, together with team of experts
YES
Phase III
Sufficient safety ?
NO
Other updating possible ?
NO
Large consequen-ces ?
YES
Targeted site visit
Questions, advice and team work
Analysis using specific tools
Do nothing till new doubts come up
YES
NO
Report III: Conclusions, decisions
Phase IV
Intensify monitoring


YES
Sufficient safety ?
NO
Other updating possible ?
NO
Large consequen-ces ?
YES
Phase I
Targeted site visit
Questions, advice and team work
Analysis using specific tools
Report III:
Conclusions, decisions
YES
ng till
ubts
up
NO
Phase IV
Intensify monitoring
Repair
Reduce loads
Strengthen structure
Demolish structure
New residual service life has to be pointed out

Concrete repair process*

Steps of the repair process:

1. see an effect
2. determine the cause
3. decide whether or not the problems need to be repaired
4. perform condition survey to quantify the problem
5. perform analysis and select repair strategy
6. accomplish repair

Fixing an effect without understanding the cause is likely to result in premature failure of the repair...

*From Prof. Soudki's CIVE 512 notes.

Steps 1 and 2: Effect / cause

See an effect (concrete structures):

- Cracking
- Leakage
- Settlement
- Deflection
- Wear
- Spalling
- Disintegration
- Scaling
- Delamination

Steps 1 and 2: Effect / cause

Determine the cause, e.g.:

- *defect in:* design, materials, construction
- *damage from:* overload, vehicle impact, chemical spill, earthquake, fire
- *deterioration from:* freeze-thaw cycles, alkali-aggregate reaction (AAR, sulphate attack), reinforcing bar corrosion

Steps 1 and 2: Effect / cause

See: spalling of the concrete cover
Cause: fire

See: failed column
Cause: earthquake

Step 3: Is the repair required?

This is an issue the owner must deal with, working with the engineer. Various factors must be considered, such as:

- cost *(money needed to carry out the repair versus money available)*,
- public safety, and
- loss of function.

Step 4: Condition survey

- A condition survey is necessary to determine the extent and nature of damage. This should be followed by suitable diagnosis and laboratory assessment of the root cause(s).
- The testing carried out in this step could include field testing and/or laboratory testing.
- The information from the condition survey also provides a means for quantifying, prioritizing, and documenting the repair.

Step 4: Condition survey

Typical steps of condition survey (ACI 201.2R-08):

1. visual inspection,
2. review of engineering data (design and construction documents, operation and maintenance records, concrete records),
3. detailed condition survey (mapping of various deficiencies, monitoring, joints survey, non-destructive testing, structural analysis),
4. final evaluation, and
5. condition survey report.

Step 5: Repair analysis

The repair analysis combines two perspectives*:

a) owner: cost, urgency, life-cycle, and

b) engineer: structural considerations, repair environment, safety, function.

A combination of all these factors will determine the optimal repair strategy, means, and materials.

* *Modern analysis approaches also consider sustainability, user cost, societal benefit, etc.*

Step 5: Repair strategy

The repair strategy includes:

- method of repair (e.g. surface repair, crack stabilization, waterproofing, strengthening, protection),
- material selection (load-carrying properties, bond to substrate, durability, dimensional stability, constructability), and
- other aspects, including: structural support design, placement method trowel applied, form and pump, form and pour, shotcrete).

Step 6: Accomplish repair!!!

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