Decision Support System for Atmospheric Corrosion of Carbon Steel Pipes

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Background

Atmospheric corrosions have been neglected, because they are very slowly.

They begin to come out, after 30 years from constructed.

Inspection for atmospheric corrosions are required.

Motivation

But, the management of insulated pipes is a hard and costly job.
1) Thousands of points are inspected, because the pipes are very long
2) The pipes are placed at hard maintenance position (ex. under equipment)
3) The pipes may not be directly observed, because the pipes may be insulated for heating or cooling.

$$\frac{\text{really corroded points}}{\text{inspection points}} \fallingdotseq 5\sim10\%$$

Decision support system for atmospheric corrosion of carbon steel pipes

Corrosion rate model

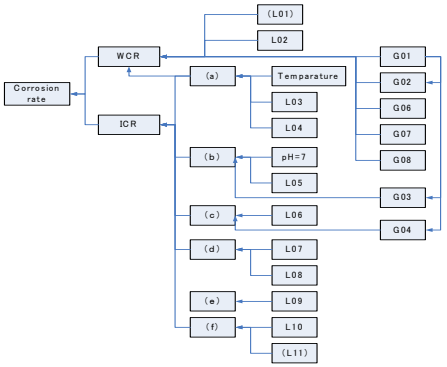
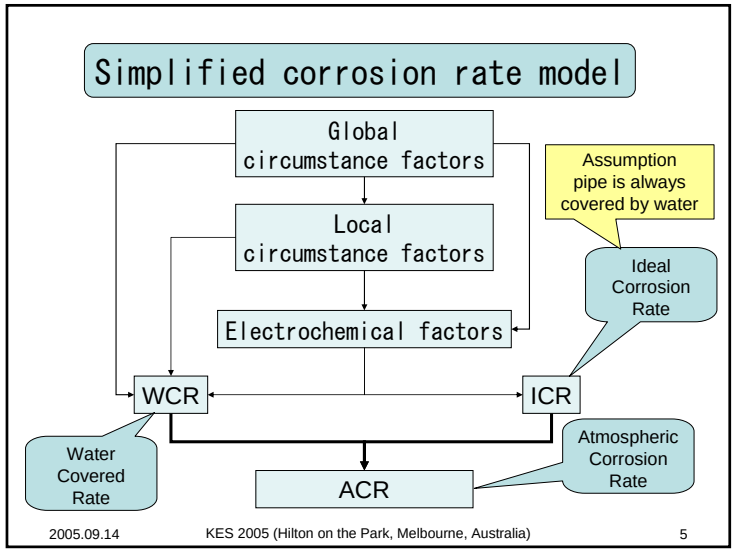
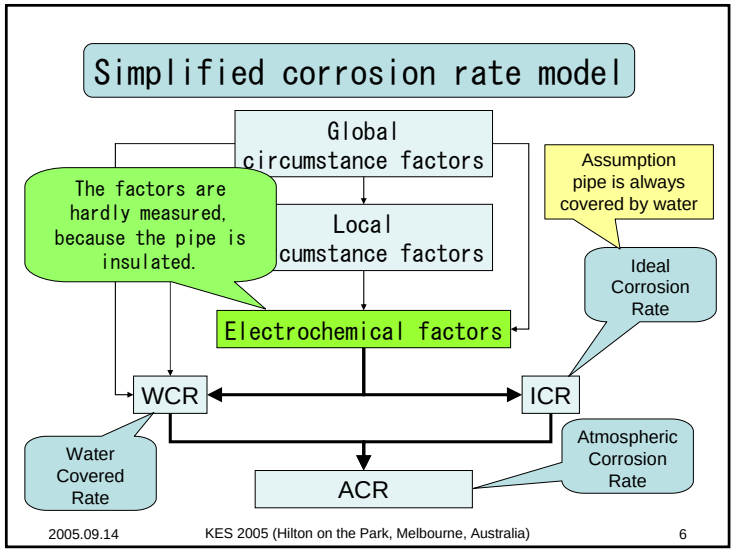


Fig. 1 The corrosion rate model


Simplified corrosion rate model
Global circumstance factors
Local circumstance factors
Electrochemical factors
Assumption pipe is always covered by water
Ideal Corrosion Rate
WCR
ICR
Water Covered Rate
Atmospheric Corrosion Rate
ACR
2005.09.14
KES 2005 (Hilton on the Park, Melbourne, Australia)
5


Simplified corrosion rate model
Global circumstance factors
The factors are hardly measured, because the pipe is insulated.
Local cumstance factors
Assumption pipe is always covered by water
Electrochemical factors
Ideal Corrosion Rate
WCR
ICR
Water Covered Rate
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2005.09.14
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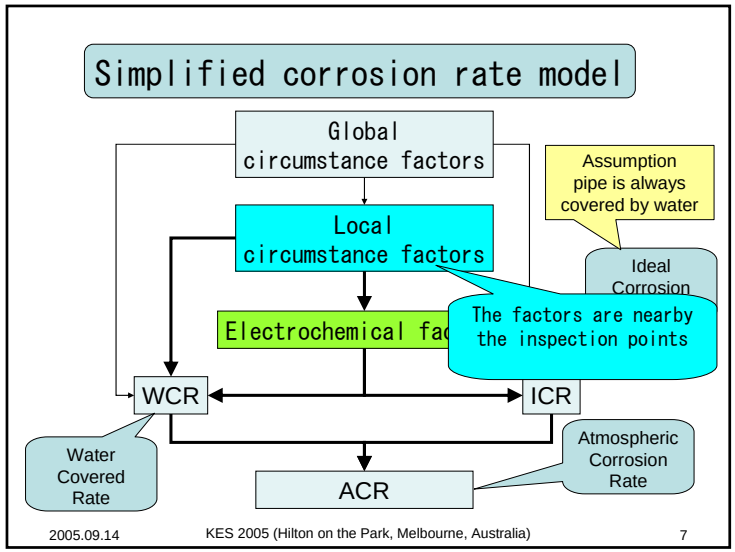
Simplified corrosion rate model
Global circumstance factors
Local circumstance factors
Assumption pipe is always covered by water
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The factors are nearby the inspection points
WCR
ICR
Water Covered Rate
Atmospheric Corrosion Rate
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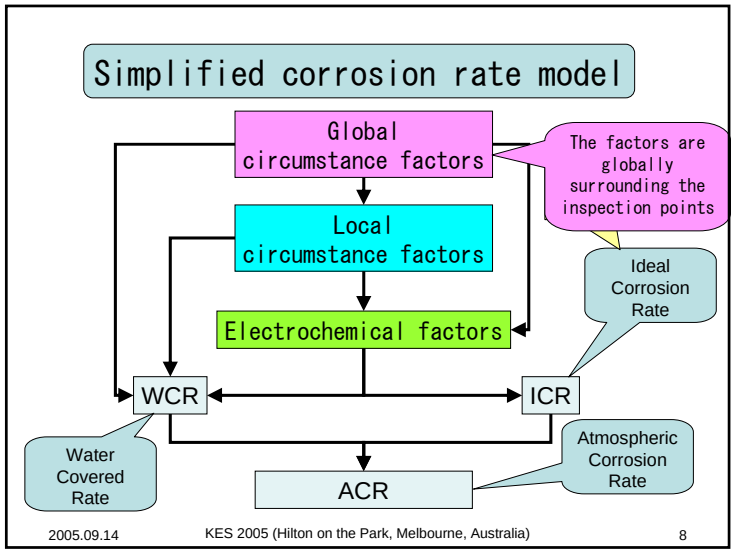
7


Simplified corrosion rate model
Global circumstance factors
The factors are globally surrounding the inspection points
Local circumstance factors
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Outline of decision support system

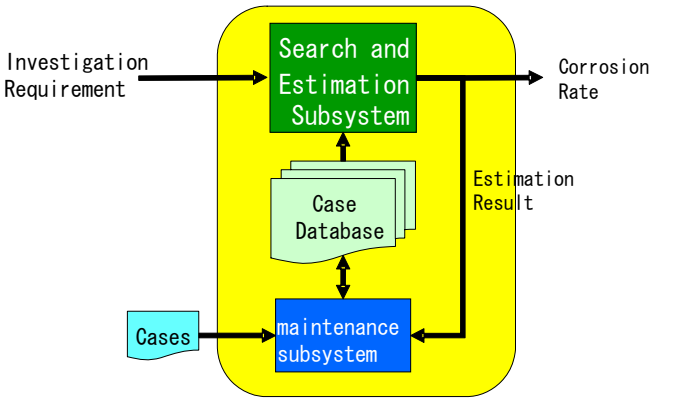
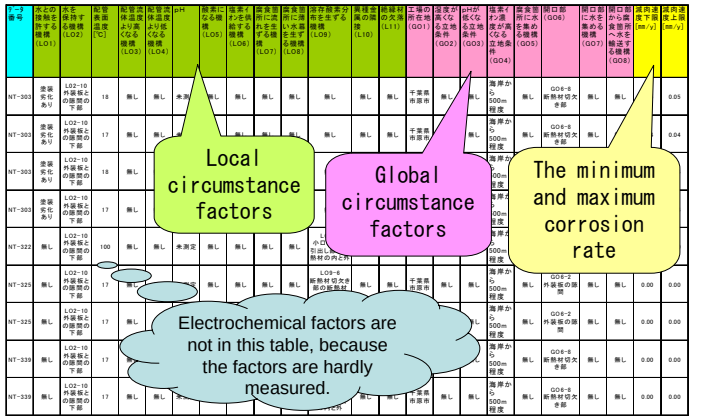


Table of case database



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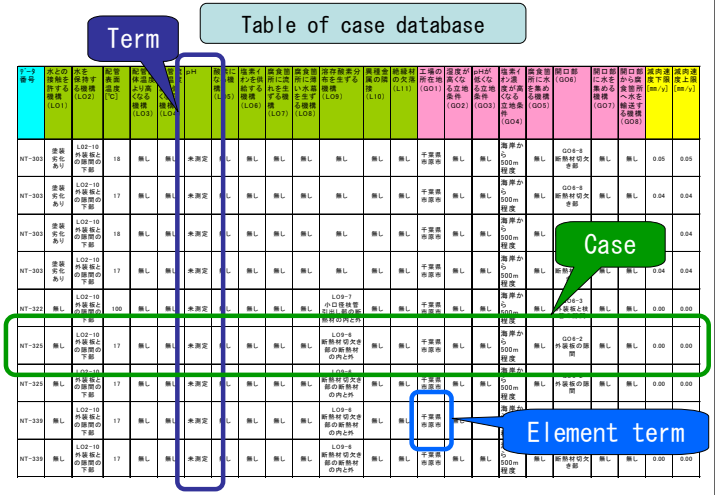

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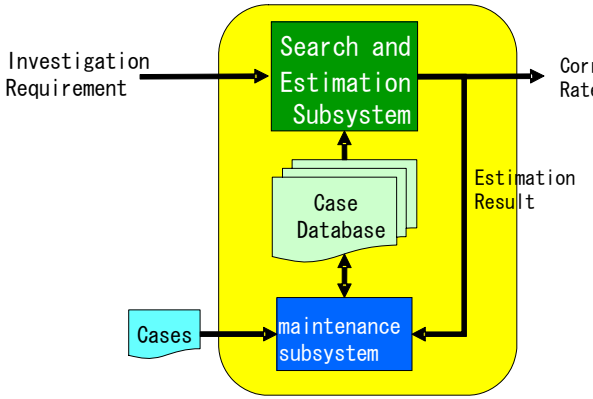

Search and estimation algorithm

- Step 1: Search the cases, whose element terms are the same as investigation requirement.
- Step 2: Collect a set of the closest cases to investigation requirement.
- Step 3: Determine the order among element term intensity of the dissimilar term from investigation requirement.
- Step 4: Estimate the corrosion rate by interpolation or extrapolation using the order.
- Step 5: Output the estimation result and register the result to database if the result is satisfied.

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Step 1

Investigation requirement: A G N · · · T V

given

case #	terms						Corrosion Rate	
	term01	term02	term03	· · ·	term18	term19	Min	Max
1					S	U	0.05	0.1
2					T	V	0.08	0.2
3					S	W	0.1	0.2
4	A	G	N	· · ·	T	U	0.05	0.08
5	A	G	N	· · ·	T	V	0.2	0.2
6	A	G	N	· · ·	T	W	0.3	0.35
7	B	F	N	· · ·	T	V	0.0	0.02

If the cases with the same element terms are found out...

output

Search and estimation algorithm

- Step 1: Search the cases, whose element terms are the same as investigation requirement.

If the cases are not found...

- Step 2: Collect a set of the closest cases to investigation requirement.
- Step 3: Determine the order among element term intensity of the dissimilar term from investigation requirement.
- Step 4: Estimate the corrosion rate by interpolation or extrapolation using the order.
- Step 5: Output the estimation result and register the result to database if the result is satisfied.

Step 2

Investigation requirement: A G N ・・・ T V

case #	terms						Corrosion Rate	
	term01	term02	term03	・・・	term18	term19	Min	Max
1				・・	S			
2				・・	T			
3	A	F	M	・・・	S		0.1	0.2
4	A	G	N	・・・	T	U	0.05	0.08
5	A	G	N	・・・	T	V	0.2	0.2
6	A	G	N	・・・	T	W	0.3	0.35
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Same as investigation requirement

Dissimilar from investigation requirement

Closest cases

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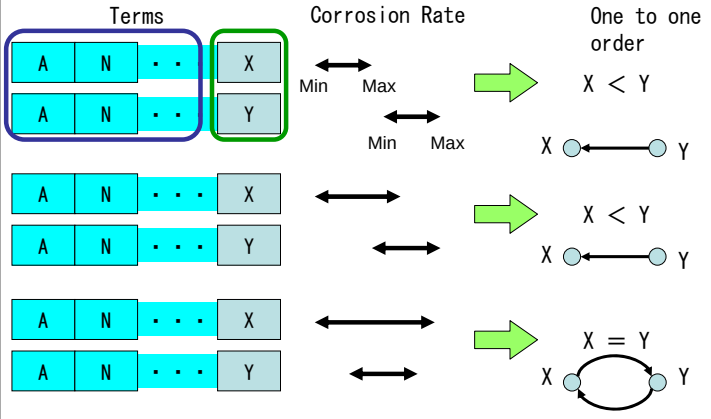
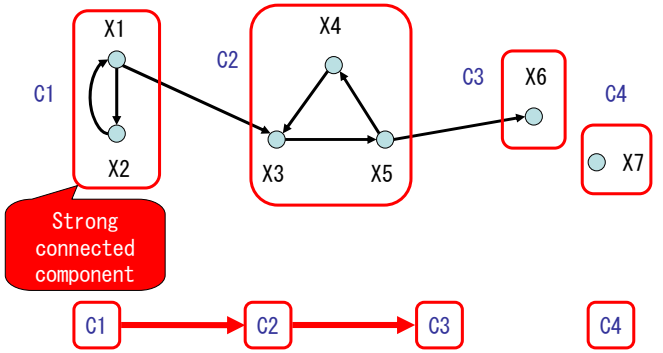
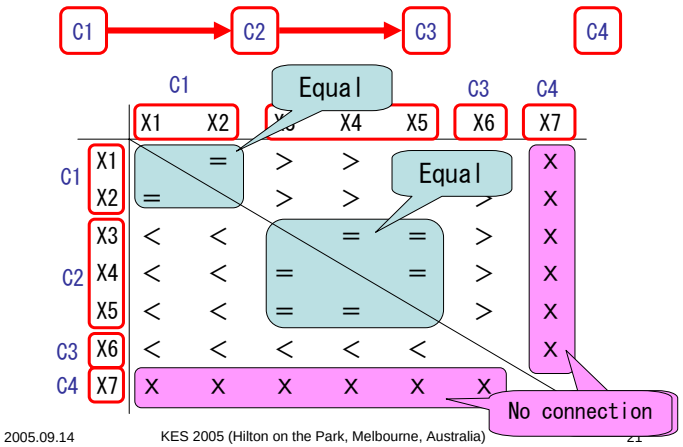
Step 3 Define one to one order



Step 3 Graph representation



Step 3
Define whole order among element terms



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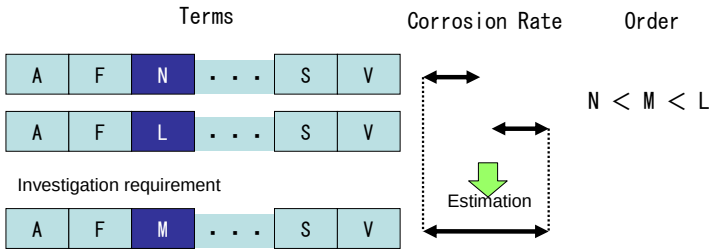
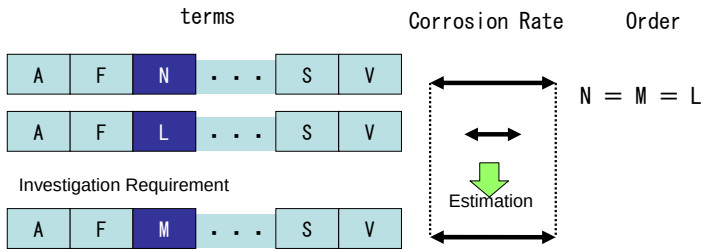
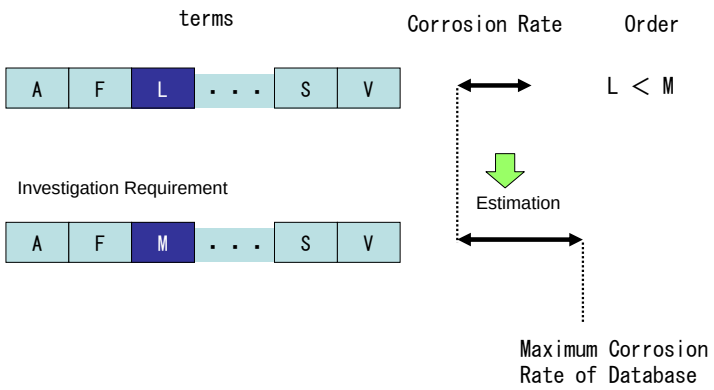
Step 4
Estimation by interpolation



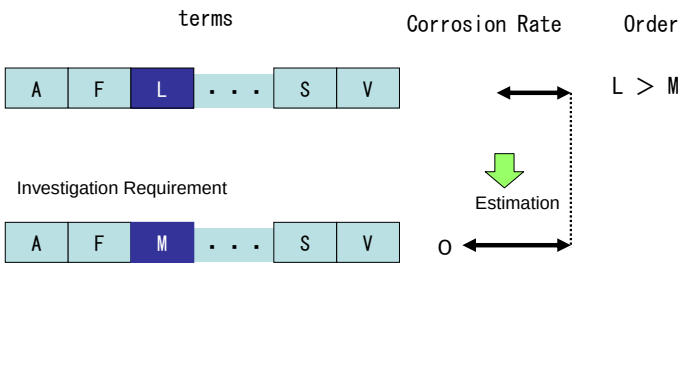
Estimation by interpolation (2)



Estimation by Extrapolation (1)



Estimation by Extrapolation (2)



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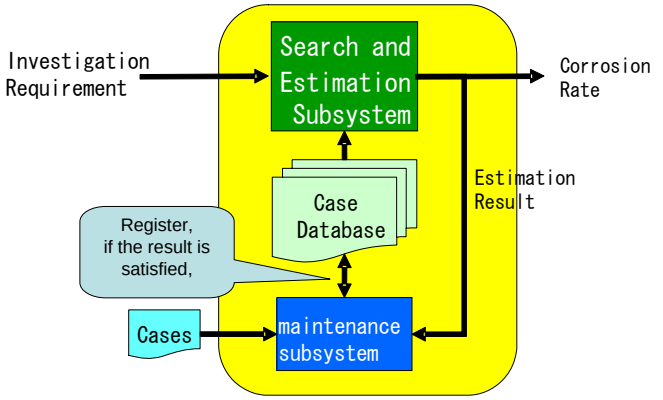
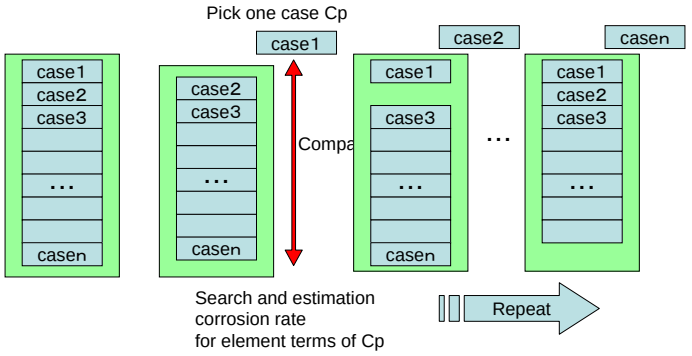
Step 5



Cross validation



Cross validation by search

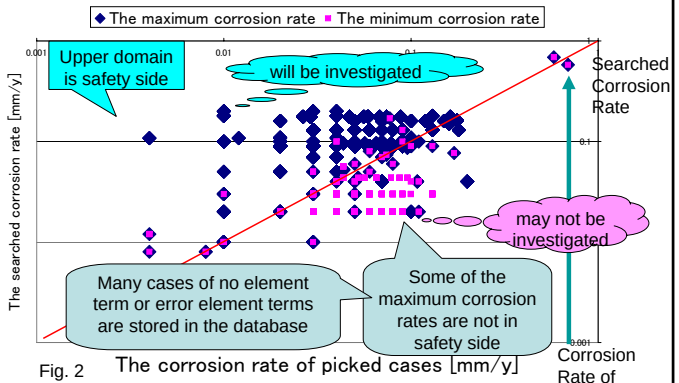


Fig. 2

Cross validation by estimation
(The cases are not found the same case)

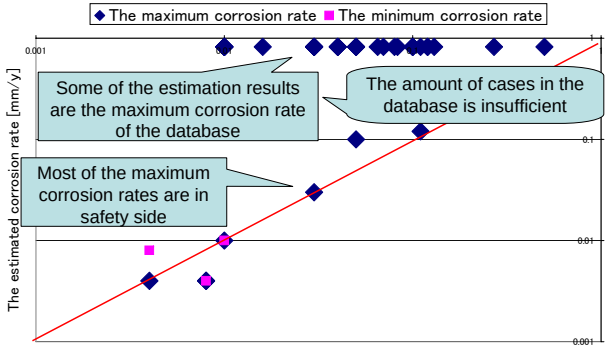


Fig. 3

Conclusion

- The corrosion rate model of atmospheric corrosion of carbon steel pipes was proposed.
- Based on the model, the decision support system was developed.
  - The system searched and estimated the corrosion rate from investigation requirement.
- The proposed system was evaluated using cross validation method.
  - Most of the maximum searched or estimated corrosion rates were in safety side, but some of them were not in safety side.
- In future works...
  - Un healthy cases will be eliminated from the database automatically.
  - how to treat the cases with no element term will be determined to be able to search and estimation in safety side.

Acknowledgement

- It is great appreciation that the support for this work and the permission to present in this conference was done by members of 2nd committee, society of equipment maintenance technology, institute of research and innovation (IRI).

Thank you for your attention !!