Application of Charpy Impact Test to Fracture Control

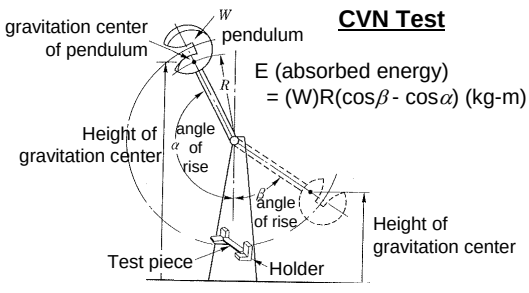
Supplement-1

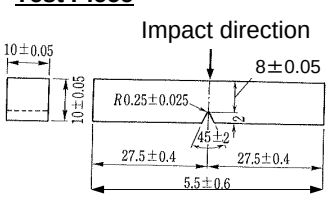
Retrofit Engineering for Urban Infrastructures

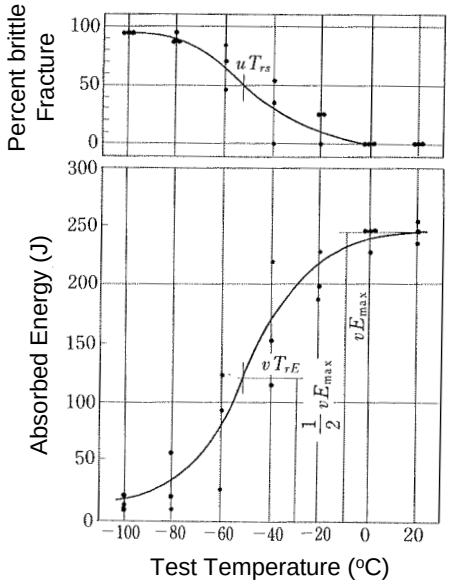
Evaluation of fracture toughness

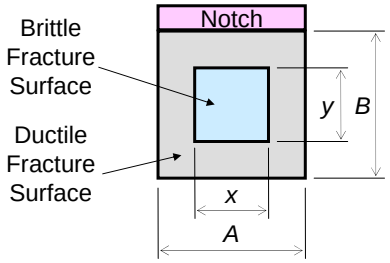
Charpy impact test(CVN)
Dynamic tear test(DT)
Crack-tip opening test(CTOD)

CVN: simple, convenient, cheap, ==>





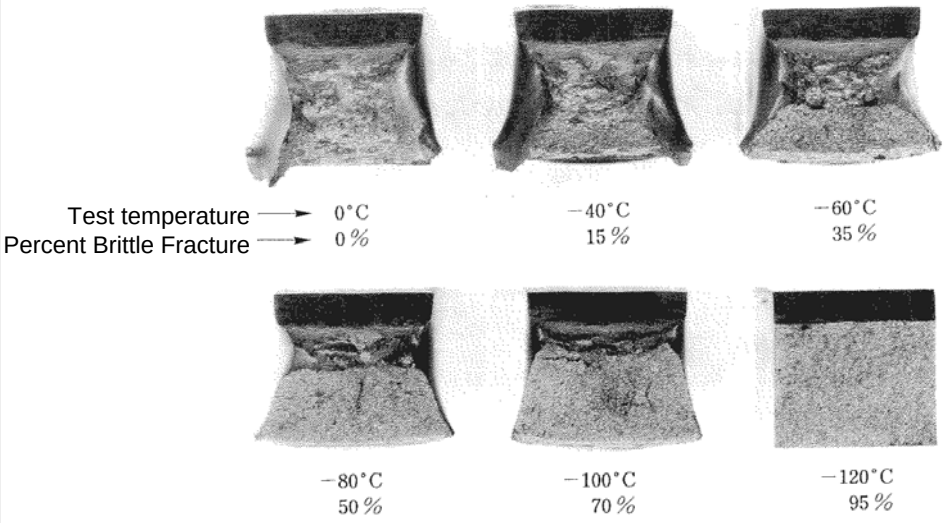




$$\text{Percent Brittle Fracture} = \frac{xy}{AB} \times 100\ (\%)$$

$$\text{Percent Ductile Fracture} = (100 - \text{Percent Brittle Fracture})$$

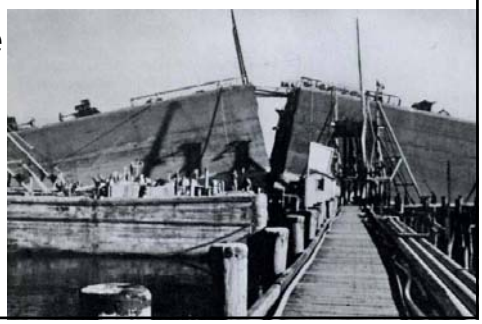
Fracture Surface of CVN



Fracture criteria

Required CVN absorbed energy
at the minimum service temperature:

Based on the world war II ship accident
15 ft-lb(20.3J): USA
35ft-lb(47.5J):UK
20ft-lb(27.1J):France



Fracture toughness requirement (AASHTO)

WELDED OR MECH. FAST.	GRADE (Y.P./Y.S.)	THICKNESS (mm)	FRACTURE-CRITICAL				NONFRACTURE-CRITICAL		
			MIN. TEST VALUE ENERGY (Joules)	ZONE 1 (Joules @ °C)	ZONE 2 (Joules @ °C)	ZONE 3 (Joules@°C)	ZONE 1 (Joules @ °C)	ZONE 2 (Joules @ °C)	ZONE 3 (Joules @ °C)
WELDED	250	$t \le 100$	27	34 @ 21	34 @ 4	34 @ −12	20 @ 21	20 @ 4	20 @ −12
	345/345S/345W	$t \le 50$	27	34 @ 21	34 @ 4	34 @ −12	20 @ 21	20 @ 4	20 @ −12
		$50 < t \le 100$	33	41 @ 21	41 @ 4	41 @ −12	27 @ 21	27 @ 4	27 @ −12
	HPS 345W	$t \le 100$	33	41 @ −12	41 @ −12	41 @ −12	27 @ −12	27 @ −12	27 @ −12
	HPS 485W	$t \le 100$	38	48 @ −23	48 @ −23	48 @ −23	34 @ −23	34 @ −23	34 @ −23
	690/690W	$t \le 65$	38	48 @ −1	48 @ −18	48 @ −34	34 @ −1	34 @ −18	34 @ −34
		$65 < t \le 100$	49	68 @ −1	68 @ −18	not permitted	48 @ −1	48 @ −18	48 @ −34
MECH. FAST.	250	$t \le 100$	27	34 @ 21	34 @ 4	34 @ −12	20 @ 21	20 @ 4	20 @ −12
	345/345S/345W	$t \le 100$	27	34 @ 21	34 @ 4	34 @ −12	20 @ 21	20 @ 4	20 @ −12
	HPS 345W	$t \le 100$	33	41 @ −12	41 @ −12	41 @ −12	27 @ −12	27 @ −12	27 @ −12
	HPS 485W	$t \le 100$	38	48 @ −23	48 @ −23	48 @ −23	34 @ −23	34 @ −23	34 @ −23
	690/690W	$t \le 100$	38	48 @ −1	48 @ −18	48 @ −34	34 @ −1	34 @ −18	34 @ −34

Minimum Service Temperature	Temperature Zone
−18°C and above	1
−19°C to −34°C	2
−35°C to −51°C	3

Transition tempereture approach

Transition temperature (T_{tr}) < service temperature