Society for Underwater Technology

Presented by:
David Szczepanski
Student, Edith Cowan University

Supervisor: Dr Cheslav Balash
Industry advisor: Marius Martens, INTECSEA

A Steel Lazy-Wave Riser for Turret Vs. Spread-Moored FPSO

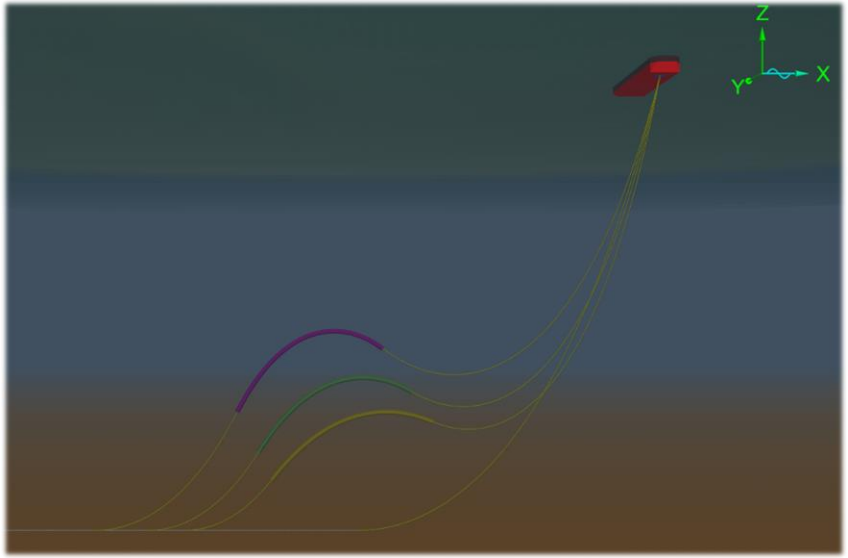
Background

- Steel catenary riser (SCR)
  - cost effective
  - Critical fatigue damage in touch down zone in large wave
- Wave configured flexible riser
  - Buoyancy modules (BMs) reduce vessel payload & decouple dynamic vessel motions from TDZ
  - Water depth limitations

- Free-standing hybrid riser (FSHR)
  - Solution to deepwater developments
  - High costs & complexities

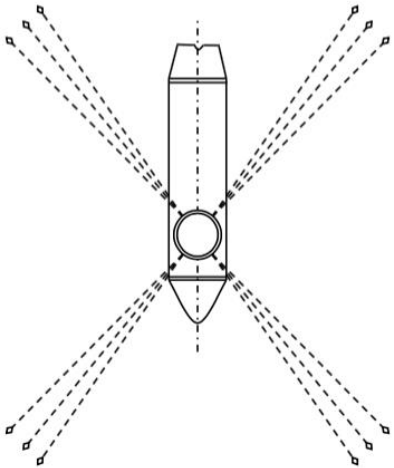
Solution: Steel Lazy Wave Riser

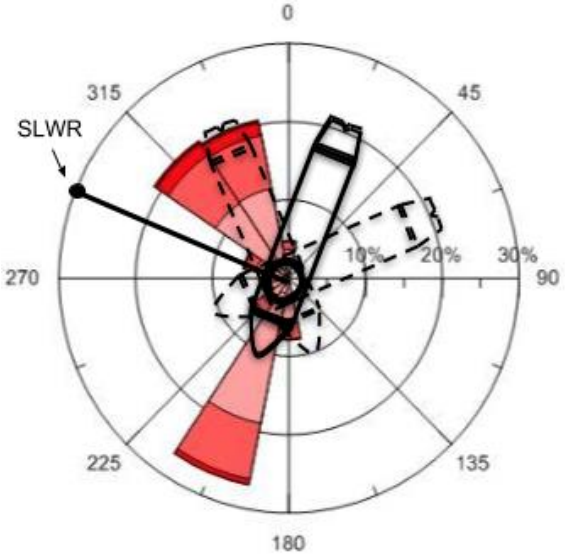
- An alternative solution to FSHR
- Combines advantages of:
  - Steel catenary risers
  - Wave configured flexible risers



Turret Vs. Spread-Moored FPSO

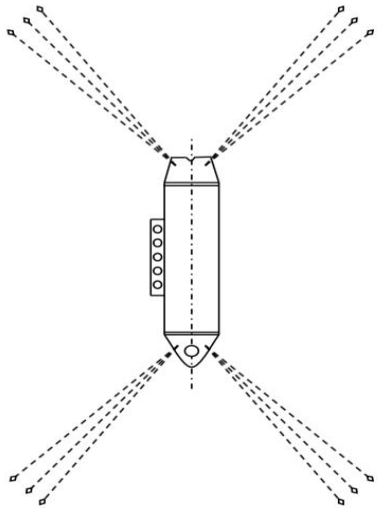
- Turret
  - Passive weathervaning in omni-directional environment
  - Riser hang-off at vessel bow

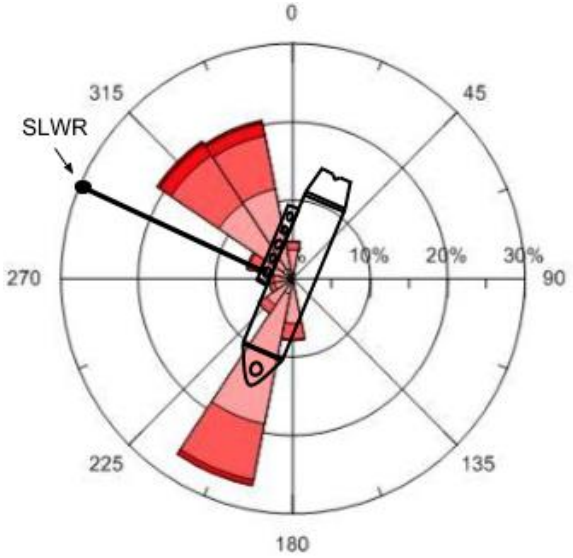




Turret Vs. Spread-Moored FPSO

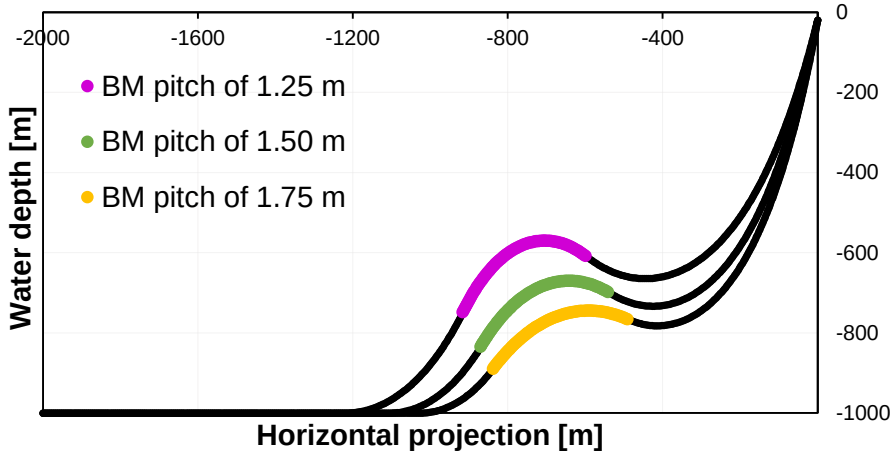
- Spread
  - Fixed heading into prevailing environment
  - Limited to directional environments
  - Riser hang-off at mid-ship





Riser Configuration

- 2600 m long
- 0.324m D_o & 0.283 m D_i
- BMs were 1 m x 1 m
- Riser shaped by varying BM pitch
- Stress & flex joint at vessel interface
- Filled with sea water



Section lengths:

Hang-off	= 1000 m
Buoyancy	= 400 m
Touchdown	= 1200 m

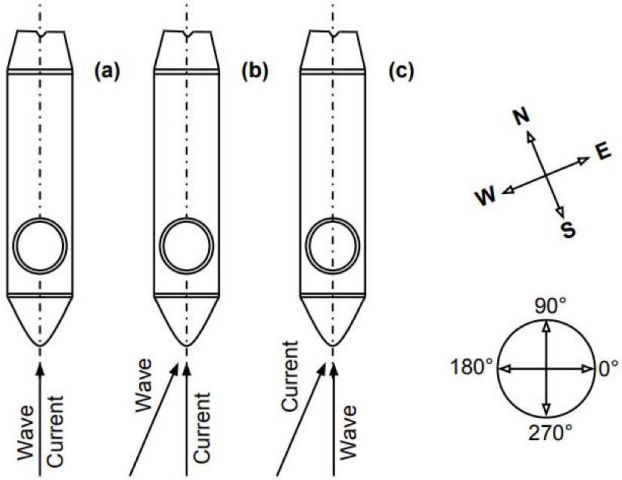
* BM pitch: spacing between BMs

Extreme Conditions

- Yield strength of 450 Mpa
- 100-year return metocean conditions:

Current:		Wave:	
Near surface	= 0.90 ms^{-1}	H_{max}	= 12.2 m
Mid-depth	= 0.35 ms^{-1}	T_{Hmax}	= 17.8 s
Near bottom	= 0.17 ms^{-1}		

- 3 cases:
  a) Collinear wave & current
  b) Current on bow, wave on quarter
  c) Wave on bow, current on quarter



Fatigue Conditions

- Target life of 25 years with SF of 10 (250 years un-factored life)
- No current to ensure conservative approach

Turret

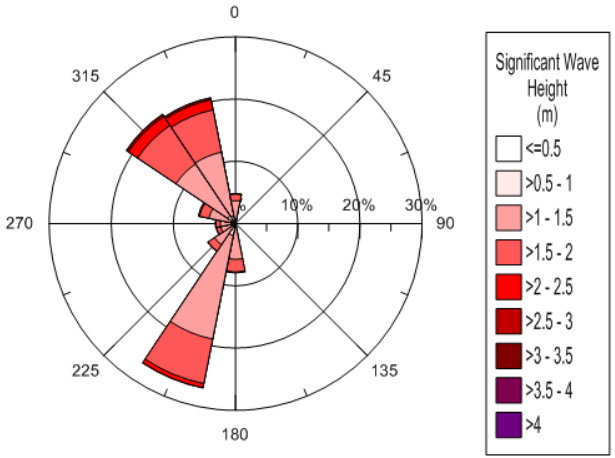
- Face head seas 50% of the time
- ± 45° from wave direction the rest of the time

Spread

- Fixed heading to face the prevailing swell direction

Fatigue Conditions

- Wave scatter tables for West Africa
  - Greater than 1% probability selected
  - Normalised to 100%

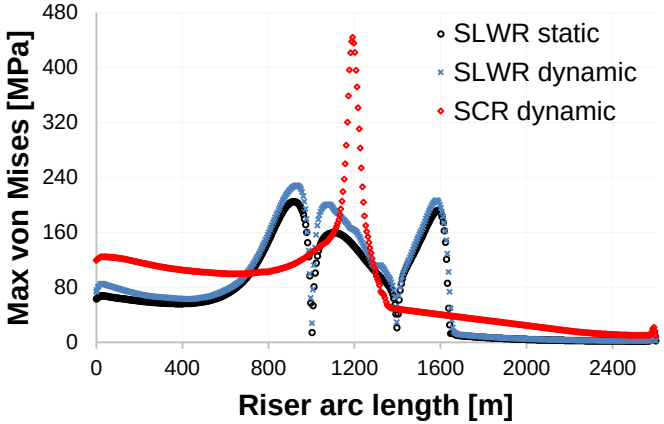


Annual		Wave peak period, T_p [s]				
		5	8	11	14	17
Significant wave height, Hs [m]	1		1.6	4.7	2.0	
	1.5	1.7	9.3	25.0	20.4	2.7
	2		3.3	7.6	16.1	2.3
	2.5				3.2	
						100

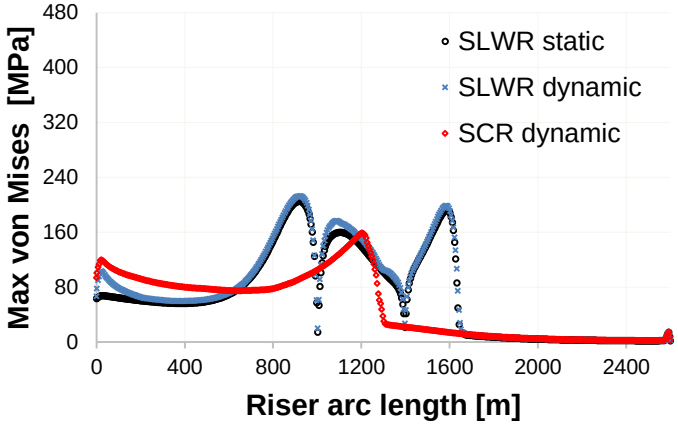
Annual		Significant wave height, H_s [m]			
		1	1.5	2	2.5
Mean wave direction, [oN, from]	N		3.2	1.1	
	S		5.5	2.2	
	SSW	2.1	18.4	7.9	
	SW		3.9	1.4	
	WSW		2.2		
	W		2.1		
	WNW		3.9	1.7	
	NW	1.7	10.8	8.1	1.9
	NNW	1.5	11.2	7.5	1.8
					100

Ultimate Limit State

- Turret hang-off experienced greater vertical vessel motions
  - Dynamic buckling in SCR
  - Buoyant section in SLWR effectively absorbs vertical motions



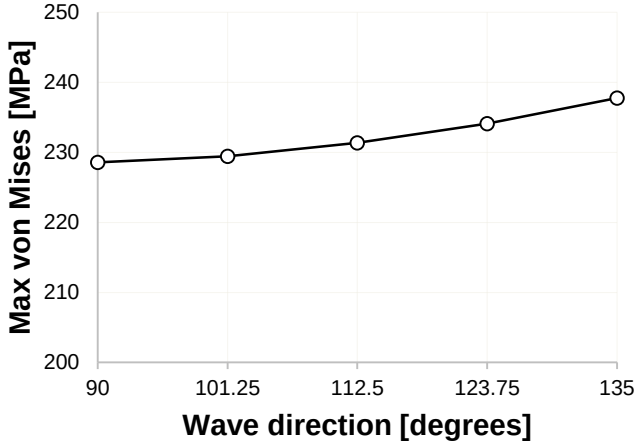
Turret-moored



Spread-moored

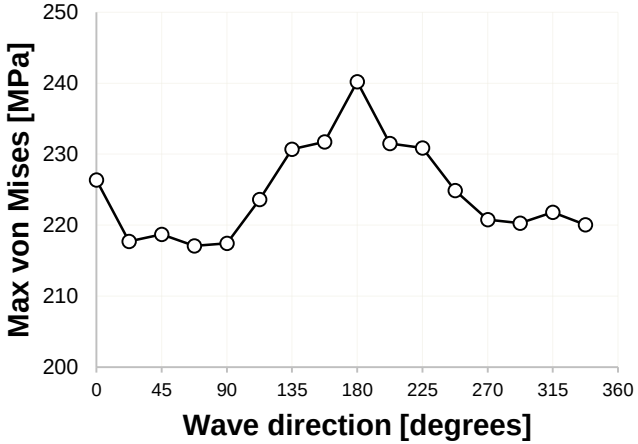
Ultimate Limit State

- Wave & current collinear



Turret-moored: +45° wave direction from head seas for turret

- Max stress on-par
  - motion-isolation phenomenon

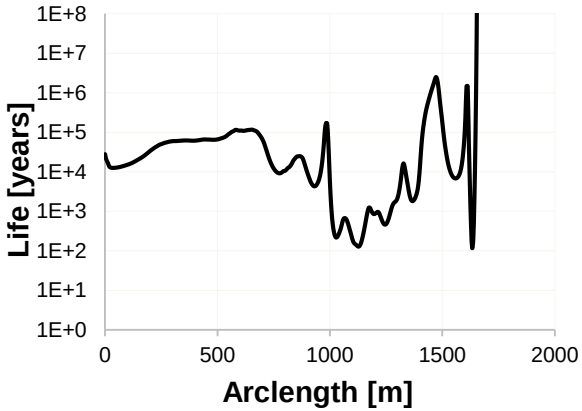


Spread-moored: 0° - 360° for spread

Fatigue Limit State

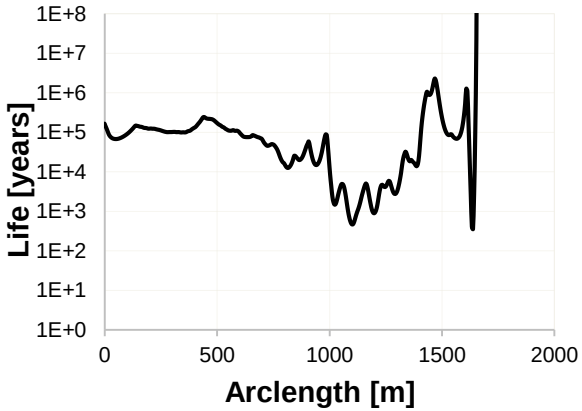
Turret moored:

- 117 years fatigue life
- Amplified pitch motions
- Head seas 50% of the time significantly increased vertical motions



Spread moored:

- 358 years fatigue life
- Predominantly roll-induced heave
- Vessel design effectively reduced pitch & roll-induced heave



Fatigue Limit State

- Increasing buoyancy amount (BM pitch of 1.5 m) increased the fatigue life

Riser	Turret: bow-mounted riser	Spread: mid-ship-mounted riser
SCR	< 1	3
SLWR Pitch - 1.75	117	358
SLWR Pitch - 1.50	236	1114
Target life – 250 years		

Conclusions

- Extreme conditions show on-par results for both mooring configurations
- Spread-moored FPSO showed more favourable fatigue life due to riser hang-off at vessel mid-ship
- Future studies will consider SLWR performance sensitivity to:
  - Water depth
  - Motions of different vessel types
  - Weathervaning

Questions?

For further enquiries, please don't hesitate to contact me on:

Email: david.szczepanski92@gmail.com
Phone #: 0434407533