

# Analysis of riser-induced loading on wellhead

André Lylund | Prof. Bernt Johan Leira| NTNU

## Problem / Question

- Analysis of riser-induced loading on wellhead
- Investigate how the loads affect the fatigue life of the wellhead

## Background

Wellhead fatigue is an old problem that has received growing attention in recent years. Continuous development of methods and technologies within the petroleum industry, has made it possible to expand existing wells lifetime. Higher requirements for safety and efficiency results in more and often heavier equipment that is connected on top of the wellhead. During drilling, workover or plug and abandonment operations, environmental forces is absorbed and transmitted to the subsea wellhead by the MODU, BOP and riser (Statoil, 2014). This results in a high number of cyclic loadings, and this may not have been taken into consideration when the wellhead was initially designed.

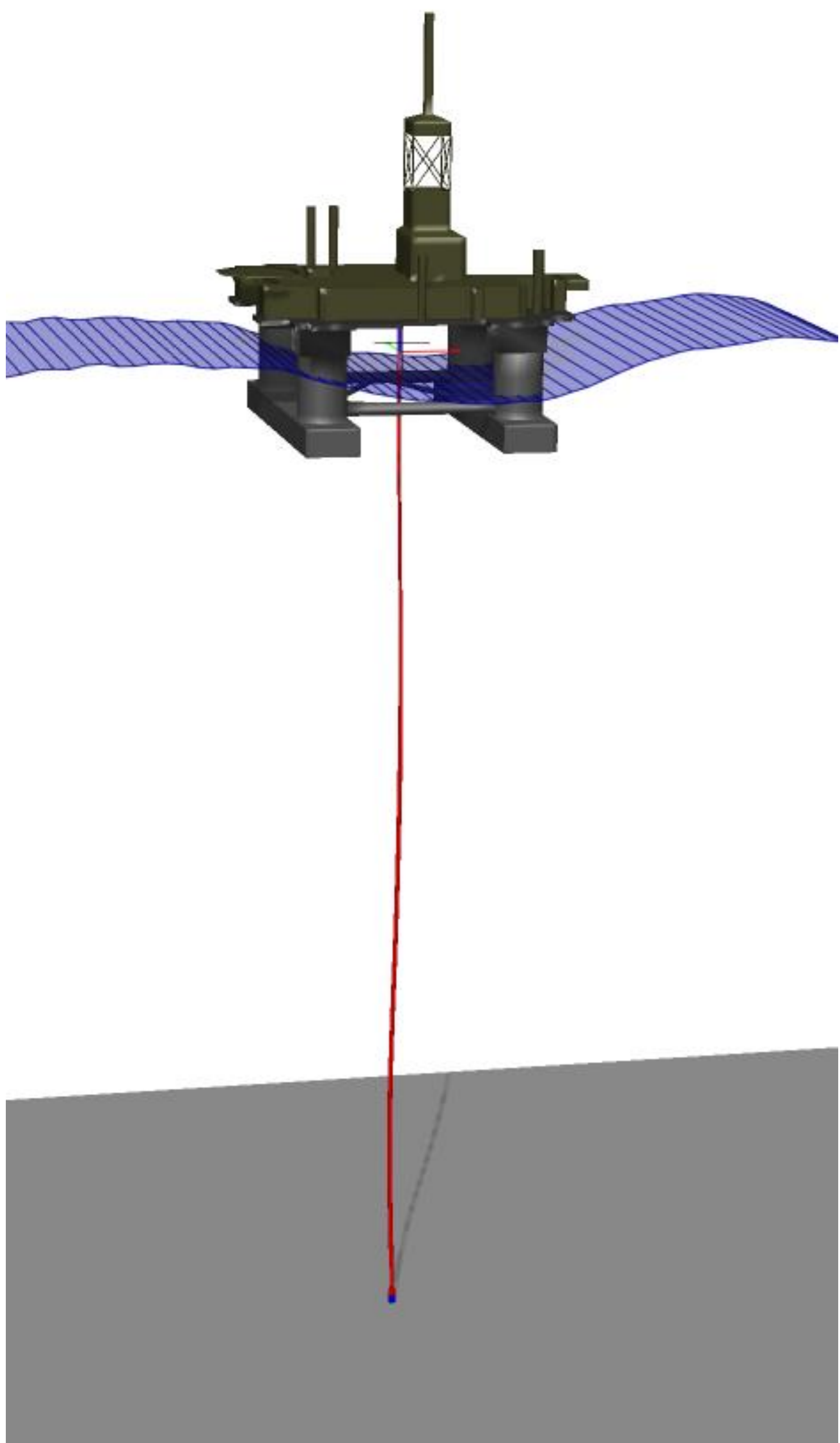
## Scatter diagram

The scatter diagram gives information of the sea states in the operation area and their probability of occurrence. The environment for the irregular sea are based on the sea states in the scatter diagram.

Hs / Tp	<4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
0.5	219	247	98	56	108	139	85	53	38	28	16	9	3	1	1	1		1102
1.0	462	1444	1332	551	394	409	362	255	153	126	66	73	28	20	9	4		1 5689
1.5	54	763	1991	1654	703	436	327	258	176	86	49	49	23	21	22	3	3	3 6621
2.0	1	114	994	2015	1329	583	260	246	193	91	37	20	10	16	14	3	1	5927
2.5		7	189	1122	1532	734	261	182	165	124	48	20	8	1	1	2	1	4397
3.0			14	329	1082	958	309	137	139	96	39	13	6			1	1	1 3125
3.5				59	533	983	382	140	87	72	33	15	4	2		1		2311
4.0				10	133	660	418	144	65	36	23	14	3	4				1510
4.5					28	313	417	149	41	25	7	10	4	1				995
5.0					2	113	271	190	40	19	8	6	2	1				652
5.5						23	154	136	49	23	7	12	4					408
6.0						4	61	109	52	26	4	6	4					266
6.5							20	58	35	14	6	4	5					142
7.0							6	23	35	14	5	2	1					86
7.5								2	21	16	13	4	3	2	1	1		63
8.0									4	8	9	3	1					25
8.5									2	8	3	2	3	2				20
9.0										2	5	2						9
9.5										1	5	1	3	2				12
10.0												1						1
10.5											2	1	1		1			5
11.0												1						1
11.5											1			1				3
12.0													1					1
	736	2575	4618	5796	5844	5355	3335	2107	1303	818	362	267	111	70	48	15	6	5 33371

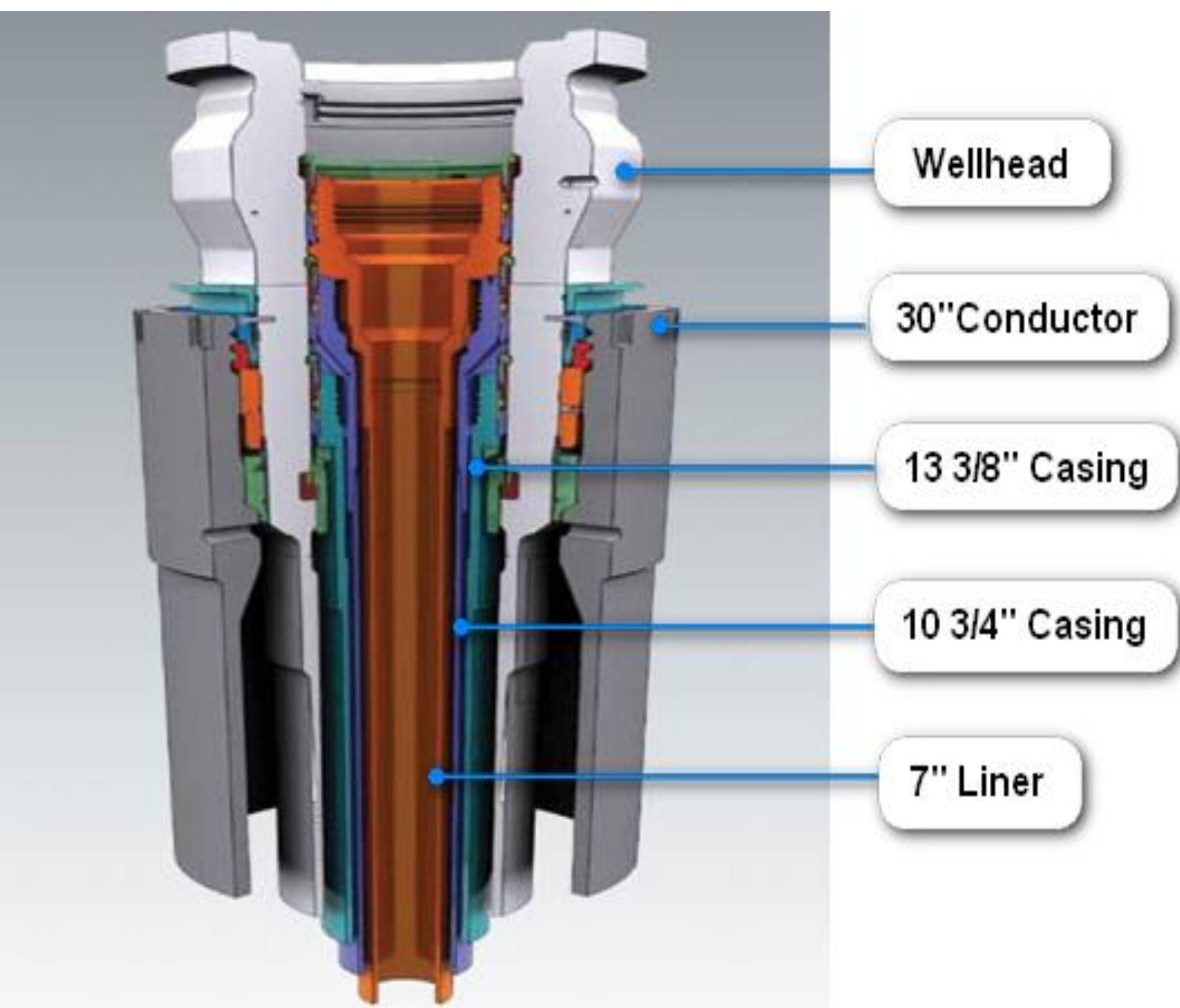
## Drilling rig and riser column

The drilling rig and riser column are experiencing environmental loads such as waves and current. A realistic computer model of the system and environment are established in the analysis program RIFLEX. The computer model is simulated for all the sea states in the scatter diagram. Time series of the forces and moments are stored in order to calculate fatigue damage on the wellhead.



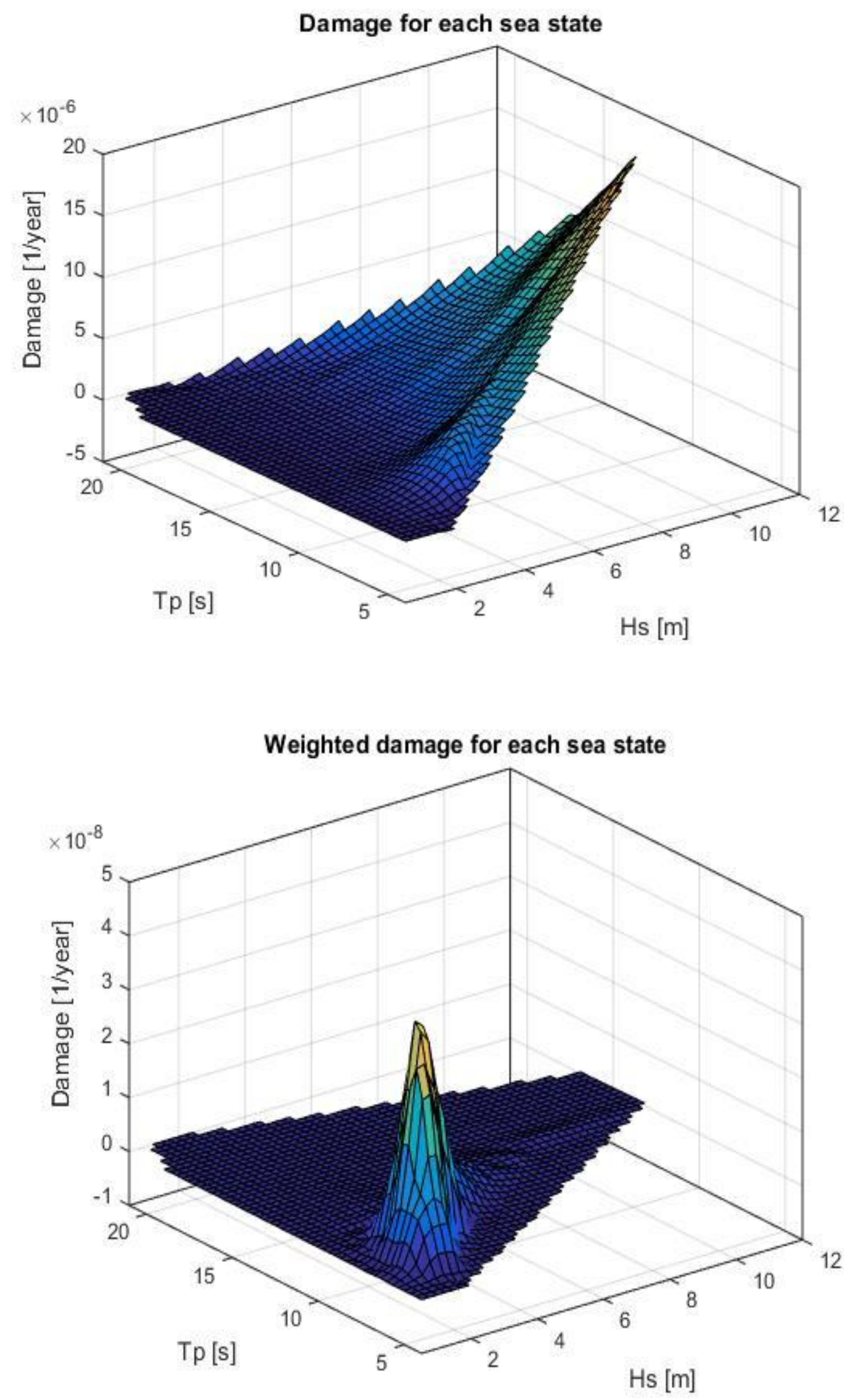
## Well

The Drilling rig with the heavy drilling subsea equipment are connected to the wellhead. This causes large forces and moments on the upper part of the well.



## Results

The upper diagram illustrates that the damage increases with increasing Hs. However, the sea states witch individually causes large damage are very seldom. Sea states in the area of Hs 2-4 and Tp 7-11 do not individually causes much damage, but they are very common. For that reason the sea states in this area, as a sum causes much damage. This is illustrated in the lowest diagram.



## Conclusion

The study shows that the estimated fatigue life are hugely depending on the parameters used. Small variation in load-stress curves, soil model and the choice of design SN curves may have large influence on the fatigue life. There are many uncertainties in fatigue calculations and in order to take decisions some mean of common sense must be used. It is important to be on the conservative side but at the same time be as realistic as possible.



**NTNU – Trondheim**  
Norwegian University of  
Science and Technology