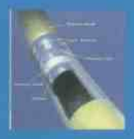
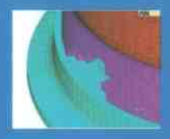
自升式工作船结构计算

PCE应用软件



软管设计

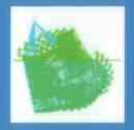


有限元及疲劳分析

膨胀弯设计及安装程序

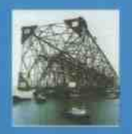
板架式海上生活楼

立柱式平台(SPAR)



导管架扶正

导管架下水



深水导管架

导管架运输

张力式平台(TLP)

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板架结构生活楼

Stressed Skin Living Quarters (LQ)

板架结构生活楼 Stressed Skin Living Quarters (LQ)

板架结构可以减轻自身结构重量的15%到25%

板架结构类似与船体结构冗余度高，抗疲劳性能优越

大型的海上油田都需要有海上平台的生活模块或生活楼。生活模块可以用不同的结构形式建造。主要有桁架型，复合墙式和板梁式。复合墙式重量最轻，但复合材料的长期安全性还有待进一步认证。由于板梁是由外力通过大变形冲压成型，构件内形成很大的塑性变形甚至微型裂纹及残余应力，其横向强度，特别是疲劳强度无法满足深水平台的总体强度要求，通常只能用于附属结构，如防爆墙等。随着海上开发逐步走向深水，平台对上部结构的重量及强度特别是疲劳强度要求不断提高，我们提出利用板架结构作为LQ的结构形式，不但可以增加平台的整体安全度，还可以减少成本，提高项目的技术水平。

板架结构可以减轻自身结构重量的15% 到25% 。 同时使整体浮式系统的重量减少更多倍。重量的减轻是通过充分利用墙板及甲板参与结构的总体强度计算来完成的。板架结构类似与船体结构，冗余度高，抗疲劳性能优越。模块自重的减轻可以进一步优化平台整体的结构。

板架结构的建造方法简单，有分块容易、对起重机械能力要求不高、主要焊接工作量是间断角焊缝、焊缝检测等级低等优点。可以充分利用低廉劳动力的优势。

板架结构还可以提高结构开孔的灵活性。生活模块有大量的开孔，如：建筑开孔（门、窗等）、暖通开孔、配管开孔及电气开孔等。开孔的灵活性对设计非常重要，也可以提高房间的可用率。

Most of the offshore oil and gas fields require living quarters (LQ). There are several types used in the industries: Conventional Trussed Structures, Light Weight Panel, Crimped Plate Structure and Stressed Skin Structure. The conventional truss structure is widely used due to easy to design. Light weight structure has the least weight, but the long-term performance and the safety of the composite materials are still a concern for large applications.

The crimped plate structure is formed by mechanical force and has large residues tresses and small cracks. Its lateral strength is also small due to the deformation. Its fatigue life is very difficult to assess, therefore, they are mainly used as appurtenances, rather than primary structures, such as ballast walls. As moreand more deepwater fields are developed, the requirements forlighter weight structures and higher fatigue performance are increasing.

The stressed skin structure is best suited for the deepwater applications. It will not only increase the global strength and fatigue life of the structure, but also reduce weight significantly. The weight reduction for the stressed skin LQ is achieved by using the plates (deck plates and wall plates) as primary structural members to participate the global strength analysis. The weight reduction can be as much as 15 to 25% of the structural weight itself and several times more forentire floating system. If it is built by shipyards, the stressed skin structure is easy to build compared to the trussed structures. It can be built by limit crane capacity. The majority of its welding can be skip type fillet weld which has less requirements for skilled welders and NDT.This type structures also has advantage of making penetrations. LQ has significant amount of penetrations such as architectural penetrations (doors and windows),HVAC penetrations, piping penetrations and electrical penetrations. It increases the utilization ratio of the area.

The stressed skin LQ is the best solution for deepwater development. Weight reduction on the topside will further reduces the weight of supporting structures and mooring systems. Specially for FPSO, the stressed skin structure is similar to the hull structure, therefore minimal supporting structure is needed for the LQ module.





板架设计 LQ Design

构件组成 Structural Components

甲板 Decks　　纵隔舱 Longitudinal Bulkhead　　横隔舱 Tranverse Bulkhead　　结构 Frames

设计要点

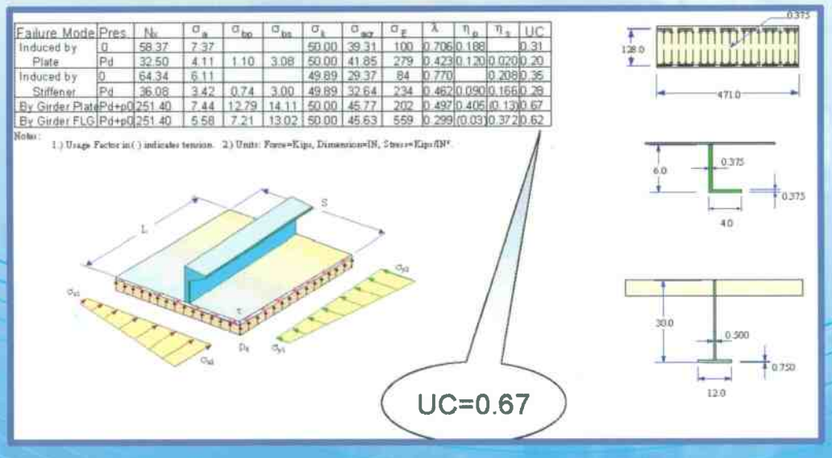
设计将按照规范及技术规格书的要求进行。除主结构外，其他参照桁架结构LQ。主结构的设计将采用ANSYS有限元计算软件分析。屈服强度（Yield Criteria）根据API RP2A 及AISC规范设计，屈曲强度(Buckling Criteria)将根据DnV 30.1。板块的屈曲计算可以通过如下板壳分析完成：

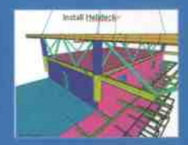
Design Highlights

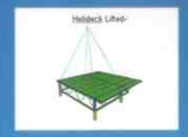
The design is in accordance to major industry specifications. The entire structure is modeled using ANSYS finite element (FE) program. The yield strength is to meet API RP 2A and AISC specifications. The buckling strength is to meet DnV 30.1. The buckling design is completed by stiffened panel design.

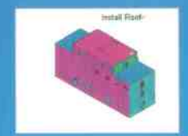
Failure Mode	Pres.	N_x	σ_a	σ_{bp}	σ_{bs}	σ_h	σ_{acr}	σ_E	λ	η_p	η_s	UC
Induced by Plate	0	58.37	7.37			50.00	39.31	100	0.706	0.188		0.31
	Pd	32.50	4.11	1.10	3.08	50.00	41.85	279	0.423	0.120	0.020	0.20
Induced by Stiffener	0	64.34	6.11			49.89	29.37	84	0.770		0.208	0.35
	Pd	36.08	3.42	0.74	3.00	49.89	32.64	234	0.462	0.090	0.166	0.28
By Girder Plate	Pd+p0	251.40	7.44	12.79	14.11	50.00	45.77	202	0.497	0.405	(0.13)	0.67
By Girder FLG	Pd+p0	251.40	5.58	7.21	13.02	50.00	45.63	559	0.299	(0.03)	0.372	0.62

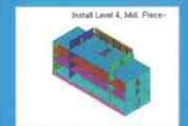
Notes:
1.) Usage Factor in ( ) indicates tension. 2.) Units: Force=Kips, Dimension=IN, Stress=Kips/IN²

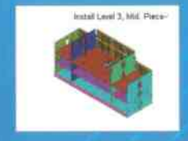












建造程序 Fabrication Sequence