SPACE STATION STRUCTURES

W. Schneider
NASA Johnson Space Center
Houston, Texas

Large Space Antenna Systems Technology - 1984
December 4-6, 1984
WILL PRESENT BRIEF OVERVIEW OF SOME STRUCTURAL RESULTS THAT CAME FROM SPACE STATION "SKUNK WORKS"

PRESSURIZED MODULES

PRIMARY TRUSS STRUCTURE

DEPLOYABLE SINGLE FOLD BEAM

ERECTABLE BEAM

DEPLOYABLE DOUBLE FOLD

TYPICAL TRUSS ATTACHMENT DEVICES

DEPLOYMENT BACKUP PROCEDURES

CONCLUDING REMARKS
I. PRESSURIZED MODULES

LAB1

HAB MODULE
THE PRIMARY STRUCTURE OF THE MODULES USES TYPICAL AIRCRAFT CONSTRUCTION

- I.E. SKIN-STRINGER
- HONEYCOMB

IT IS DESIGNED PREDOMINANTLY BY ORBITER LAUNCH LOADS.

SOME UNIQUE ITEMS THAT ARE BEING STUDIED FOR POSSIBLE USE ON THE MODULES ARE:

- MECHANICALLY PRESTRESSED CIRCULAR WINDOWS
- PENETRATION TOLERENT STRUCTURE

MECHANICALLY PRESTRESSED CIRCULAR WINDOWS

- GLASS FLAW GROWTH RELATED TO TENSILE STRESS
- WINDOWS SENSITIVE TO SURFACE DAMAGE
- TEMPERED WINDOWS FAIL WHEN SURFACE COMPRESSION PENETRATED
- MECHANICAL PRESTRESS MINIMIZES TENSION IN GLASS
- MECHANICAL PRESTRESSED WINDOW DEVELOPMENT SUPPORTS LONG TERM SPACE PROGRAMS
II. SPACE STATION PRIMARY TRUSS STRUCTURE

0 NUMEROUS SPACE STATION CONFIGURATIONS WERE CONSIDERED BUT A GRAVITY GRADIENT STABILIZED STATION WAS SELECTED AS A REFERENCE

0 SUCH A CONFIGURATION USES A LONG TRUSS (~400 ft) BEAM AS ITS BACKBONE TO WHICH ARE ATTACHED SUCH COMPONENTS AS THE PRESSURIZED MODULES, SOLAR COLLECTOR STRUCTURE, VARIOUS PAYLOADS, ETC.

0 ALL COMPONENTS MUST BE BROUGHT TO ORBIT BY THE SPACE SHUTTLE AND ASSEMBLED IN SPACE

0 VARIOUS DEPLOYABLE AND ERECTABLE STRUCTURES ARE BEING CONSIDERED FOR THE PRIMARY TRUSS
DEPLOYABLE SINGLE FOLD

DEPLOYABLE DOUBLE FOLD

ERECTABLE

delta shaped keel

0 UTILITIES CAN BE PREINTEGRATED

Schematic of deployable beam showing one bay being deployed and detail of joint.
3 stowed bays
Bay-size payload element
3 stowed bays
Packaged structure

First bay erected for deployment stability

First bay deployed

Fully deployed structure

Truss deployment sequence and rail detail.

1) STOWED PACKAGE

2) DEPLOYMENT OF
   • ADAPTER
   • JACKSCREW SUPPORT FRAME ASSEMBLY
   • FIRST BAY (BAY 1)

3) PARTIAL DEPLOYMENT BAY 2

4) DEPLOYMENT OF BAY 2 COMPLETE

DIAGONAL/LONGERON UNLOCKING SYSTEM INSIDE HOUSING

5) COMPLETION OF DEPLOYMENT - LAST BAY (BAY 10) LOCKED
Erectable strut quick attachment joint.

Nodal cluster fitting and MRMS guide pin.
典型细胞的四面体桁架。
DEPLOYABLE TETRAHEDRAL TRUSS

The torsional and bending stiffnesses of the diagonal and the foldable struts (ignoring joint tolerances) force nodes to remain parallel and restrict joints to deploy together.
Gravity gradient Space Station with delta shaped keel

DEPLOYABLE DOUBLE FOLD
(DELTA KEEL)

MOBILE REMOTE MANIPULATOR SYSTEM

LOG MOD
HAB MOD
COMMAND MODULE
LAB MOD
TUNNEL

III. TYPICAL TRUSS ATTACHMENT DEVICES

MODULE ATTACHMENT TO 9 FT SQUARE TRUSS.
MODULE ATTACHED TO FLAT SIDE OF TRUSS.

ADJUSTABLE STRUTS

ADJUSTABLE STRUT ASSEMBLY
TRUNNION ATTACH FITTING
TURNBUCKLE
TELESкопING LOCK
NODE ATTACH FITTING
ATTACHMENT OF LARGE PACKAGES TO TRUSS.

VIEW C
ATTACHMENT OF SMALL PACKAGES TO TRUSS

DETAIL D
DEPLOYMENT

IV. BACKUP PROCEDURES

MMU FLY-AROUND INSPECTION
ON ORBIT USE OF JACK

CREW MEMBER REMOVING OBSTRUCTION
ON ORBIT USE OF JACK

CREW MEMBER JACKING UP TO

FULL ON CENTER
CONCLUDING REMARKS

0 Next years will be heavily occupied with challenging structures work.

0 The space station is more space facility than the space vehicle.

0 Launch volume is more critical than launch weight.

0 One of the greatest challenges presented will be that of space station assembly
   0 Constraints imposed by shuttle size and center of gravity
   0 Behavior at each step of construction

0 We are on a threshold of space where the crew member will share with the hardware in
  providing full system reliability and maintenance.