장치 매달기

2015 무대예술 전문교육

장치 매달기

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2015 무대예술전문교육

장치 매달기

1 교육 개요

○ **교육 기간 :** 2015. 6. 10.(수) ~ 6. 12.(금) / 3일(24h)

○ **교육 대상 :** 무대 관련업무 종사자

○ **교육 장소 :** 한국문화예술위원회 아르코예술인력개발원(경기도 고양시)

2 교육 목표

○ 무대 장치의 기초 이론을 소개 후, 장치 매달기 과정을 이론, 및 실습한다.

○ 심화 과정을 학습하기 이전에 사전 지식으로 필요적인 요소들을 습득한다.

3 세부 내용

일정	시간	교과목	주요 내용	학습 방법
1일차 (6. 10/수)	11:00~13:00(2h)	장치 매달기 이론	• 장치 매달기 기초이론	이론
	14:00~18:00(4h)	장치 매달기 1	• 매듭 묶기 • 평판, 복합평판 매달기	이론 및 실습
2일차 (6. 11/목)	09:30~12:30(3h)	무대 구조 계산	• 구조 역학	이론
	13:30~17:30(4h)	장치 매달기 2	• 복합 장치 매달기 실습	실습
3일차 (6. 12/금)	09:30~12:30(3h)	장치 매달기 3	• 장치 매달기 응용 실습	실습
	13:30~16:30(3h)	장치 매달기 4	• 장치 매달기 응용 실습	실습

※ 교육 목표를 벗어나지 않는 범위에서 교과목 및 세부내용은 일부 변경될 수 있습니다.

4 교육 평가 및 시상

○ 교육 평가 : 100점 만점 절대 평가 실시

평가 내용	평가척도	점수
현 장 평 가	• 강사 평가(활동평가, 실습평가)	70점
근 태 평 가	• 승인받지 않은 결석 (시간당 –2) 감점 • 승인받지 않은 수업 불참 (시간당 –1) 감점 ※ 결강 · 이석 · 조퇴 · 지참 · 외출 등 • 승인받은 결석 (1일당 –1) 감점 ※ 2일 이상 결석 시 미수료 • 승인받은 수업 불참 (시간당 –0.5) 감점 ※ 결강 · 이석 · 조퇴 · 지참 · 외출 등 • 강사에 대한 불손한 언동이나 태도 (회당 –2) 감점 • 학습태도 불량 (회당 –0.5) 감점 • 실내음주, 교육질서문란 등 (회당 –3) 감점 • 기타 준수사항 불이행 (회당 –1) 감점	30점
미 수 료	• 현장평가 + 근태평가 점수가 70점을 넘지 못하는 경우	

○ 교육 우수 수료자 : 한국문화예술위원회 위원장상 + 시상품 증정

5 교육생 준수사항

○ 교육생은 교육기간 중 개발원의 제반규정과 지시사항을 준수하고 모범적인 교육 분위기 조성을 위하여 솔선수범하여야 하며, 교육생으로서의 품위를 유지하여야 한다.

○ 교육생은 신병이나 기타사정으로 인하여 결강 · 조퇴 등 교육에 임할 수 없게 된 때에는 개발원장의 사전허가를 받아야 한다.

○ 교육생은 원활한 교육진행 및 다른 교육생의 취침을 위해 밤 10시(22:00) 이후에는 외출 및 음주 등을 삼간다.

세부 일정표

일자 / 시간	1일차 6. 10(수)	2일차 6. 11(목)	3일차 6. 12(금)
08:00~09:30	★ 교육입소 버스 탑승 (3호선 구파발역 4번 출구, 10:00 출발) ★ 개발원 입교시간 10:30 ◉ 입교식 (0.5h)	◉ 강의 준비 ◉ 버스 탑승(3호선 구파발역 4번 출구, 09:00 출발)	
09:30~12:30	강의 1 **장치 매달기 이론 (2h)** – 장치 매달기 기초이론 **강 사 : 손호성** 한국예술종합학교 겸임교수	강의 3 **무대 구조 계산 (3h)** – 구조 역학	강의 5 **장치 매달기 3 (3h)** – 장치 매달기 응용 실습
12:30~13:30	점심식사		
13:30~17:30	강의 2 **장치 매달기 1 (4h)** – 매듭 묶기 – 평판, 복합평판 매달기	강의 4 **장치 매달기 2(4h)** – 복합 장치 매달기 실습	강의 6 **장치 매달기 4 (3h)** – 장치 매달기 응용 실습
17:30~19:30	◉ 간담회 (2h) * 강사와 교육생의 네트워크 구성을 위한 간담	◉ 공연관람 (2h)	◉ 교육설문 ◉ 수료 (0.5h)

교육담당

- **곽은석** 전화 : 02-760-4650 이메일 : kawkes@arko.or.kr
- **정지은** 전화 : 02-760-4658 이메일 : jjung@arko.or.kr

한국문화예술위원회

소개

1 설립목적 및 근거

○ **설립 목적**

훌륭한 예술이 우리 모두의 삶을 변화시키는 힘을 가지고 있다는 믿음으로 문화예술진흥을 위한 사업과 활동을 지원함으로써 모든 이가 창조의 기쁨을 공유하고 가치 있는 삶을 누리게 함

○ **설립 근거**

· 「문화예술진흥법」 제20조

"문화예술진흥을 위한 사업과 활동을 지원하기 위하여 한국문화예술위원회를 둔다."

2 한국문화예술위원회 연혁

연도	월	내용
1972	08	문화예술진흥법 제정(법률2337호)
1973	10	한국문화예술진흥원 개원
1979	05	미술회관 개관(현 아르코미술관)
1981	04	문예회관 개관(현 아르코예술가의 집)
1992	05	**무대예술연수회관 개관(현 아르코예술인력개발원)**
	10	예술자료관 개관
2005	01	문화예술진흥법 개정(법률 제 7415호)
	08	**한국문화예술위원회 기관 명칭 변경**
2007	04	공공기관의 운영에 관한 법률 시행 **– 한국문화예술위원회 : 기금관리형 준정부 기관으로 지정**

3 아르코 비전 2020



4 한국문화예술위원회 주요사업

○ 문화예술의 창작, 매개, 향수와 관련된 사업이나 활동

○ 문화예술 진흥을 위한 정책연구개발 및 교육연수 사업이나 활동

○ 민족전통문화의 보존·계승 및 발전을 위한 사업이나 활동

○ 지역 문화예술의 진흥을 위한 사업이나 활동

○ 남북 및 국제 문화예술의 교류 사업이나 활동

○ 문화예술 기반시설의 활성화를 위한 사업이나 활동

○ 문화예술인의 창작환경개선 및 후생복지증진과 국제경쟁력 제고를 위한 사업이나 활동

○ 문화예술 재원의 확충 및 조성을 위한 연구 및 사업이나 활동

○ 기타 문화예술의 진흥을 위한 사업이나 활동 및 시설의 설치·운영

아르코예술인력개발원

소개

1 설립목적 및 근거

○ **설립목적**

"창의적인 문화예술전문인력양성 및 재교육"

○ **설립근거**

· 문화예술진흥법 제6조 (전문인력 양성)

"국가는 문화시설의 전문적 운영에 필요한 기획·관리 전문인력의 양성에 노력하여야 한다."

· 공연법 제13조 (국가 등의 의무)

"국가는 무대예술전문인 양성과 자질 향상을 위하여 필요한 시책을 마련하여야 한다."

2 아르코예술인력개발원 연혁

연도	월	내용
1989	03	연출·연기·양성을 위한 '공연예술아카데미' 개설
1992	05	무대예술연수회관 개관
	08	'무대예술아카데미' 개설
2002	03	공연예술 실습 전문시설 '실험무대' 준공
	04	무대예술 전문 교육기관 지정(문화관광부)
2007	01	아르코예술인력개발원(Arko HDR Center)으로 명칭 변경
2010	09	지역주민과 함께하는 '동네방네 음악회' 시작
2011	01	국제공연예술전문가시리즈(AIPAPS) 시작
2013	01	차세대예술인력육성사업(AYAF) 시작
	11	아르코 예술인력개발원 새 비전 선포
		"한국 문화예술 전문인력 양성의 중심기관"
2014	01	문화예술 창작·기획·문화복지 등으로 인력양성 분야 확대
		* '87~'14말까지 교육 이수자 총 17,393명 배출

3 아르코예술인력개발원 주요 사업

전략목표	세부사업	주요내용
무대예술 전문인력 양성	• 무대예술 전문교육	• 무대기술 습득 제고 및 역량 강화('87년부터 운영) – '15년 무대 조명·음향·장치·공통 분야 13회 예정
	• 국제공연예술 전문가시리즈 (AIPAPS)	• 공연예술분야 해외 거장 초청 국제적 트렌드 함양, 선진 역량 및 새로운 기술 습득 ('11년 시작) – '15년 음향디자인, 조명 디자인, 무대미술 디자인 분야 등 4회 예정
	• 무대예술 전문인력 지원	• 무대예술전문인력의 현장 진출 경로 확보 및 경력개발 지원 – 민간에서 운영중인 전국 500석 미만의 등록 공연장 인력 파견 지원
	• ARKO 사이버아카데미	• 사이버아카데미를 통해 무대예술전문인력 및 문화예술 창작기획·전문인력 양성 저변 확대 및 직무능력 제고
문화예술 창작·기획 전문인력 양성	• 문화복지 전문인력 양성	• 문화복지 사업의 효과적 수행을 위한 문화복지 전문인력 양성 및 관련 분야 경력 개발
	• 공연예술분야 차세대예술인력 육성	• 공연예술분야(연극, 무용, 음악, 전통예술, 다원예술) 창작자를 대상으로 한 기금, 시설(창작공간 등) 및 교육(멘토링 등) 지원 프로그램
	• 공연기획 전문인력 지원	• 공연예술분야 창작단체 등에 대한 상시 고용 기획전문인력 인건비 지원
	• 문화예술기관 연수단원지원	• 문화예술분야 전공 졸업자들의 인턴 연수를 통해 향후 진로에 필요한 실무능력 배양 및 사회진출 기회 제공
	• 전문무용수 지원센터지원	• 전문무용수의 사회·경제적 지위향상과 무용 활동의 활성화 지원 – 직업 개발, 복지지원, 창작지원
	• 전통예술기획자 양성 프로젝트	• 전통공연예술분야 기획, 제작 등 전문 인력을 체계적으로 양성하기 위한 아카데미 운영 지원
	• 공연장안전지원센터지원	• 공연장 관리 운영 실무자, 무대시설 안전관리 업무 종사자 등에 대한 교육 및 기술 지원

2015 무대예술전문교육
장치 매달기

제 1 장 장치 매달기 이론

제1절 무대장치 기술 및 응용
제2절 공연장의 무대조명설비의 파악

강사 손 호 성

현직
• 한국예술종합학교 연극원 무대미술과 겸임교수

전공
• 무대기술(Technical Direction)

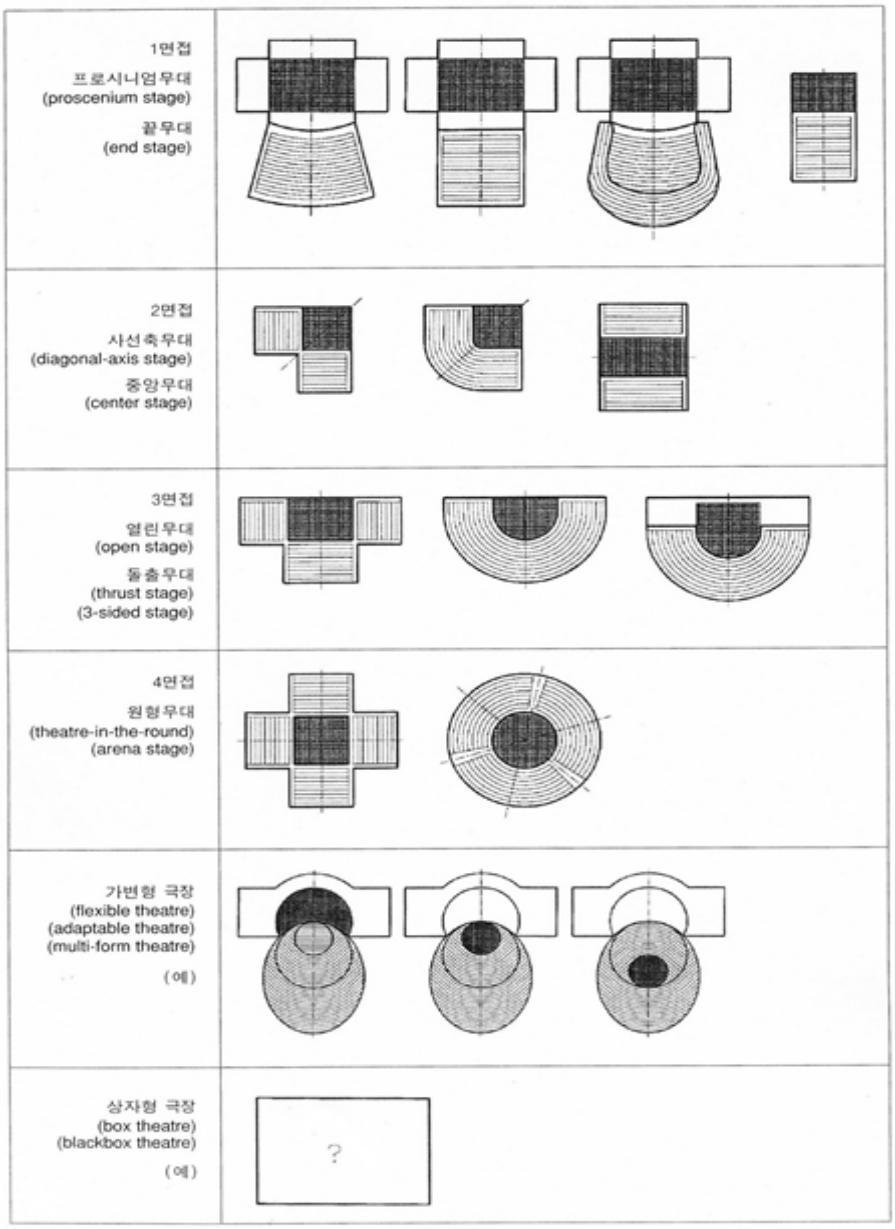
경력
• ARKO(문예진흥원) 공연예술아카데미 무대장치 전공 책임교수(2002-2011)
• 문화관광부 무대예술전문인 자격검정위원회 전문위원(무대기계분야)
• 세계국립극장 페스티벌, 국립 발레단 '왕자호동' 외 다수 기술감독

이메일
• shonhosung99@yahoo.com

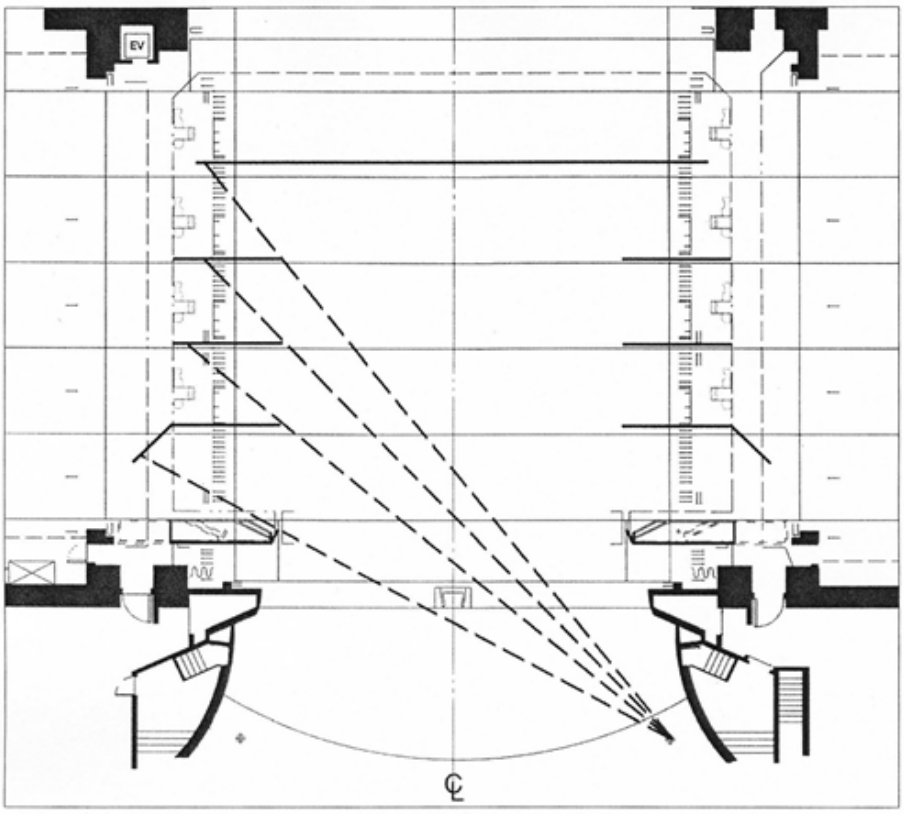
제1절 무대장치 기술 및 응용

1. 무대장치 기술

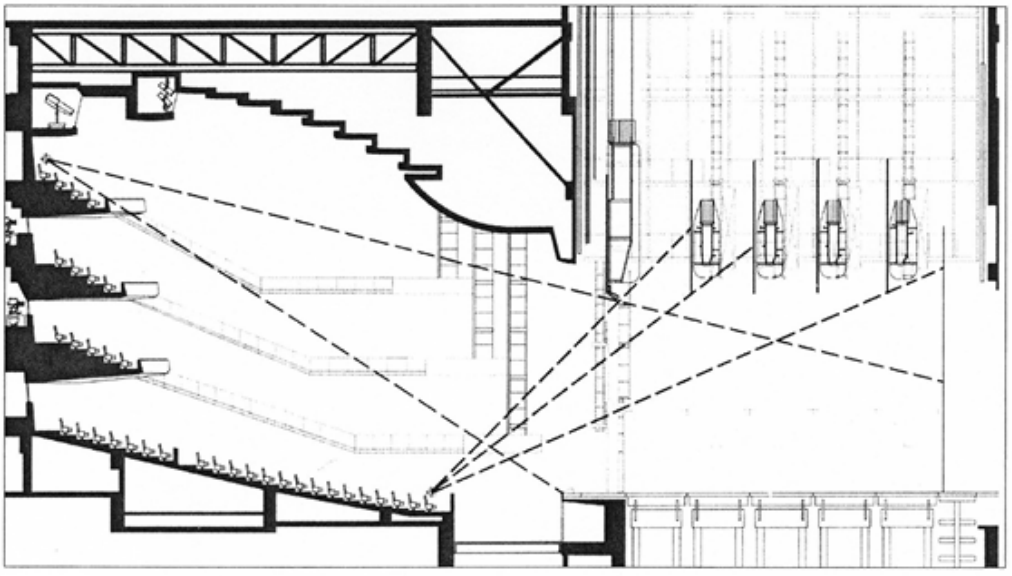
1) 극장의 형태와 무대장치 기술



<그림 1.1> 극장의 형태



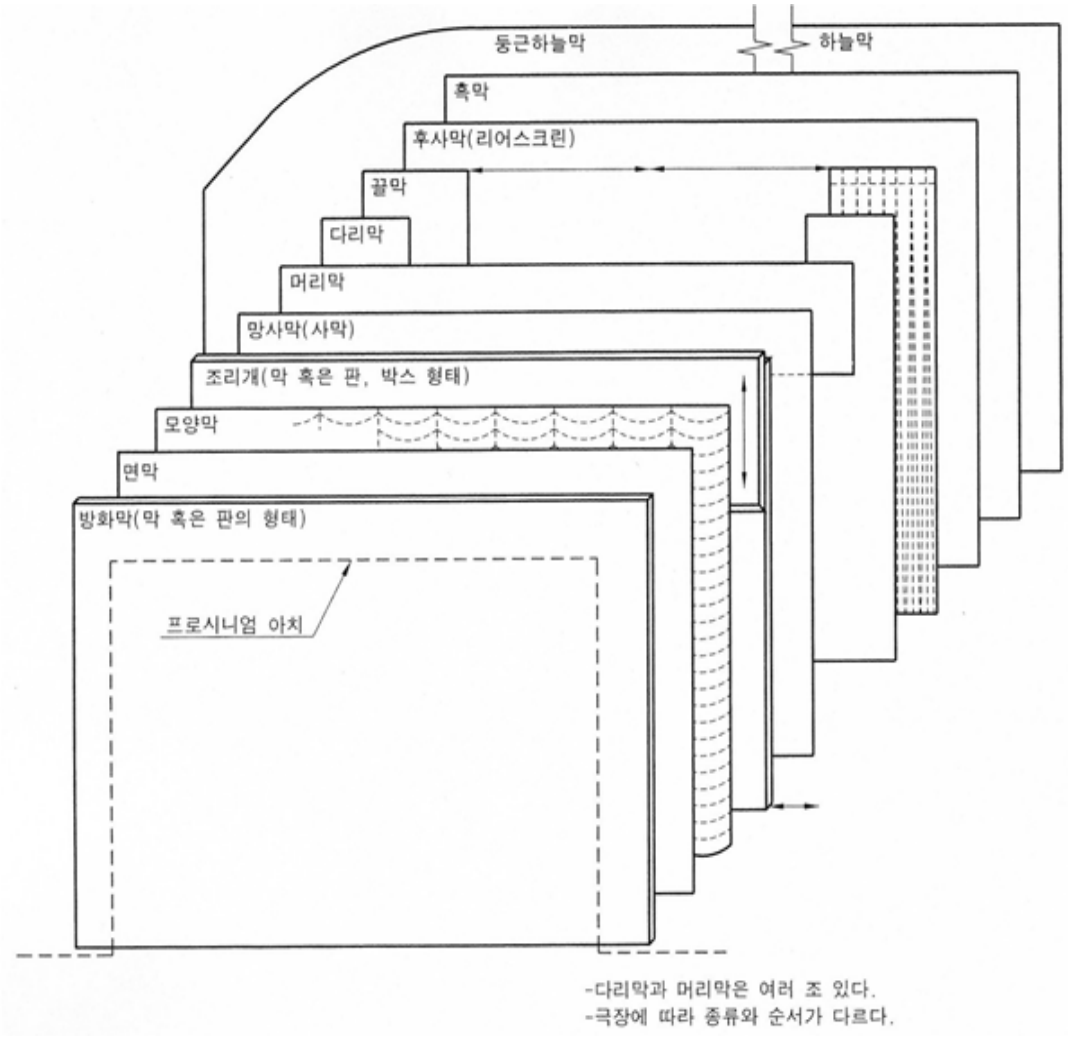
<그림 1.2> 수평시각선의 예



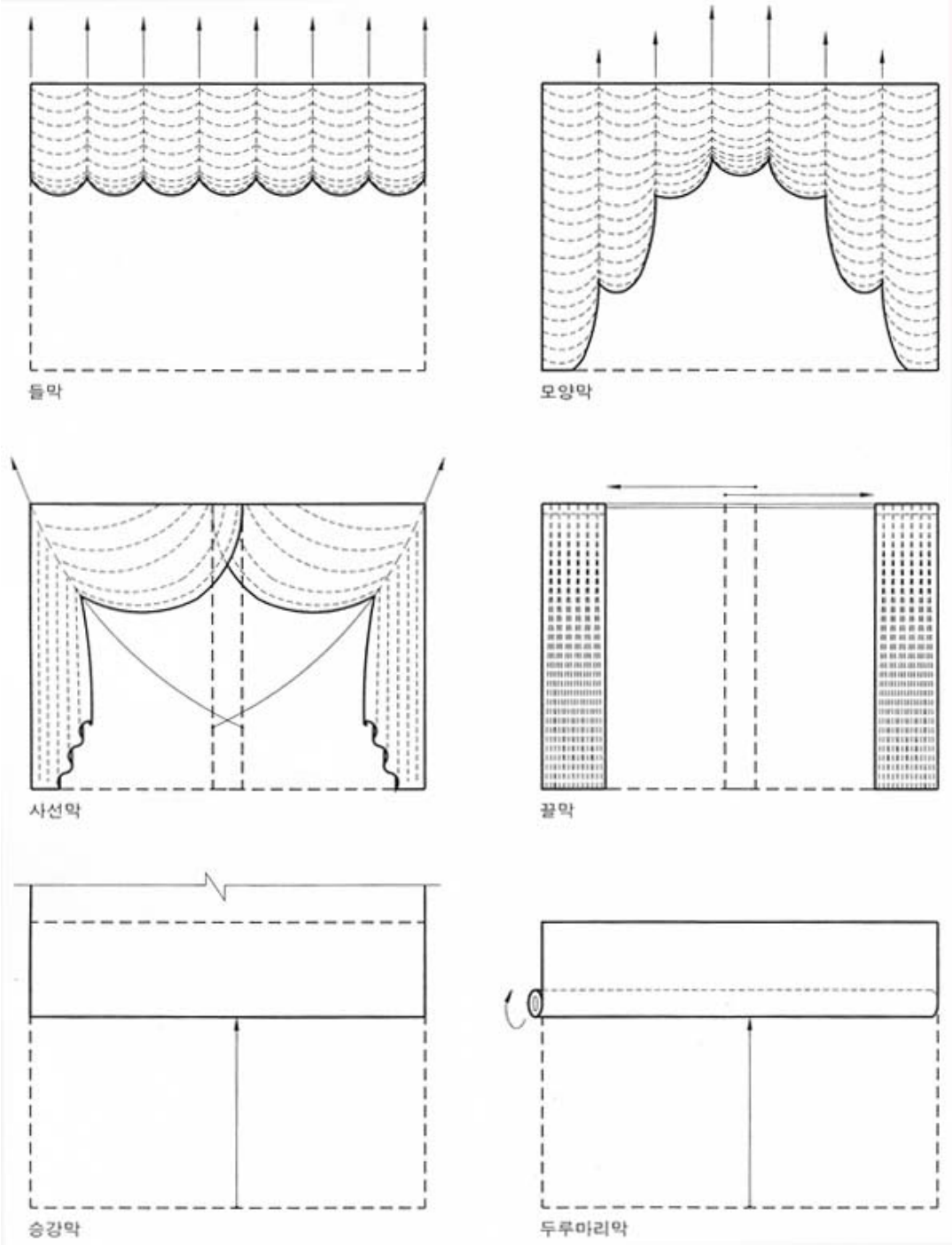
<그림 1.3> 수직시각선의 예

2. 평면장치

1) 극장막의 종류와 역할

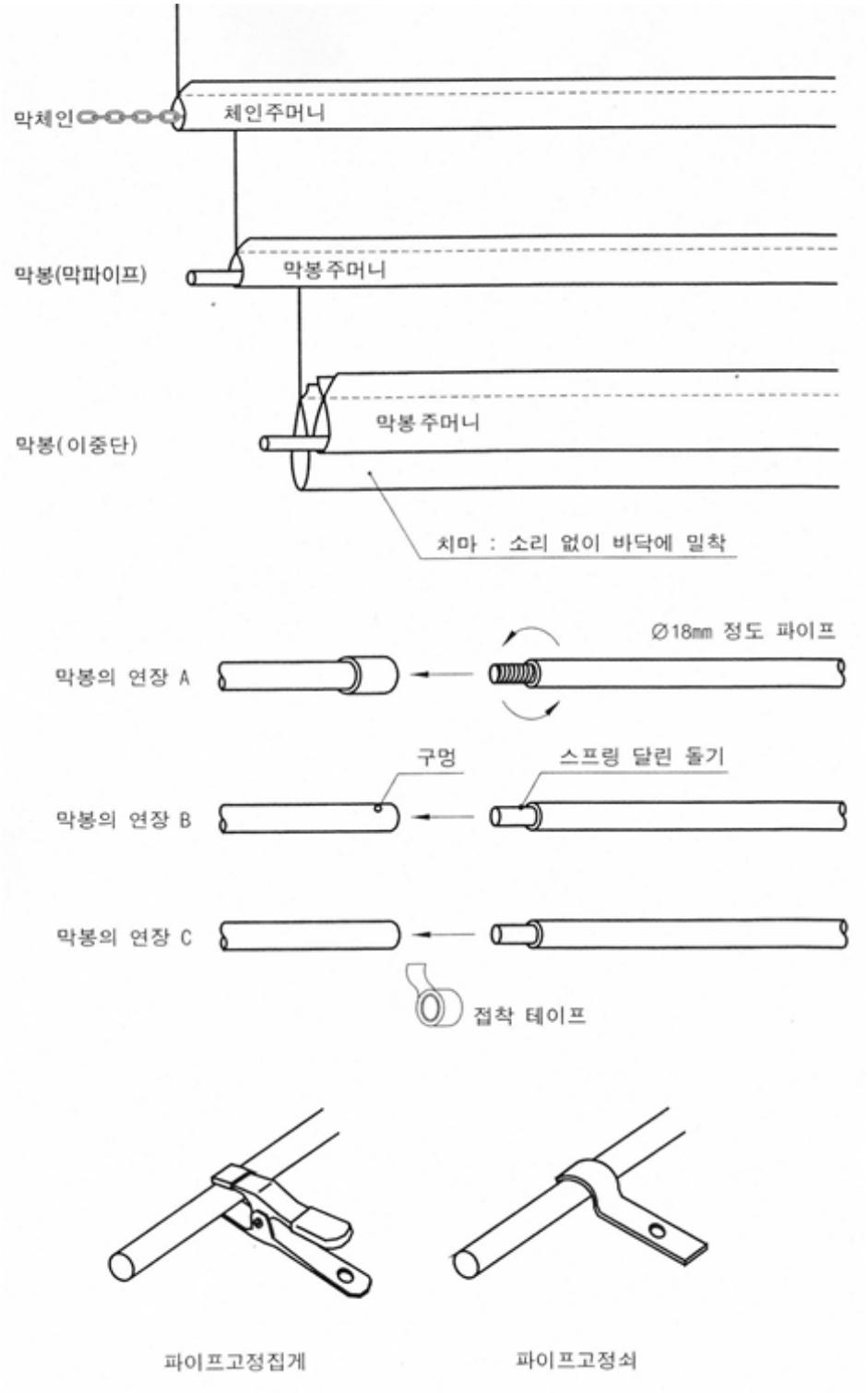


<그림 2.1> 극장막의 종류

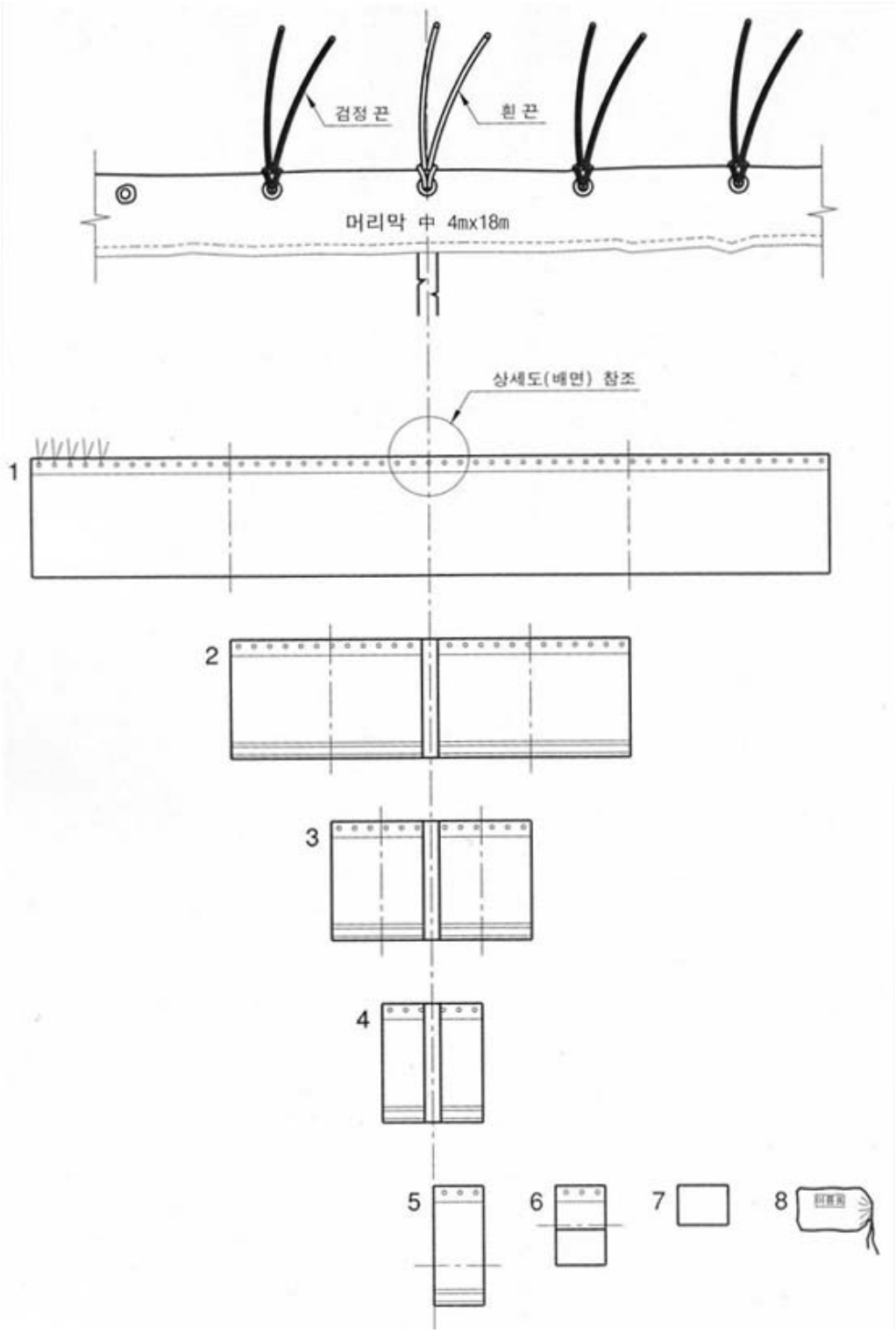


<그림 2.2> 면막의 종류

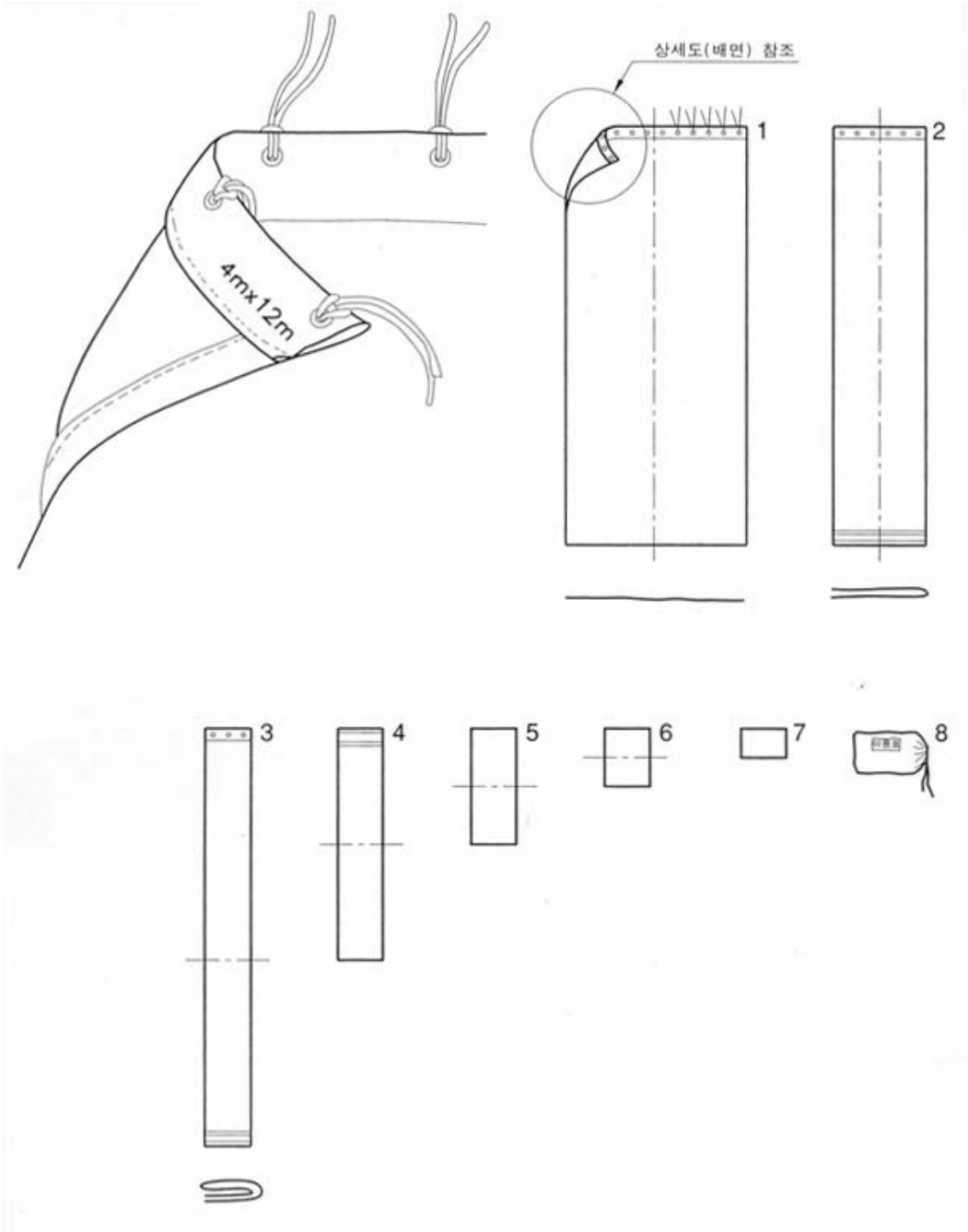
2) 막장치의 구조와 취급



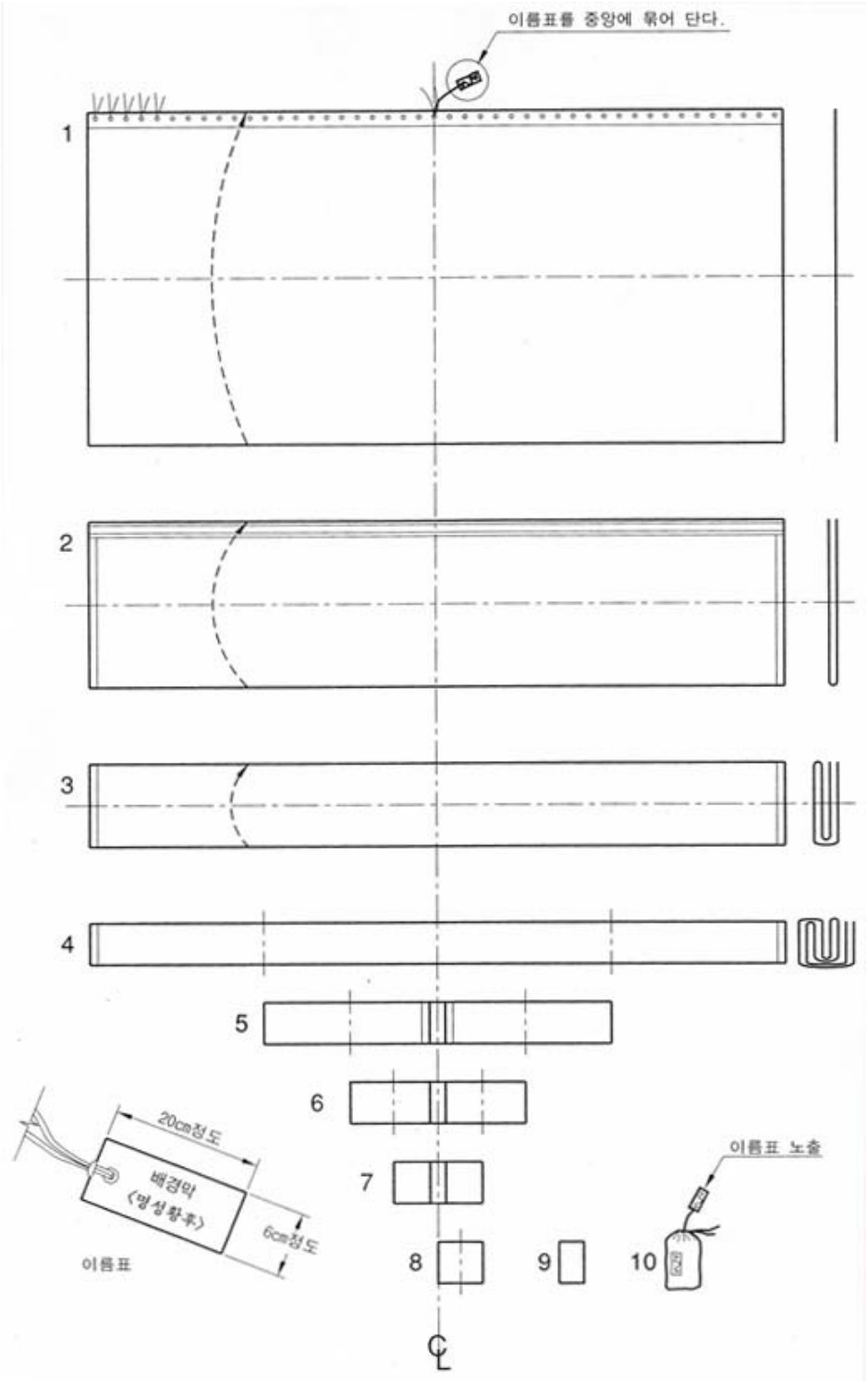
<그림 2.3> 장치막의 하단 처리



<그림 2.4> 머리막 철거

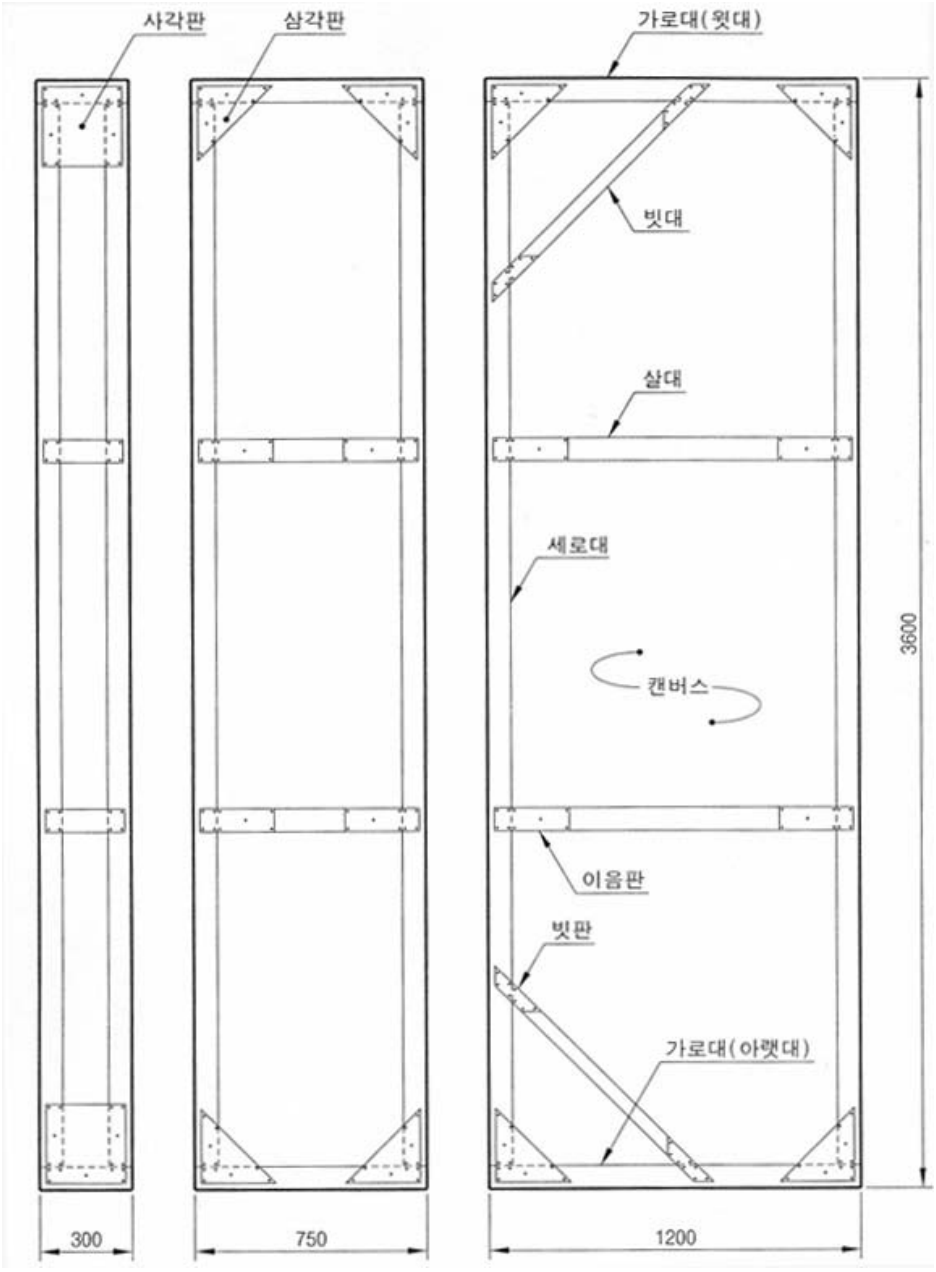


<그림 2.5> 다리막 철거



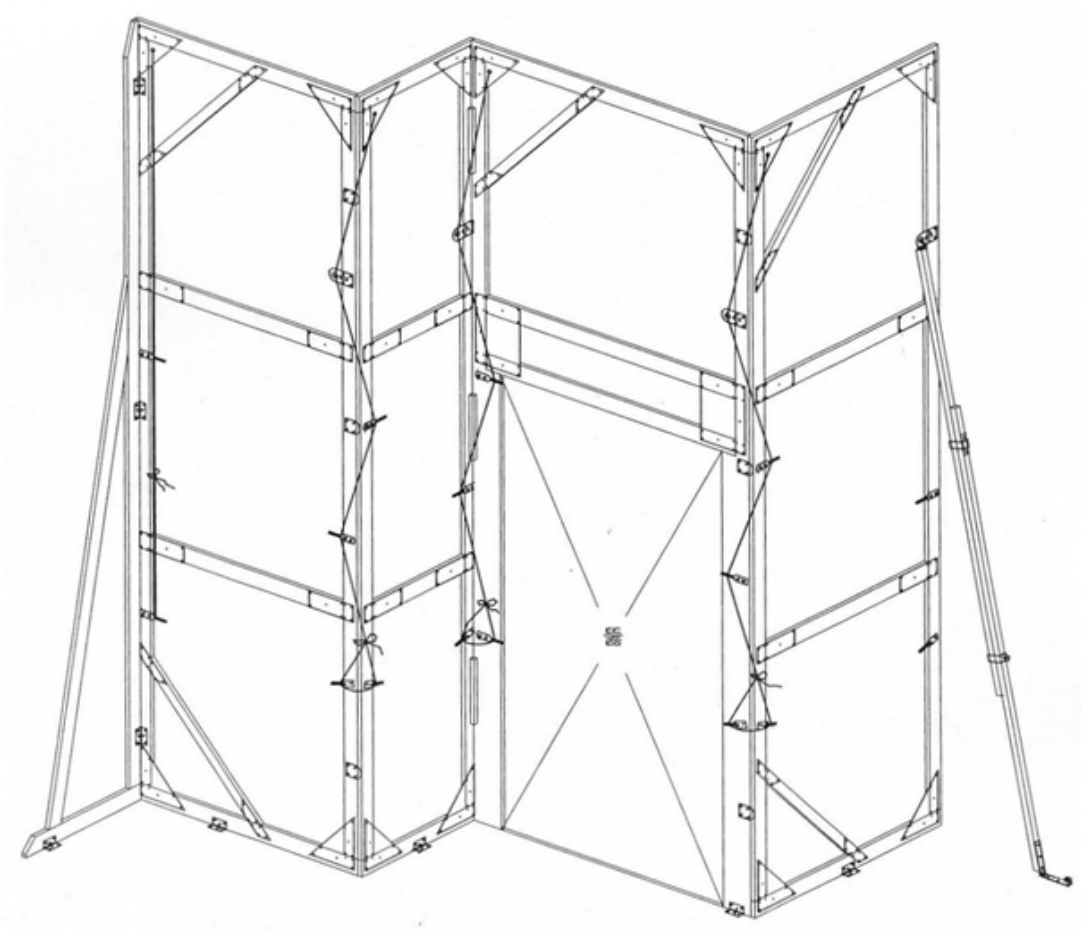
<그림 2.6> 작화막 철거

3) 평판장치의 구조

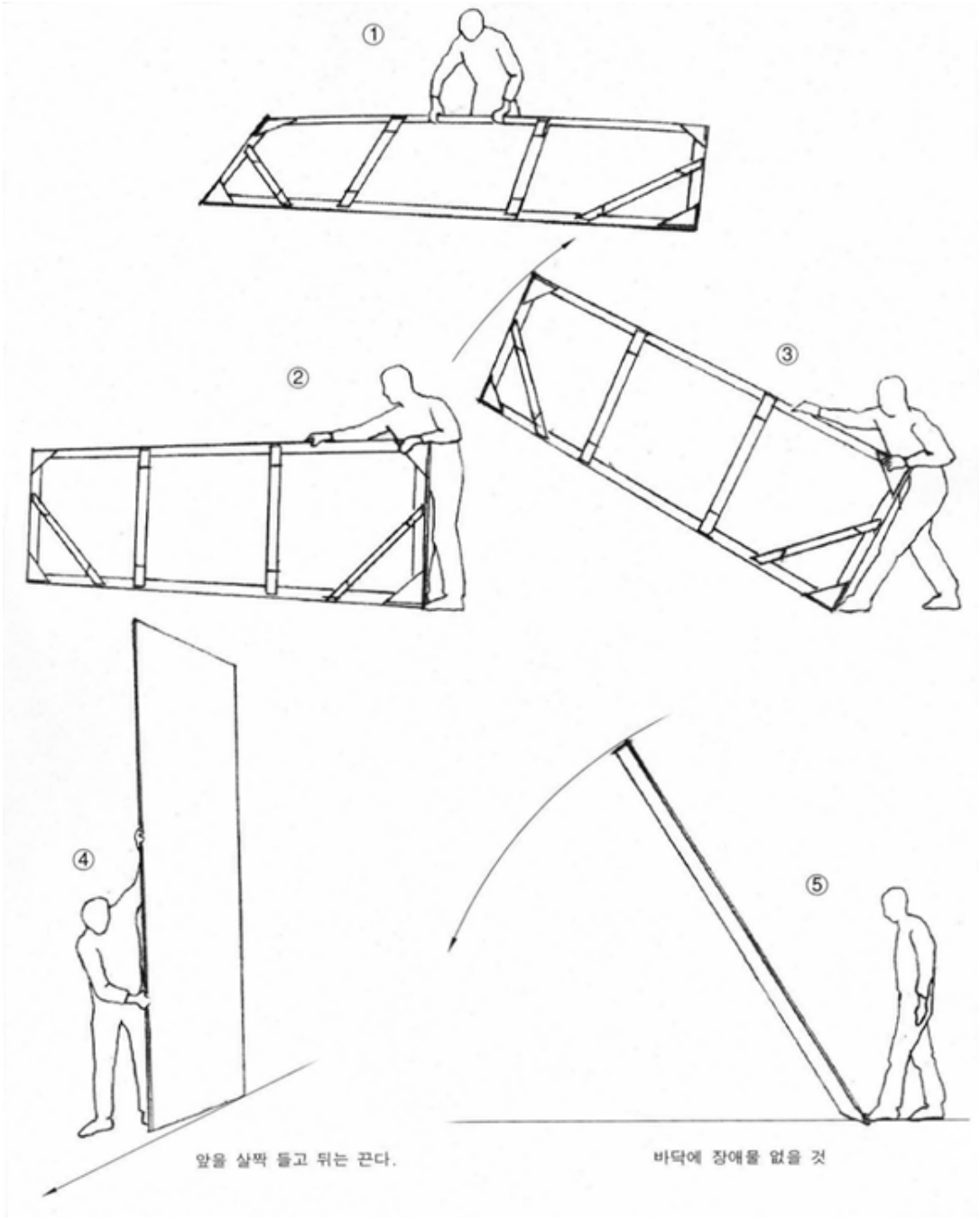


<그림 2.7> 평판의 구조

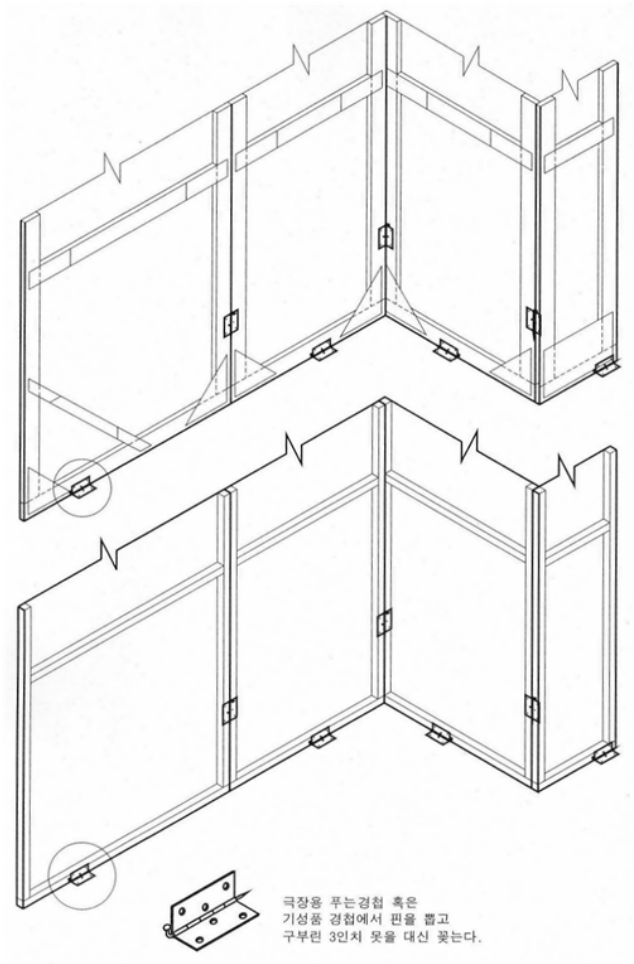
4) 평판의 설치 및 운영



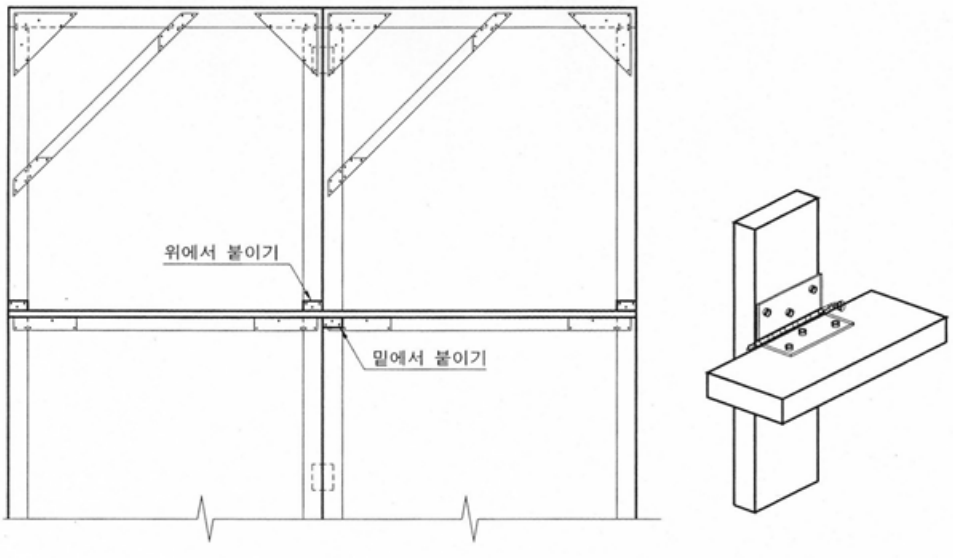
<그림 2.8> 평판의 설치 예시



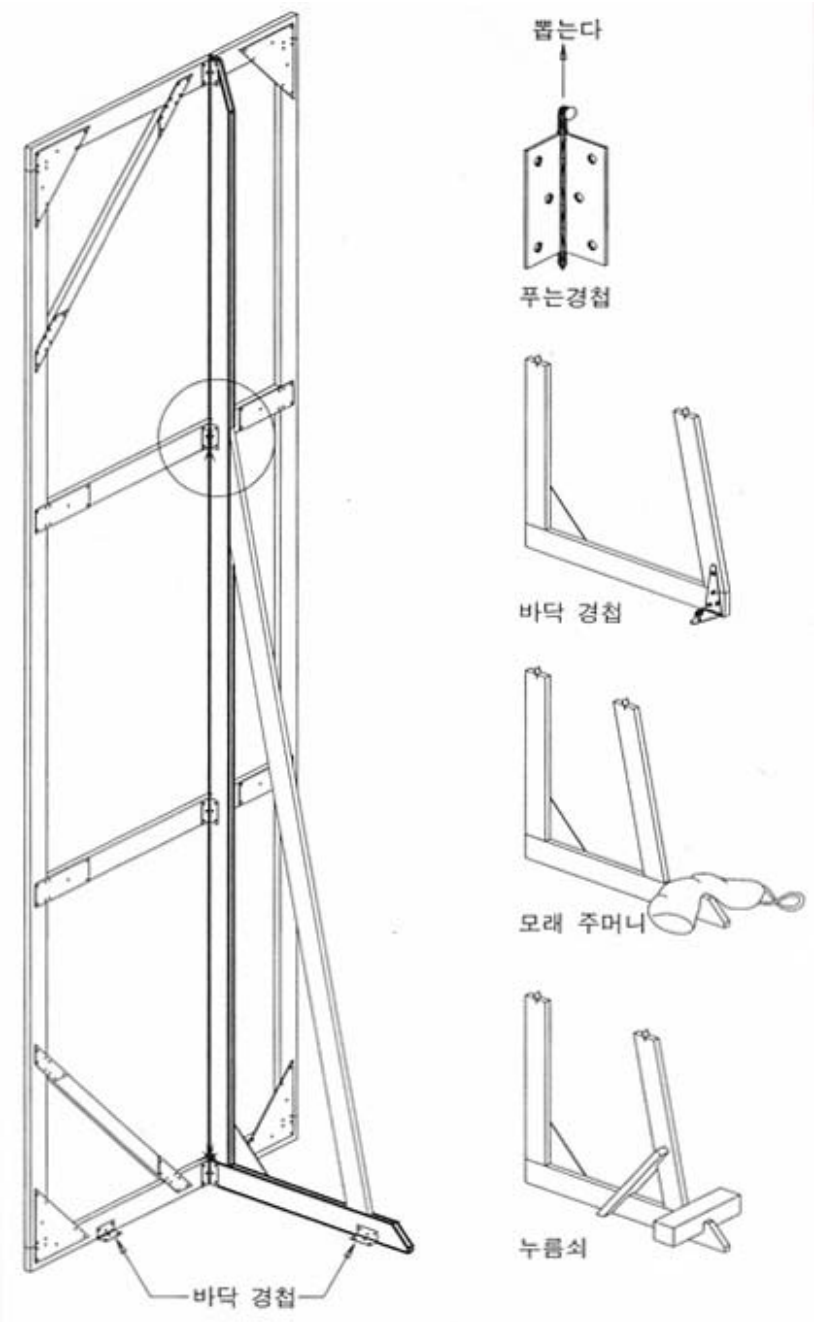
<그림 2.9> 평판 옮기기



<그림 2.10> 경첩으로 평판 잇기



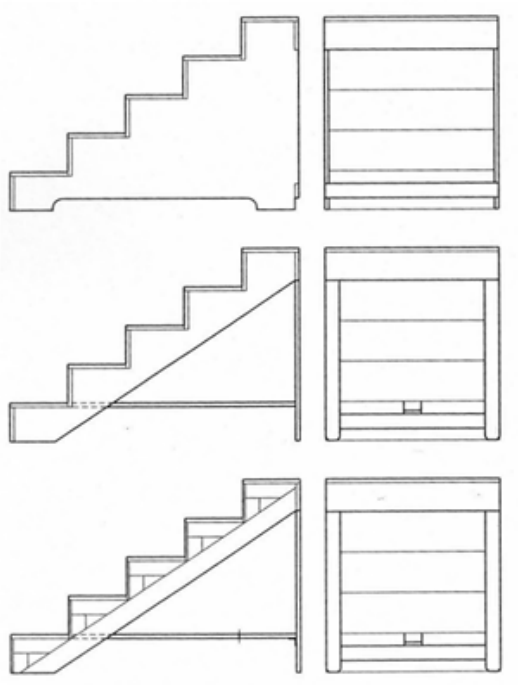
<그림 2.11> 경첩식 빗장 걸기



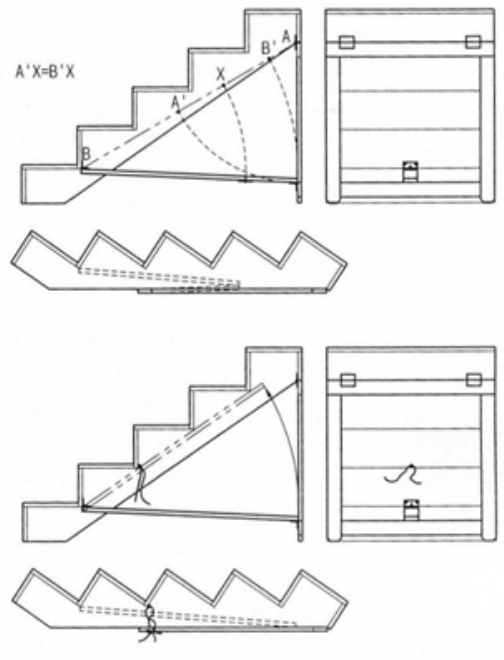
<그림 2.12> 평판 버티기: 삼각 버팀대

3. 입체장치

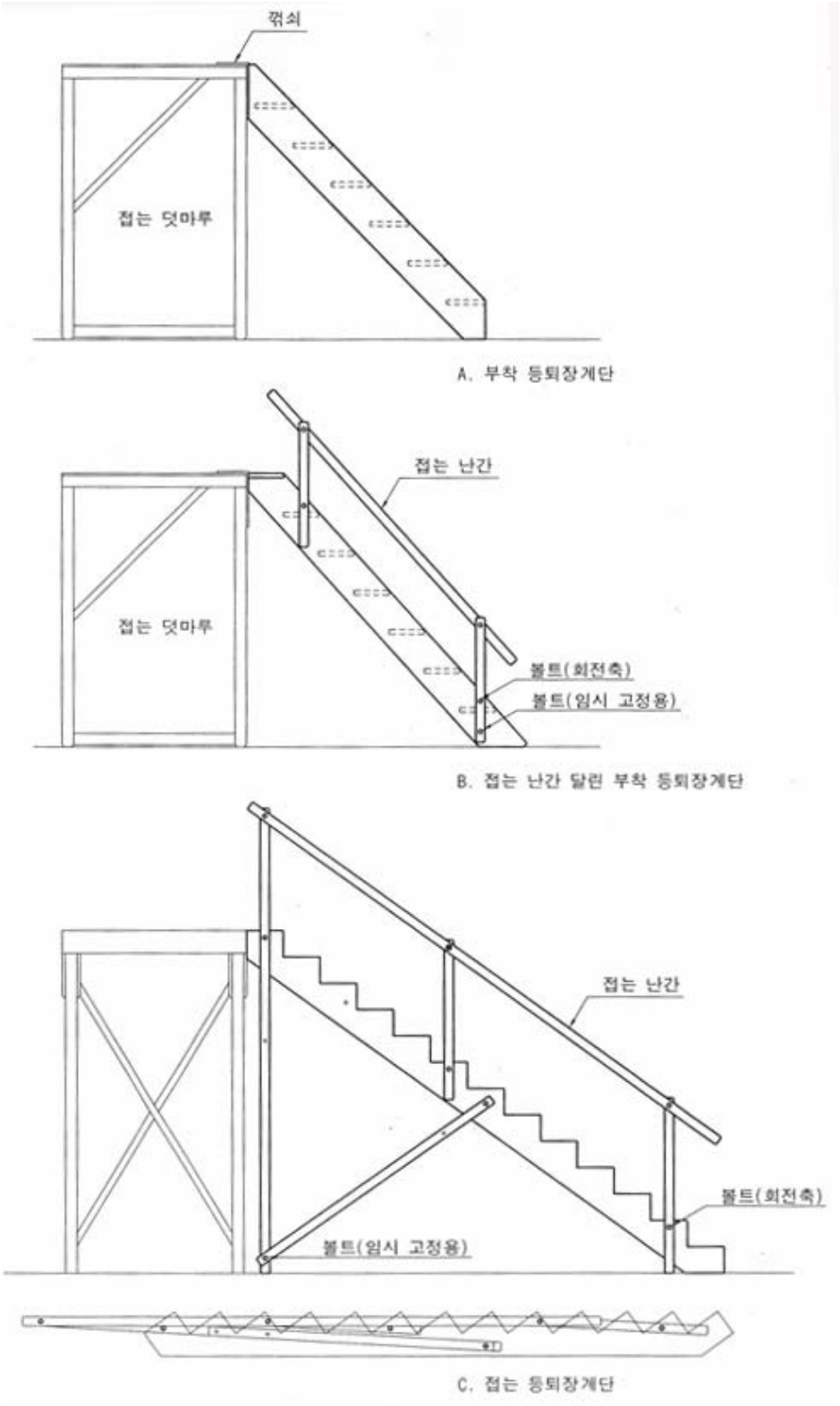
1) 계단



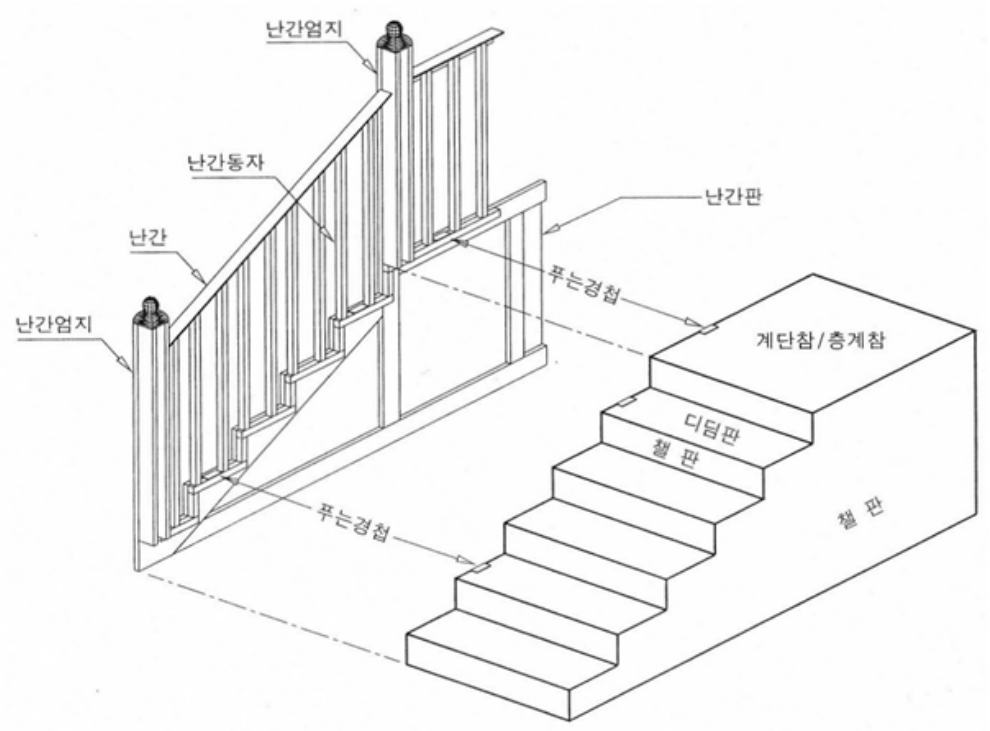
<그림 3.1> 자립계단



<그림 3.2> 접는계단


꺾쇠
접는 덧마루
A. 부착 등퇴장계단
접는 난간
접는 덧마루
볼트(회전축)
볼트(임시 고정용)
B. 접는 난간 달린 부착 등퇴장계단
접는 난간
볼트(회전축)
볼트(임시 고정용)
C. 접는 등퇴장계단

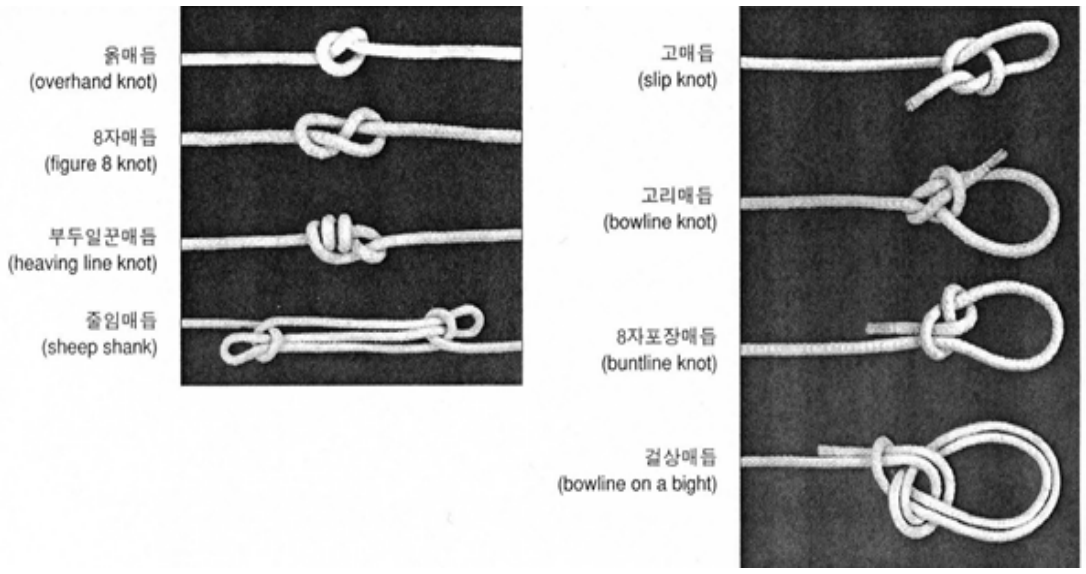
<그림 3.3> 등퇴장계단

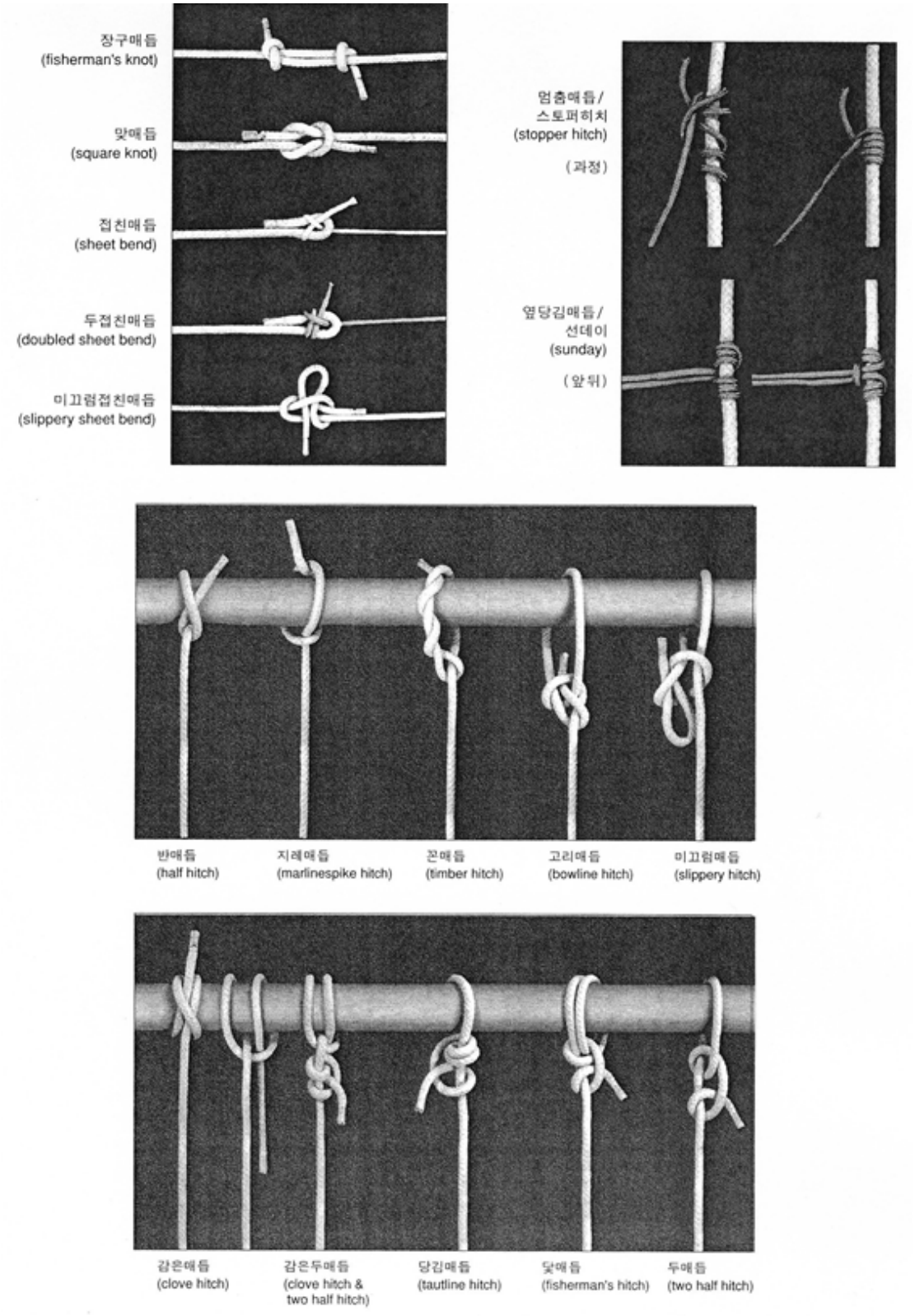


<그림 3.4> 계단장치의 구조

4. 상부 전환장치

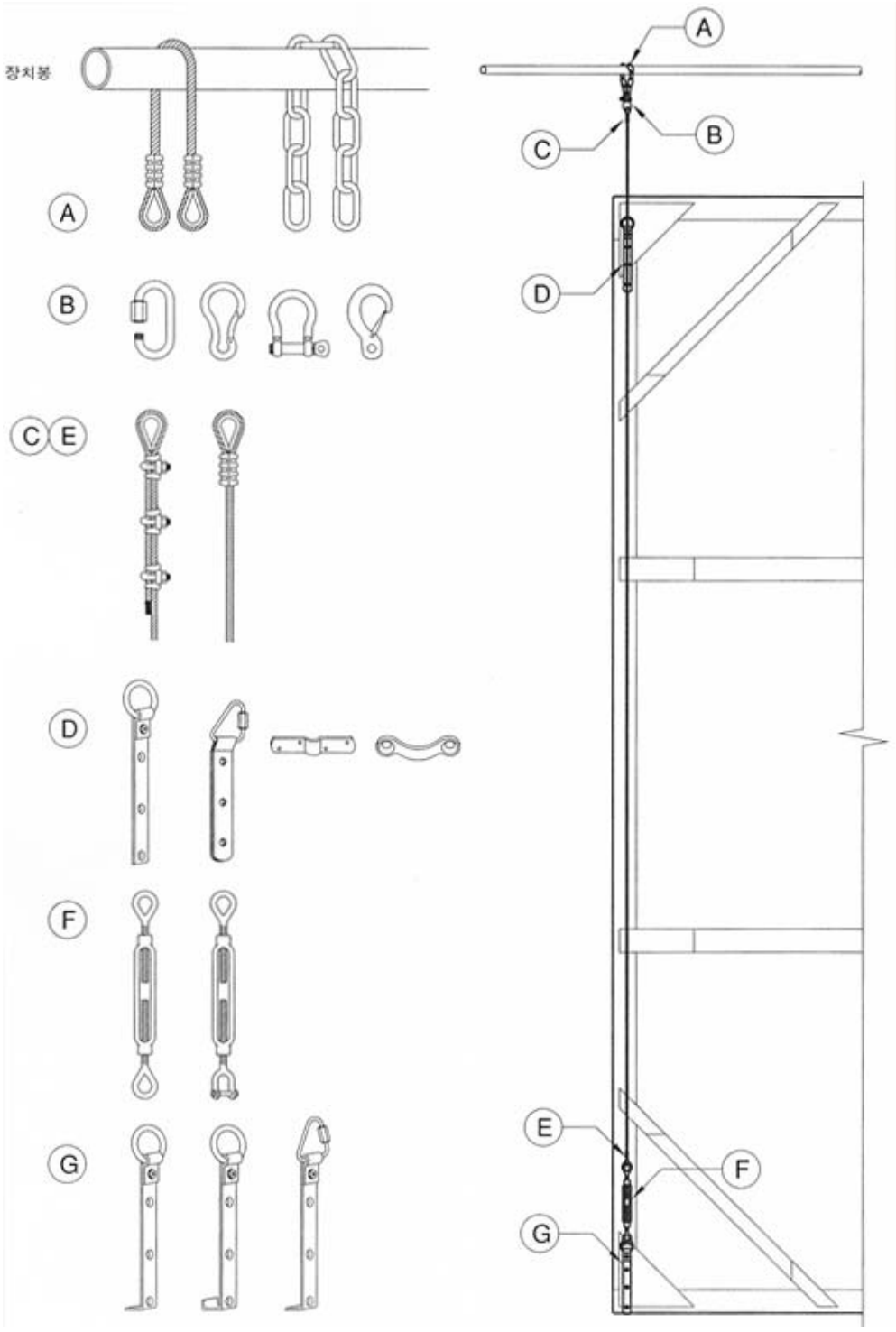
1) 매듭




장구매듭
(fisherman's knot)
맞매듭
(square knot)
접친매듭
(sheet bend)
두접친매듭
(doubled sheet bend)
미끄럼접친매듭
(slippery sheet bend)
엄춤매듭/
스토퍼히치
(stopper hitch)
(과정)
옆당김매듭/
선데이
(sunday)
(앞뒤)
반매듭
(half hitch)
지례매듭
(marlinespike hitch)
꼰매듭
(timber hitch)
고리매듭
(bowline hitch)
미끄럼매듭
(slippery hitch)
감은매듭
(clove hitch)
감은두매듭
(clove hitch &
two half hitch)
당김매듭
(tautline hitch)
닻매듭
(fisherman's hitch)
두매듭
(two half hitch)

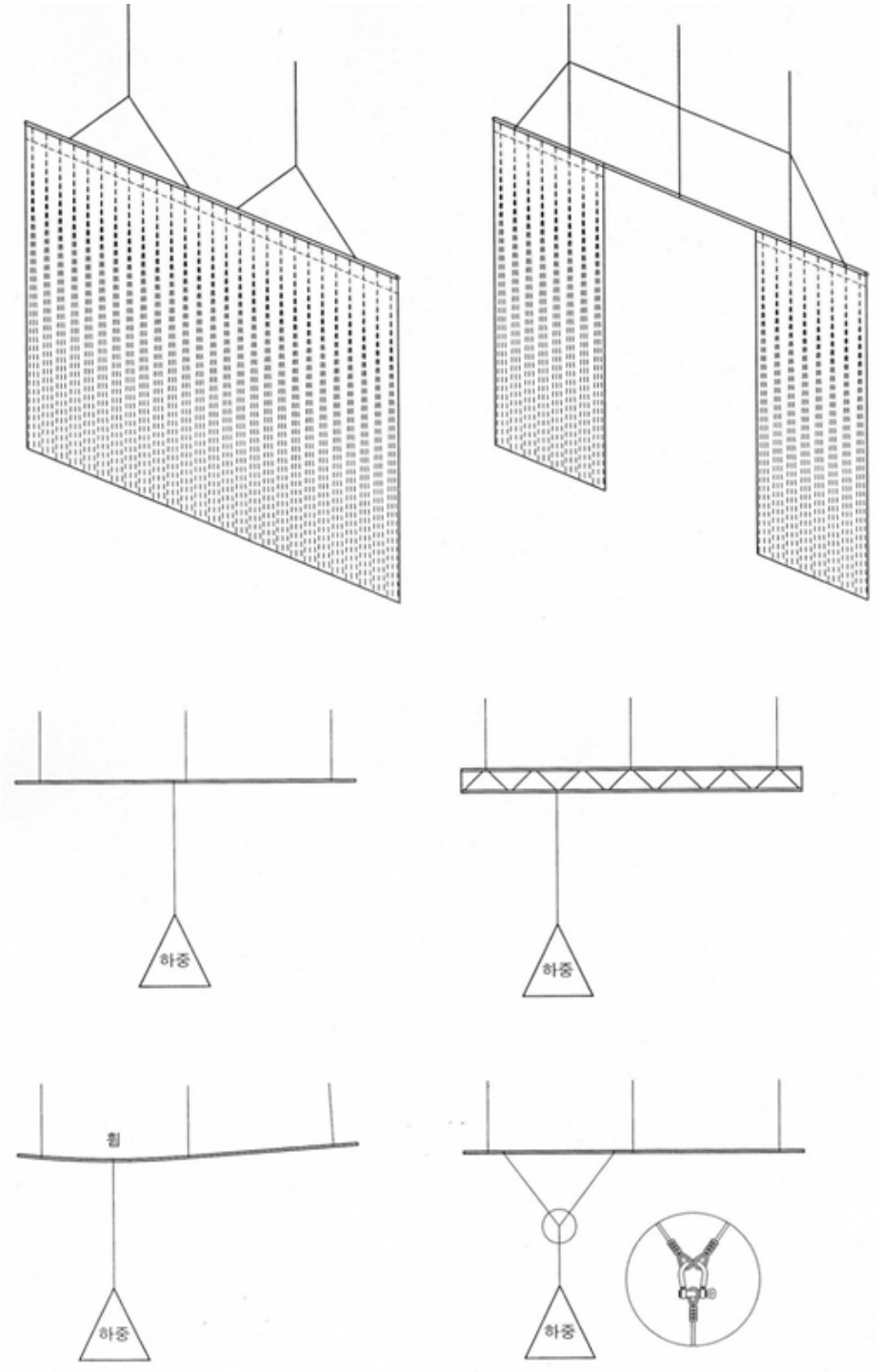
<그림 4.1> 매듭의 종류

2) 평판 달기

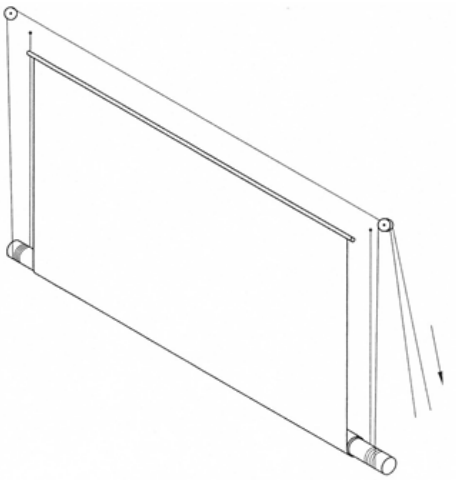


<그림 4.2> 평판 달기

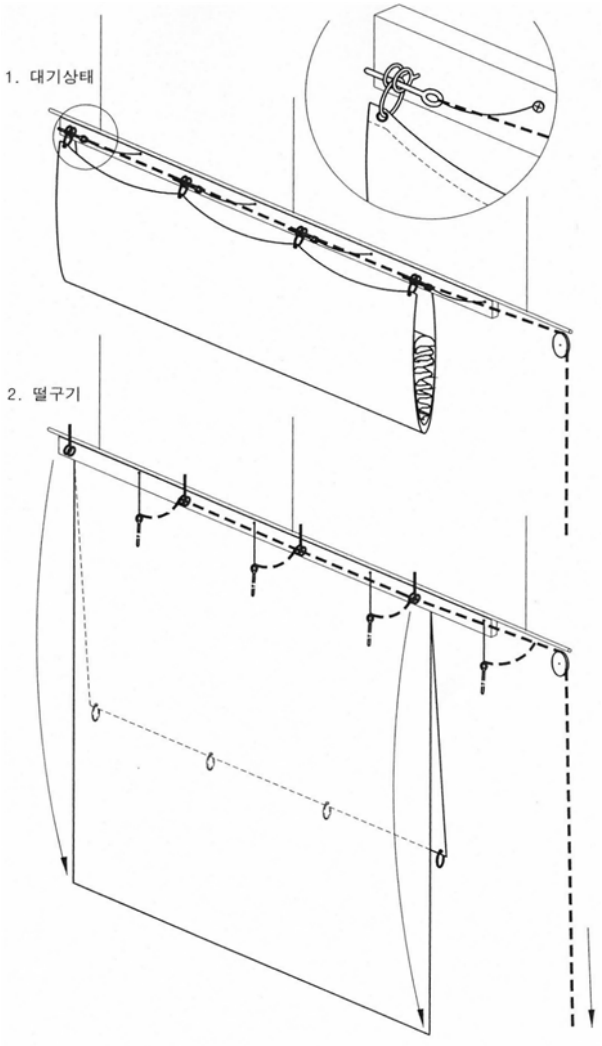
3) 다양한 장치 매달기



<그림 4.3> 모아달기

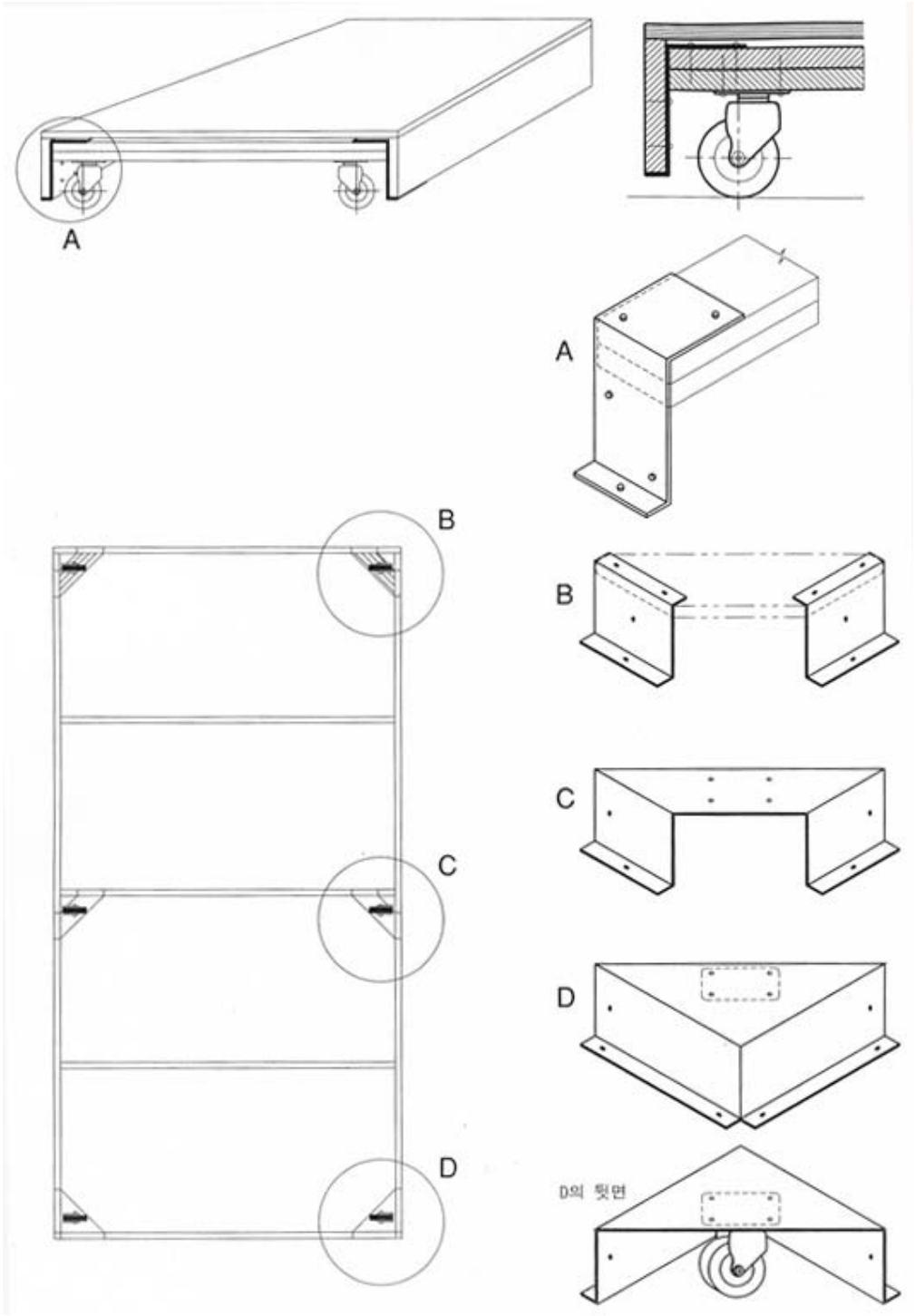


<그림 4.4> 두루마리막

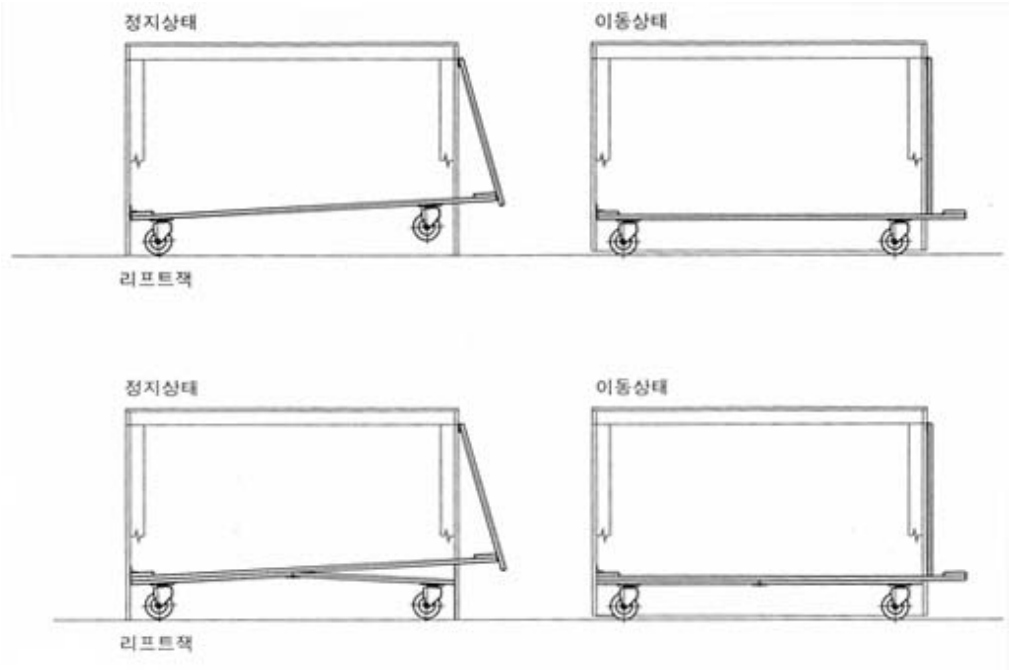


<그림 4.5> 떨구기

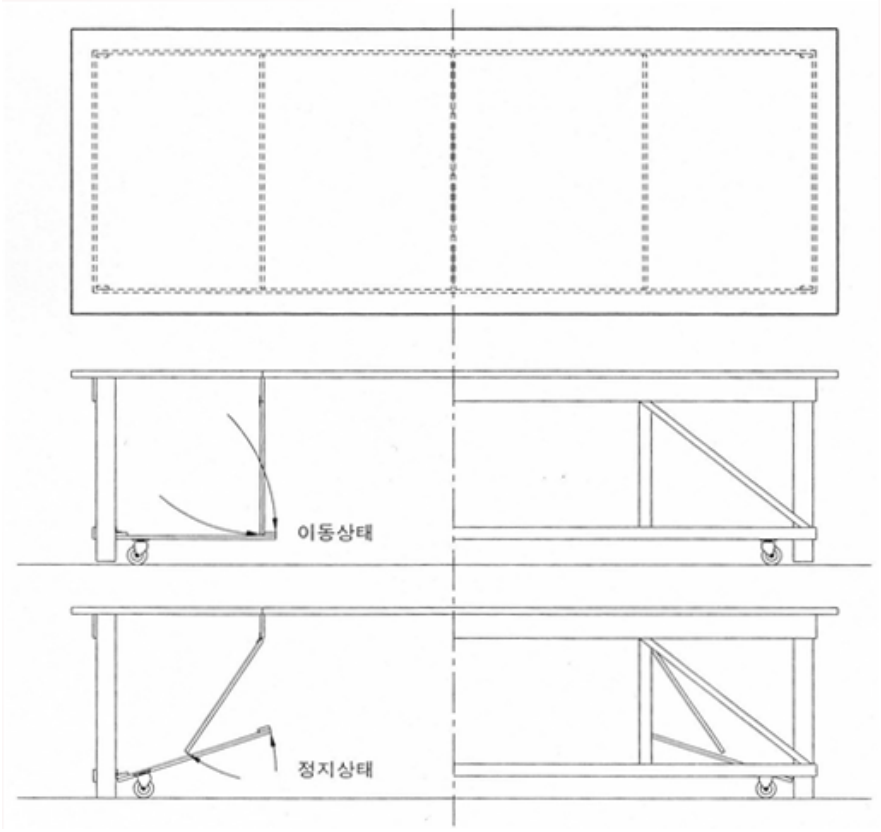
5. 하부 전환장치



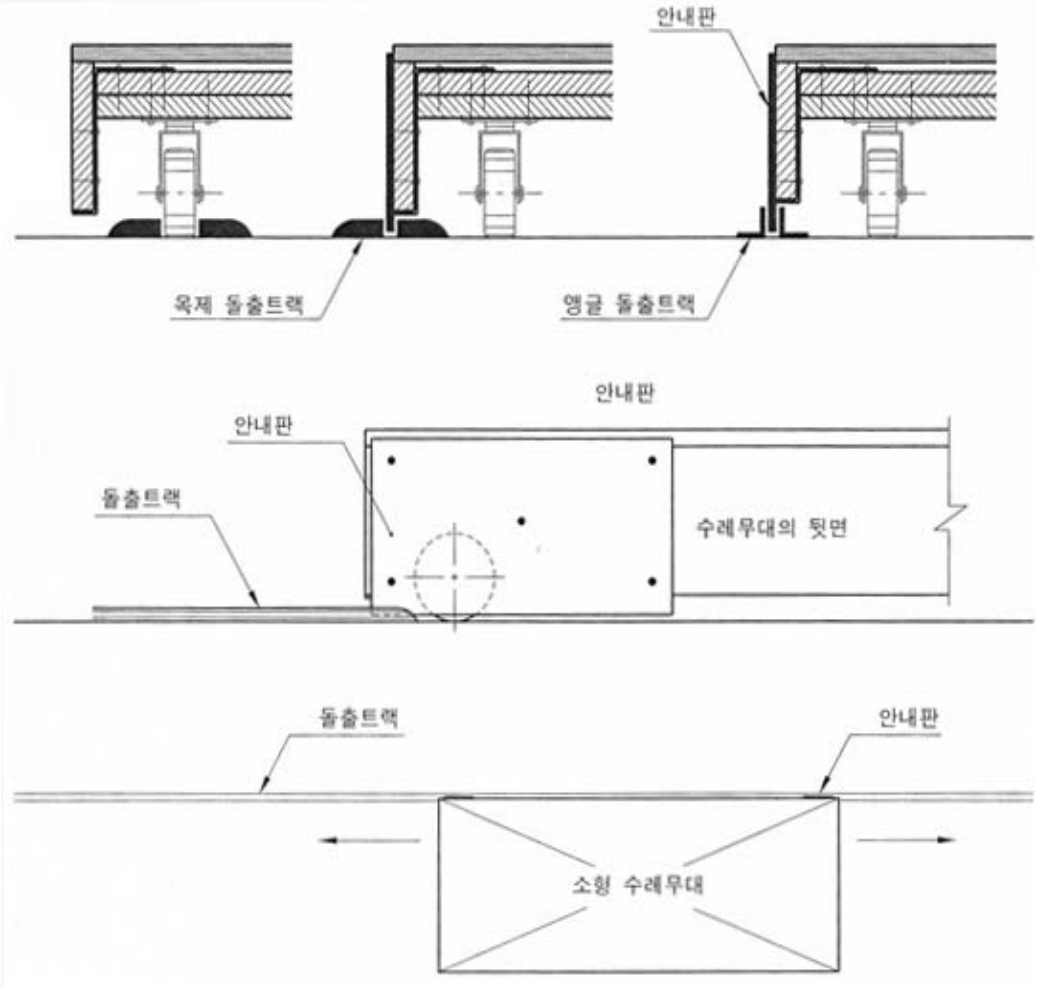
<그림 5.1> 바퀴



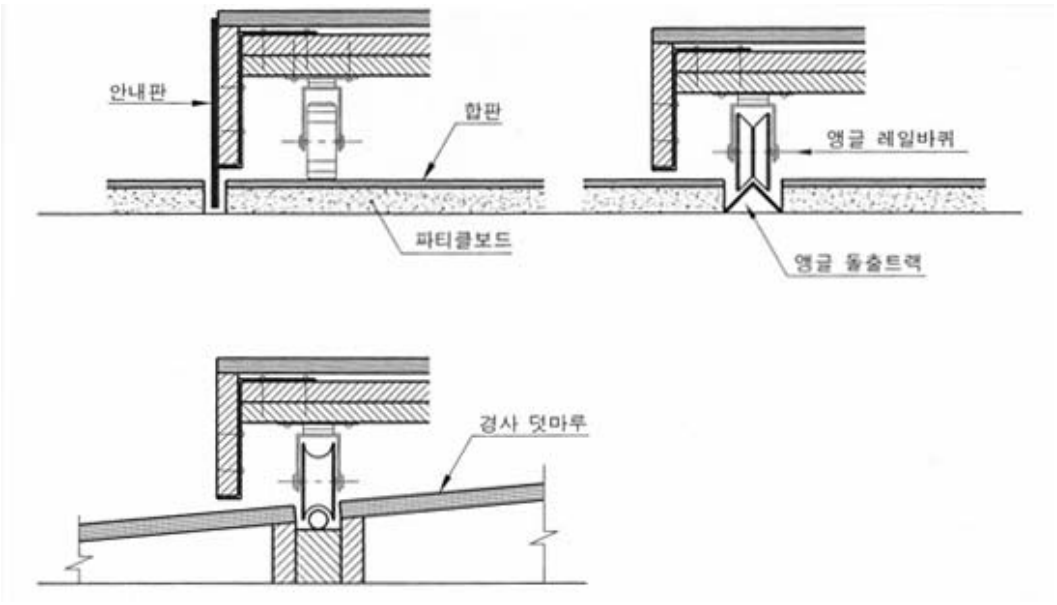
<그림 5.2> 리프트잭

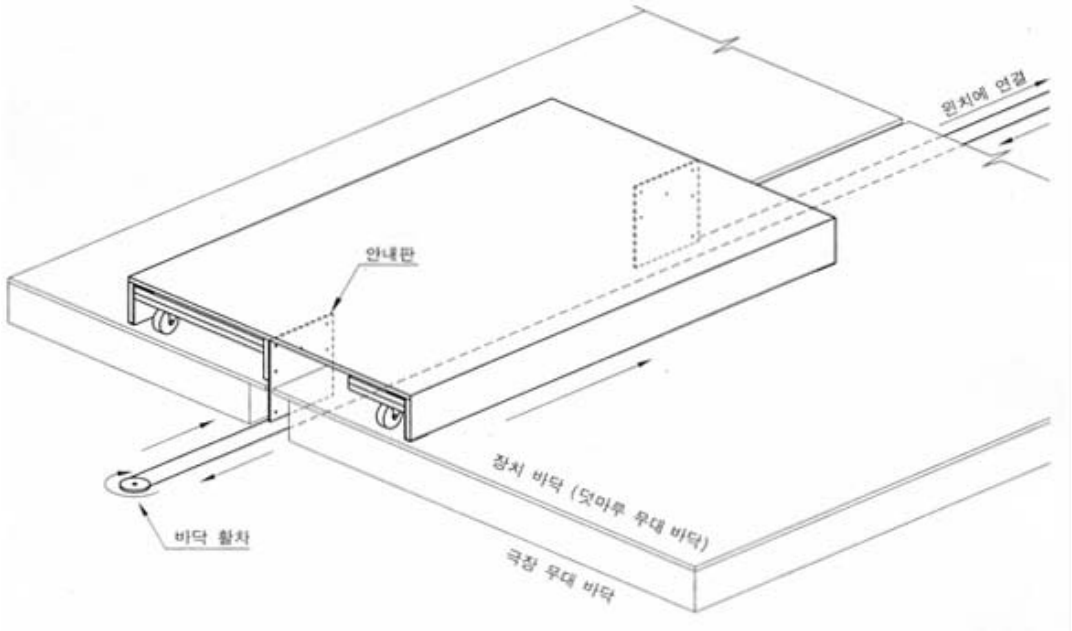


<그림 5.3> 리프트잭을 이용한 이동형 작업대

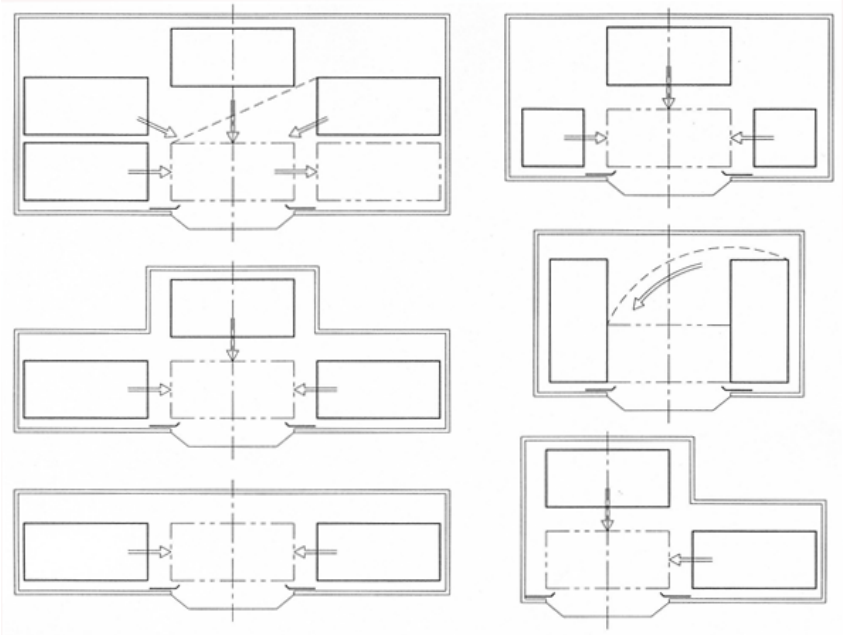


<그림 5.4> 돌출트랙

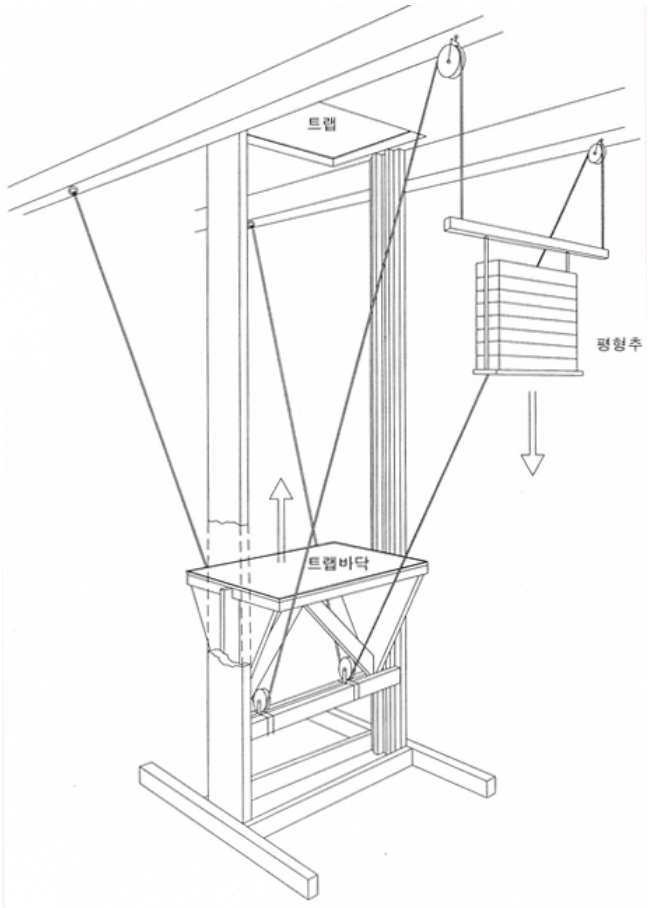

안내판
합판
파티클보드
앵글 레일바퀴
앵글 돌출트랙
경사 덧마루


윈치에 연결
안내판
장치 바닥 (덧마루 무대 바닥)
바닥 활차
극장 무대 바닥

<그림 5.5> 매설트랙



<그림 5.6> 대형 수레무대



<그림 5.7> 트랩승강장치

장치매달기

장치매달기

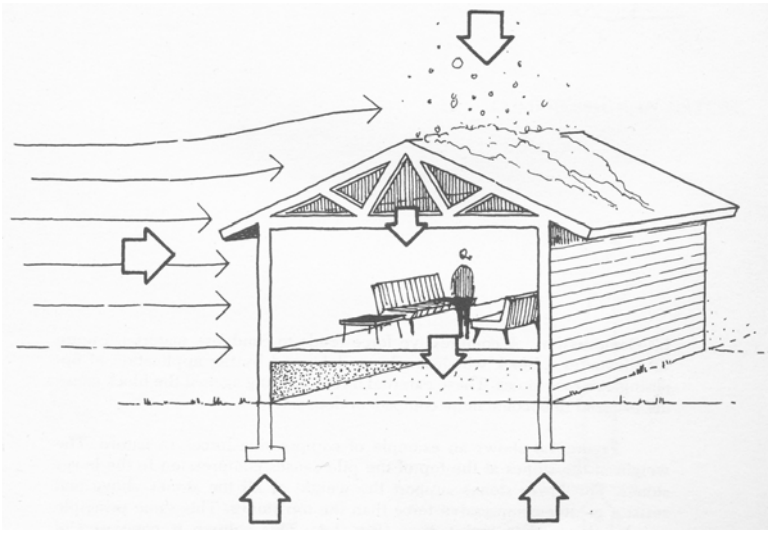
제 2 장 힘의 작용 및 균형

제1절 힘의 작용 및 균형

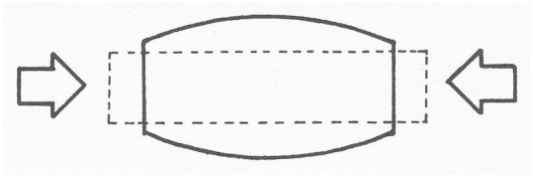
제1절 힘의 작용 및 균형

1. 하중

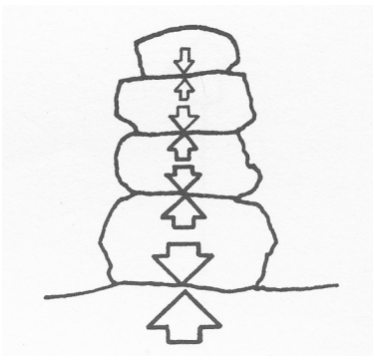
1) 하중의 종류



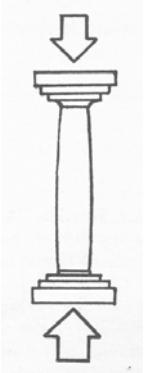
<그림 1.1> 움직이는 하중과 정지한 하중



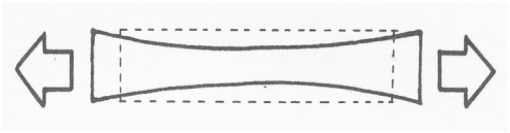
<그림 1.2> 압축 하중 (compression)



<그림 1.3> 자연에서의 압축 하중



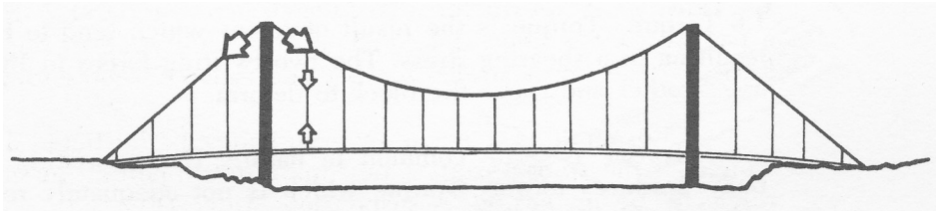
<그림 1.4> 건축에서의 압축 하중



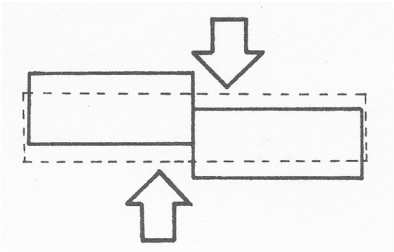
<그림 1.5> 인장 하중 (tension)



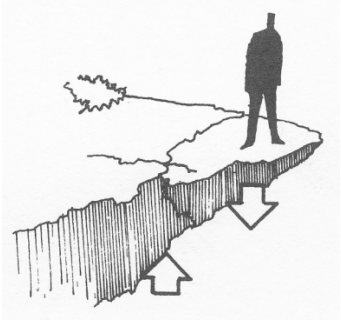
<그림 1.6> 자연에서의 인장 하중 (tension)



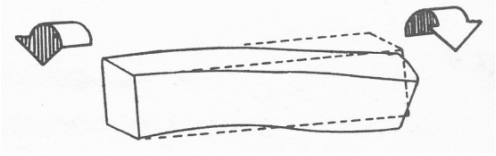
<그림 1.7> 건축에서의 인장 하중 (tension)



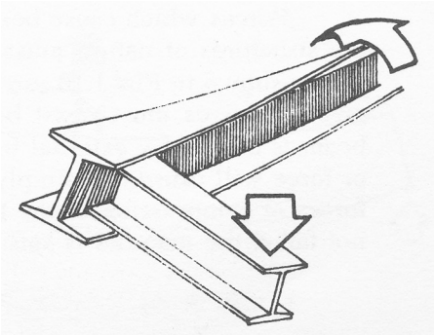
<그림 1.8> 전단 하중 (shear)



<그림 1.9> 자연에서의 전단 하중 (shear)



<그림 1.10> 비틀림 하중 (torque)



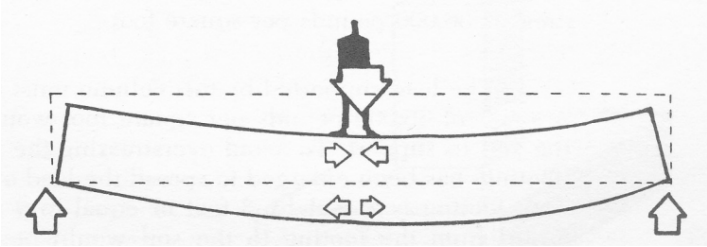
<그림 1.11> 빔에서의 비틀림 하중 (torque)



<그림 1.12> 휨 하중 (bending)



<그림 1.13> 자연에서의 휨 하중 (bending)



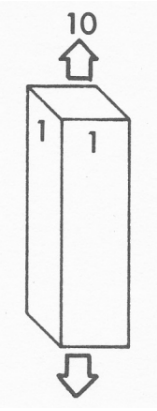
<그림 1.14> 빔에서의 휨 하중

2) 응력(stress)

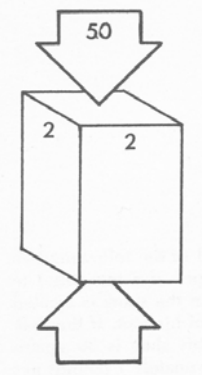
응력은 물체에 하중이 가해졌을 때 해당 물체 내부에 생기는 저항력이다.

단위면적당 작용하는 힘으로서, 단위로는 kgf/mm², psi(lb/in²) 등이 있다.

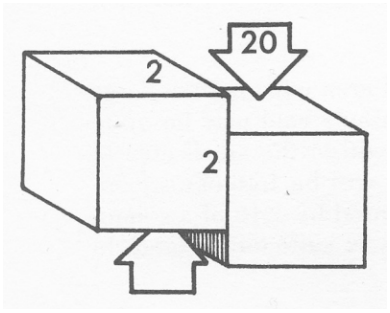
F = P / A (F:응력,Stress, P:하중, A:단면적)



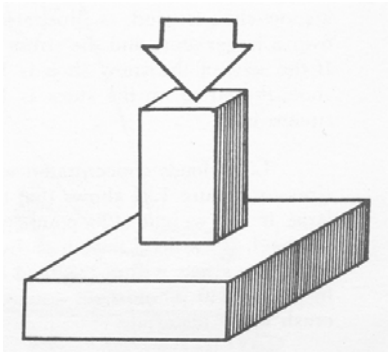
<그림 1.15> 인장응력



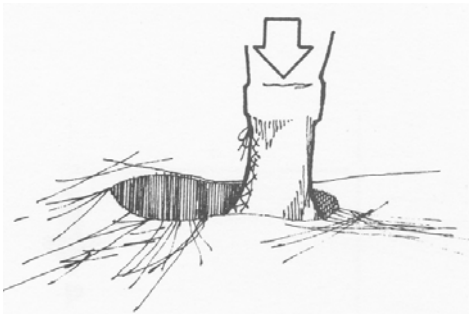
<그림 1.16> 압축응력



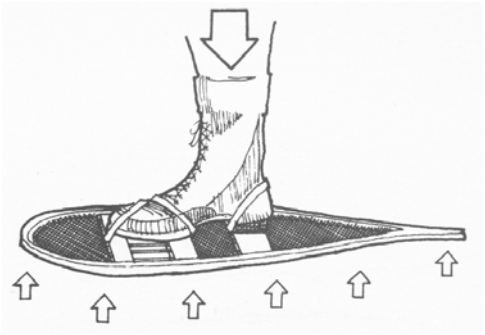
<그림 1.17> 전단응력



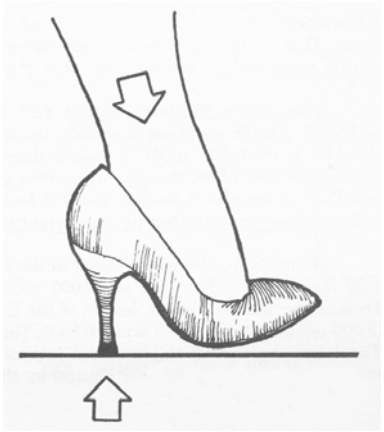
<그림 1.18> 건축에서의 응력 (기둥과 바닥)



<그림 1.19> 눈 위에서의 응력



<그림 1.20> 설피를 이용한 응력 분산

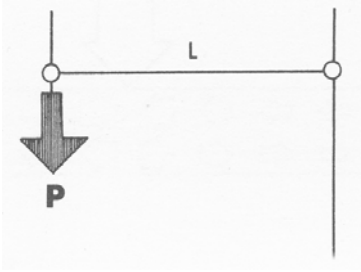


<그림 1.21> 하이힐에서의 응력

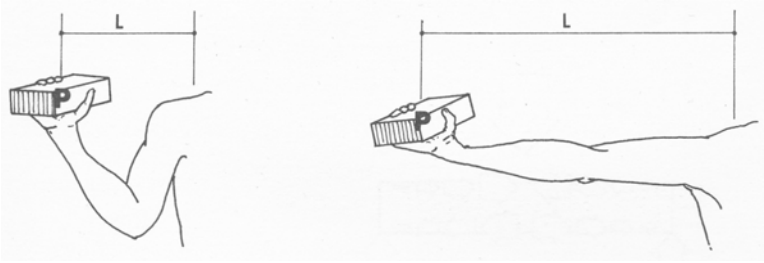
3) 모멘트(moment)

어떤 물체에 하중이 작용할 때 생기는 회전력.

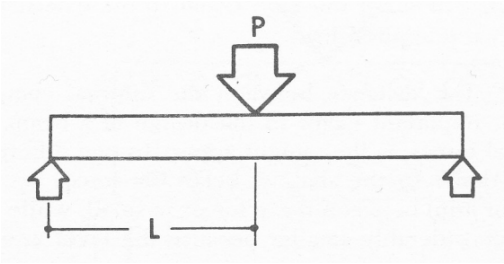
M = F x d (M:모멘트, F:힘, d:거리)



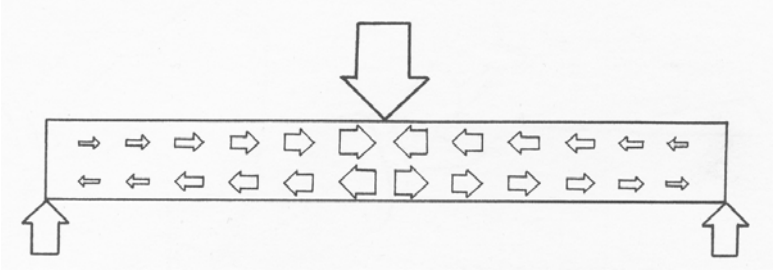
<그림 1.22> M = F x d



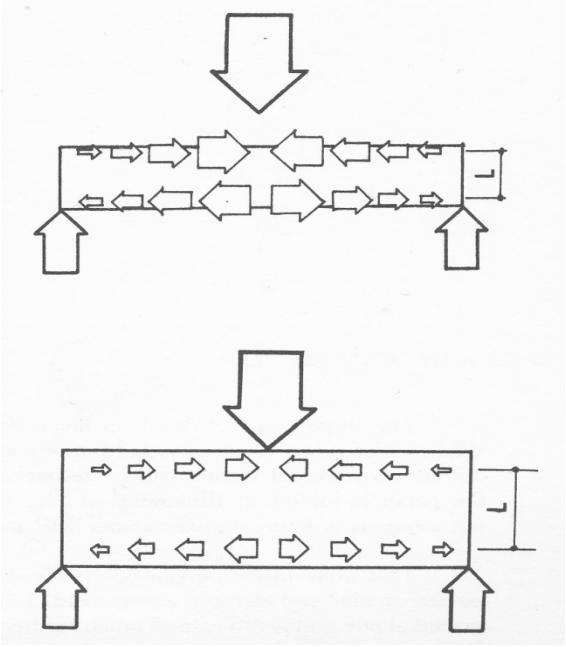
<그림 1.23> 신체로 느끼는 모멘트의 크기



<그림 1.24> 빔에서의 모멘트



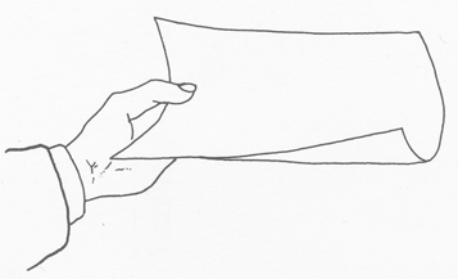
<그림 1.25> 빔 안에서 작용하는 힘



<그림 1.26> 두께가 다른 빔 안에서의 힘의 작용



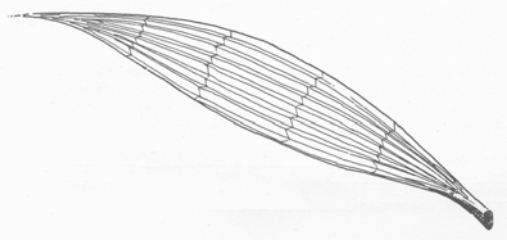
<그림 1.27> 쉽게 휘어지는 종이



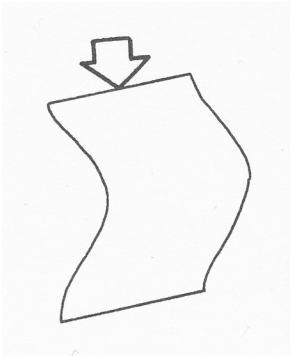
<그림 1.28> 접힌 종이



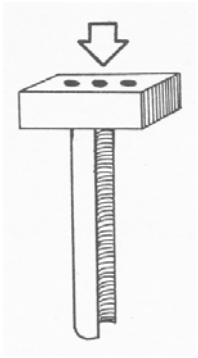
<그림 1.29> 나뭇잎



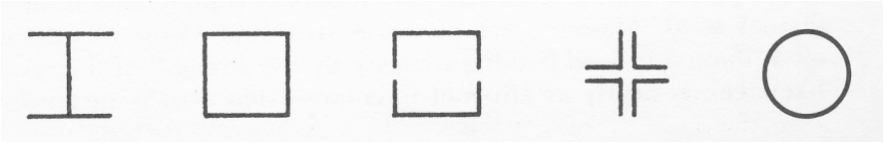
<그림 1.30> 종려나뭇잎



<그림 1.31> 종이 기둥

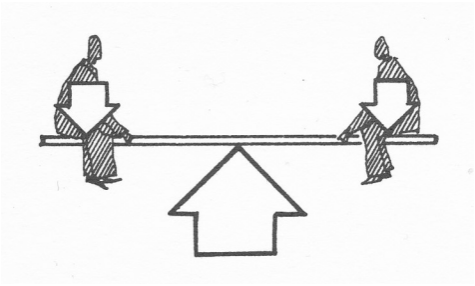


<그림 1.32> 접힌 종이 기둥

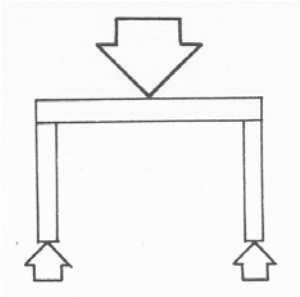


<그림 1.33> 효율적인 기둥의 단면

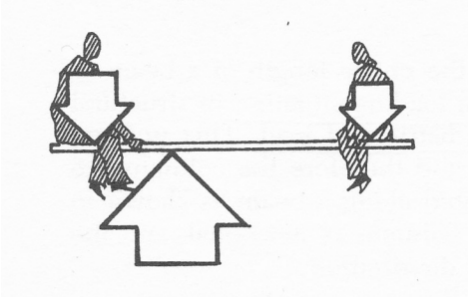
4) 힘의 균형



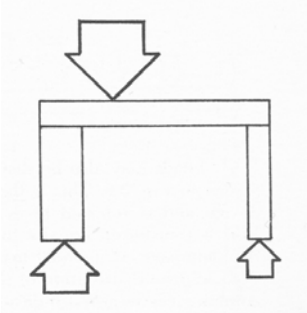
<그림 1.34> 같은 하중에 의한 평형 상태



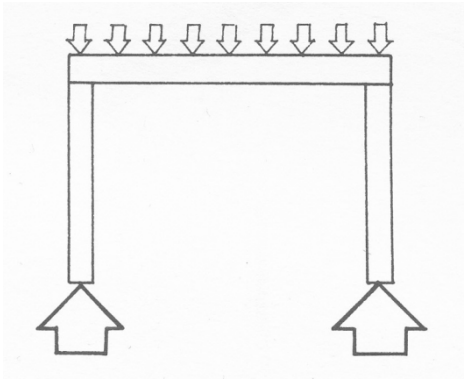
<그림 1.35> 동일한 하중을 가지는 두 기둥



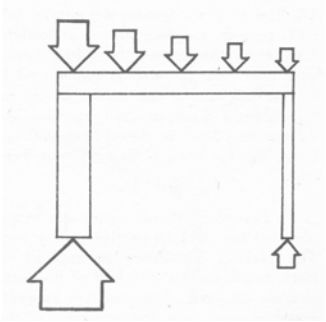
<그림 1.36> 다른 하중에 의한 평형 상태



<그림 1.37> 다른 하중을 가지는 두 기둥

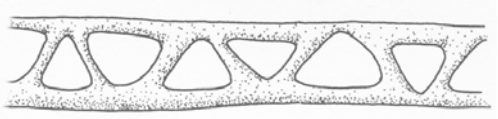


<그림 1.38> 하중이 고르게 분포된 상태

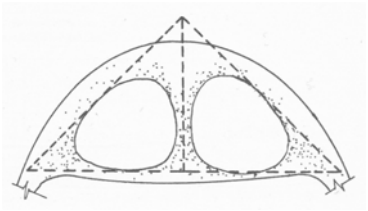


<그림 1.39> 하중이 불규칙하게 분포된 상태

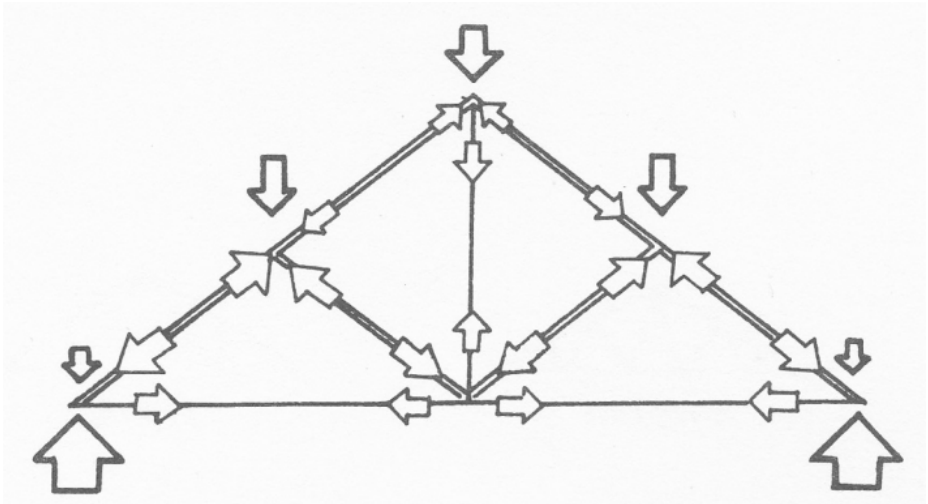
5) 트러스(truss)



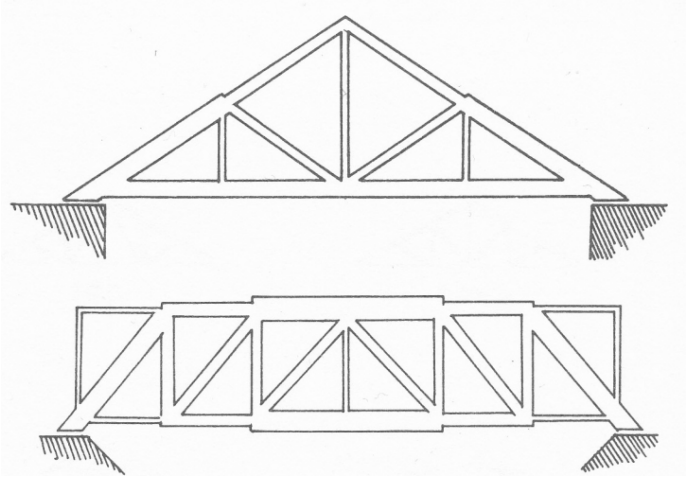
<그림 1.40> 독수리 날개의 뼈



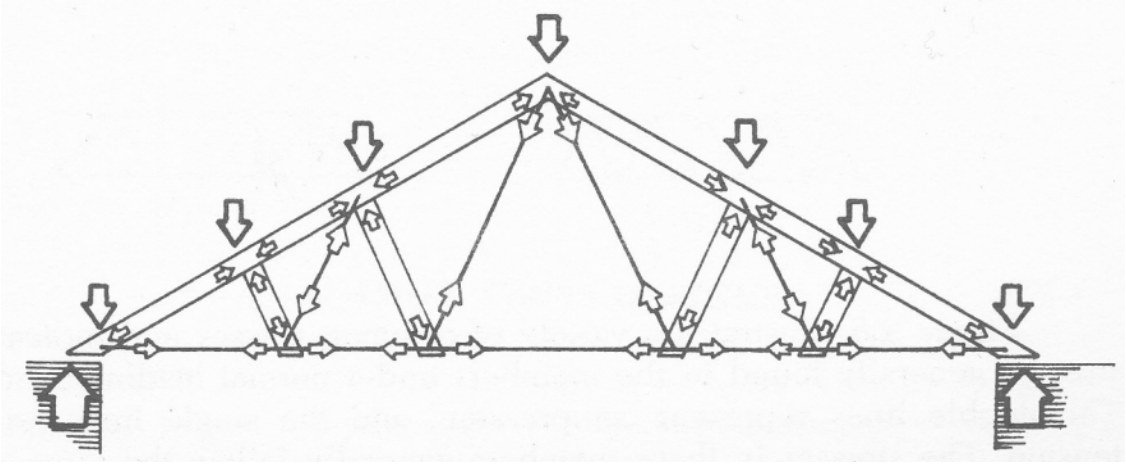
<그림 1.41> 새의 골반뼈



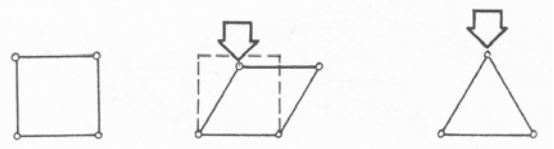
<그림 1.42> 트러스에서의 하중 분산



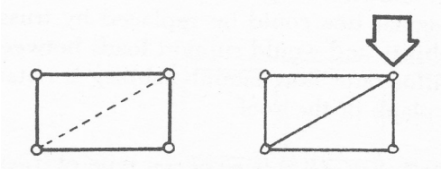
<그림 1.43> 트러스 부재의 규격 변형



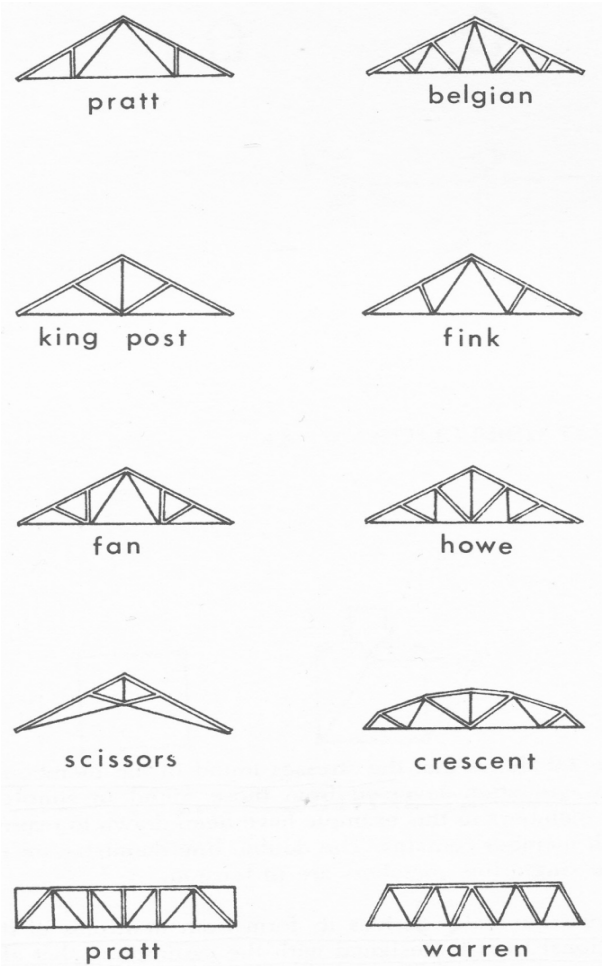
<그림 1.44> 부재에 가해지는 응력



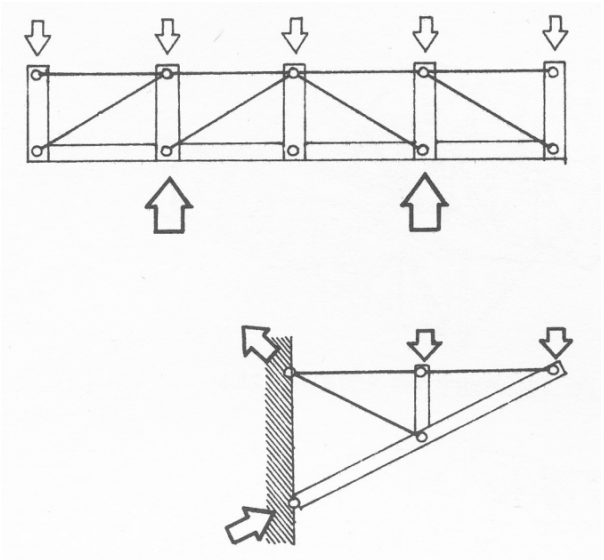
<그림 1.45> 삼각형의 안정성



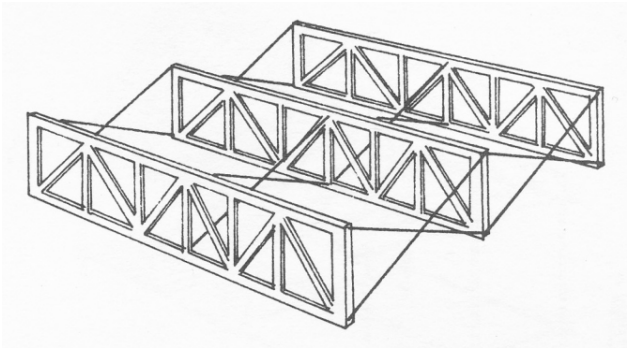
<그림 1.46> 대각선으로 고정된 사각형의 안정성



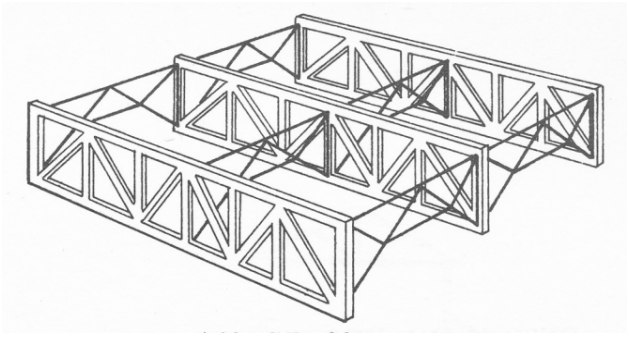
<그림 1.47> 일반적인 트러스 디자인



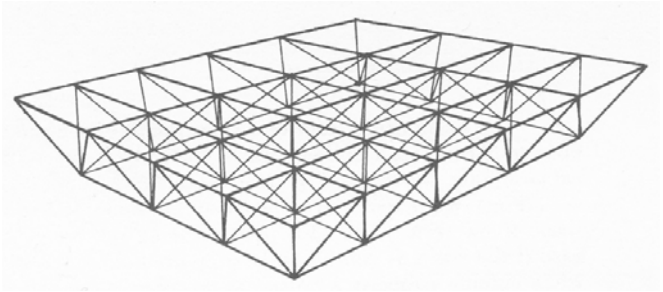
<그림 1.48> 캔틸레버 트러스



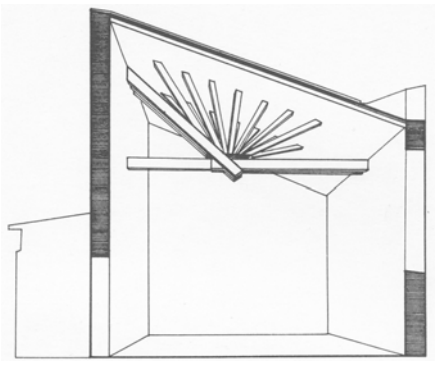
<그림 1.49> 연결된 트러스



<그림 1.50> 트러스 형태로 연결된 트러스

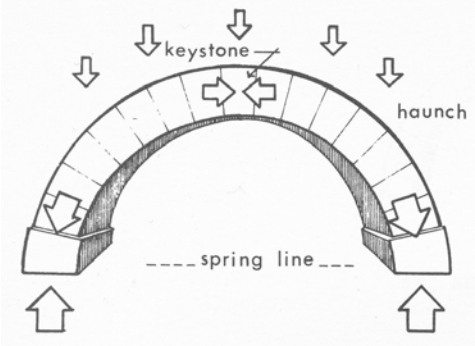


<그림 1.51> 지붕 트러스

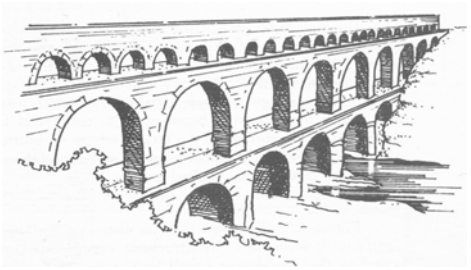


<그림 1.52> 세나자로 타운홀, 핀란드

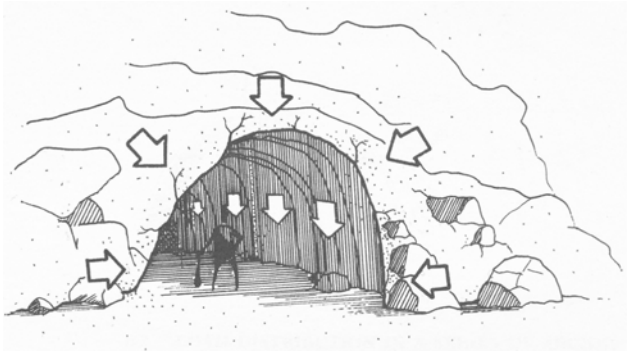
6) 여러 형태의 구조



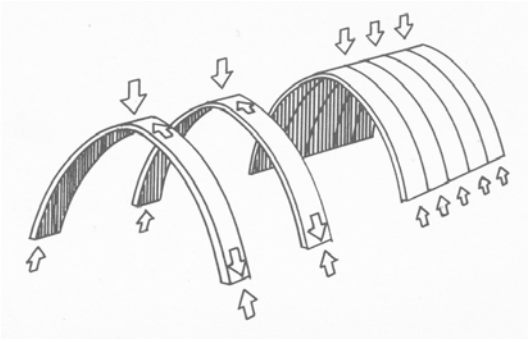
<그림 1.53> 아치(arch)의 기본형태



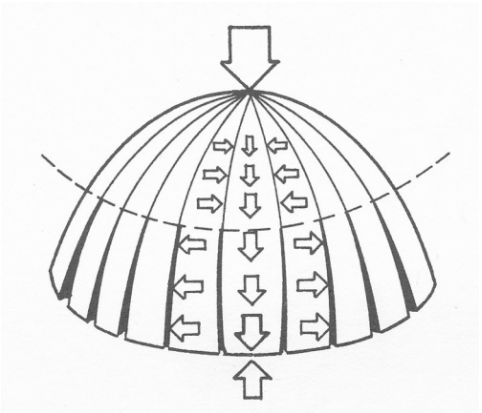
<그림 1.54> AD 150의 아치형 수로, 님스



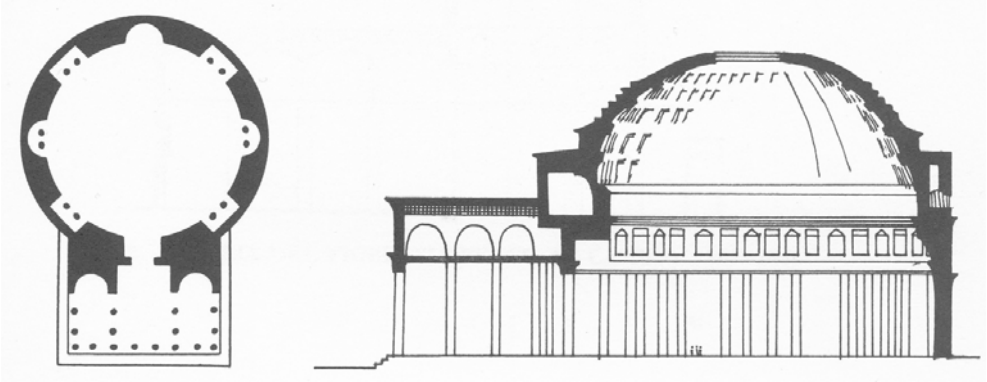
<그림 1.55> 자연 동굴



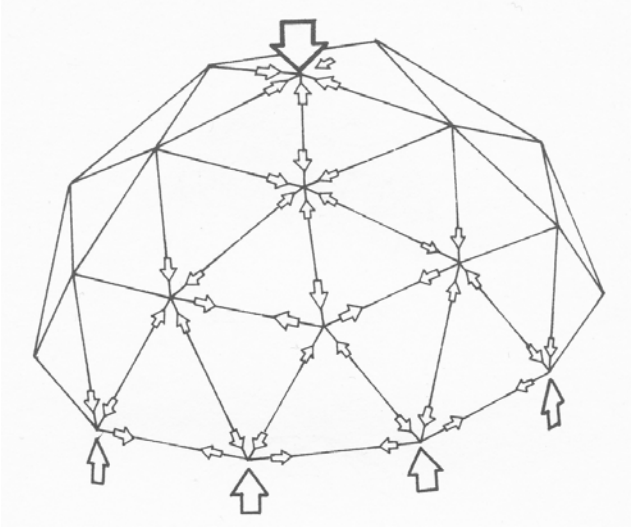
<그림 1.56> 여러 아치의 하중 분산



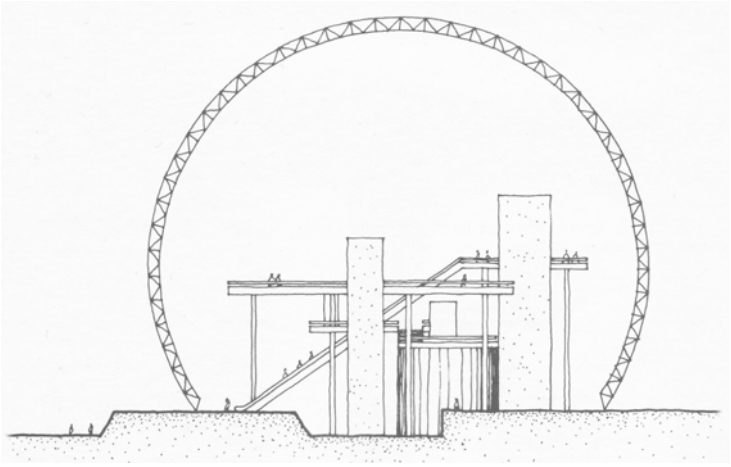
<그림 1.57> 돔(dome) 구조의 하중 분산



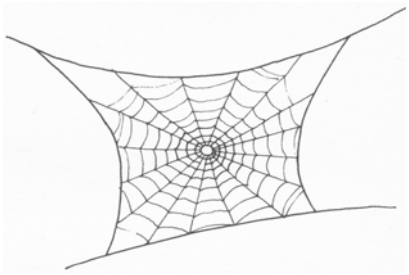
<그림 1.58> 판테온 신전, 로마, AD 120~124



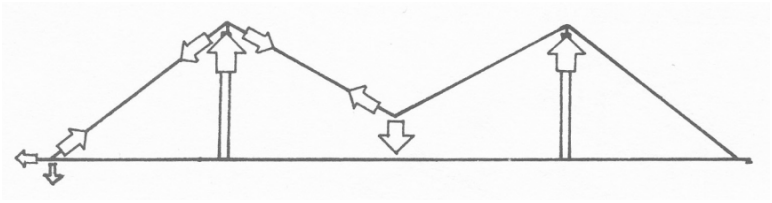
<그림 1.59> geodesic 구조에서의 하중 분산



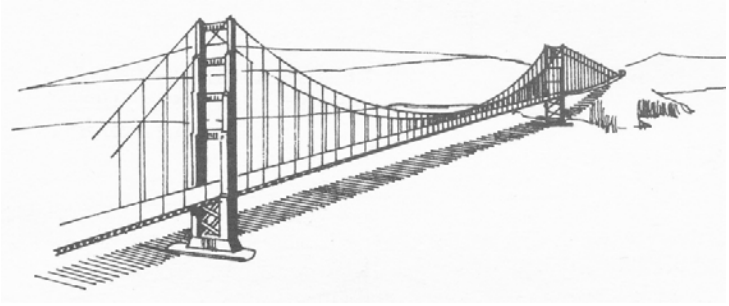
<그림 1.60> 몬트리얼 엑스포, 미국관, 1967



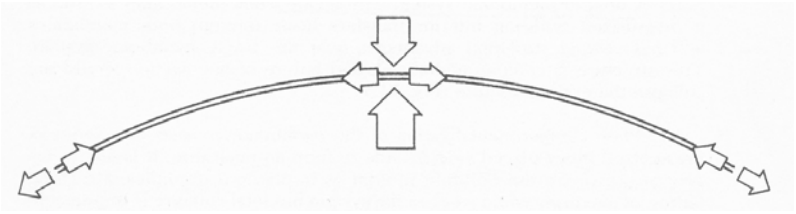
<그림 1.61> 서스펜션 구조의 거미줄



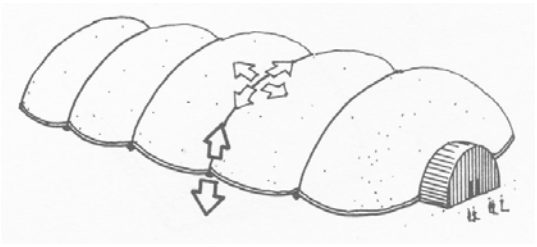
<그림 1.62> 서스펜션 케이블 슬로프



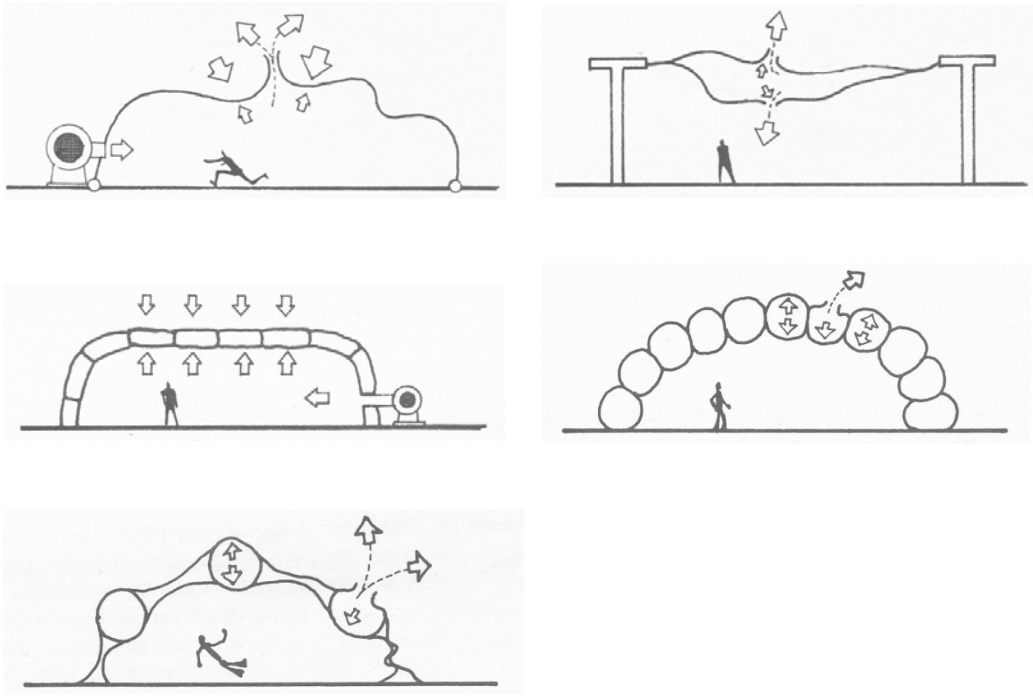
<그림 1.63> 금문교, 샌프란시스코, 1937



<그림 1.64> 공기압으로 하중 분산



<그림 1.65> 케이블로 보강한 풍선 텐트



<그림 1.66> 풍선 텐트의 여러 형태

장치매달기

장치매달기

제 3 장 장치 매달기

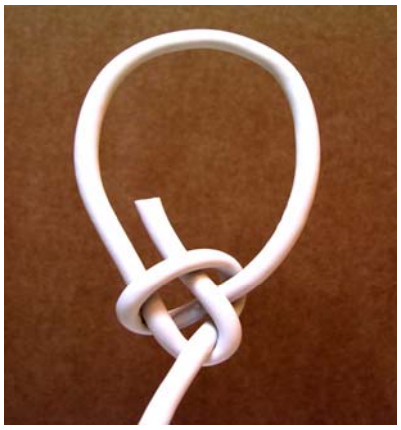
제1절 매듭
제2절 평판 달기
제3절 입체장치 달기

제1절 매듭

1. 매듭

*매듭의 효율성 <Stage Rigging Handbook>

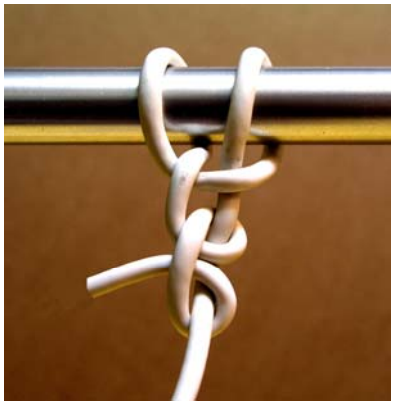
고리매듭(Bowline)	60%
감은 두매듭(Clove hitch with 2 half hitches)	65%
8자매듭(Figure-8)	64%
맞매듭(Square knot)	43%



<그림 1.1> 고리매듭



<그림 1.2> 고리매듭(고리가 조여지는 매듭)



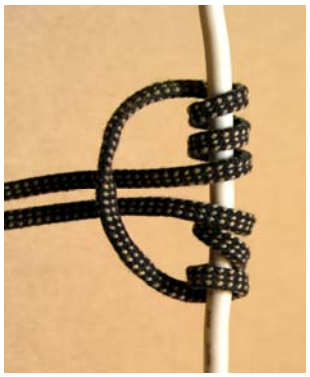
<그림 1.3> 감은 두매듭



<그림 1.4> 맞매듭



<그림 1.5> 8자매듭



<그림 1.6> 옆당김매듭

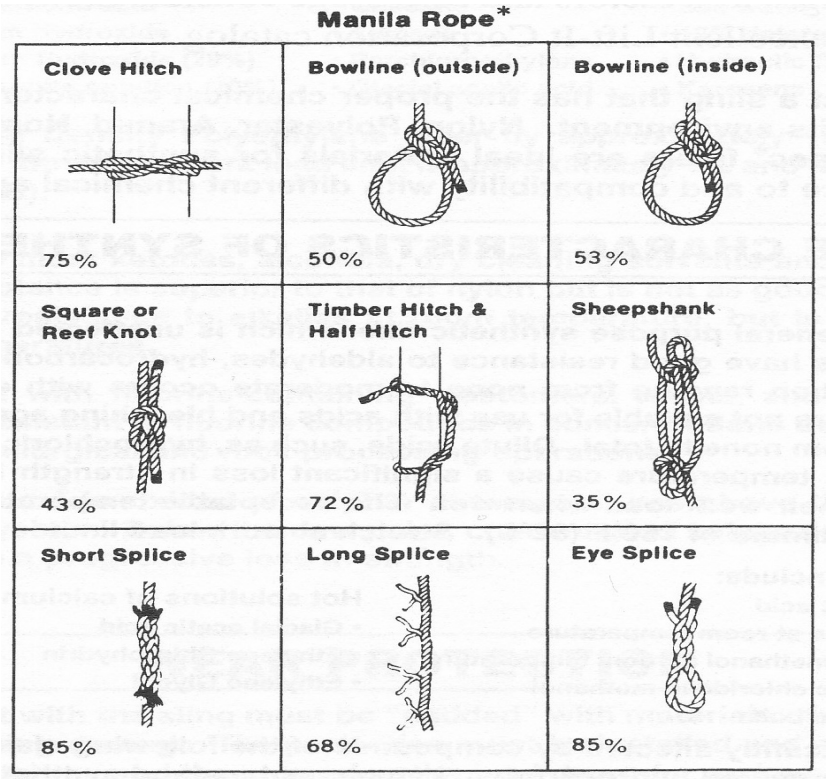


<그림 1.7> 멈춤매듭(1)

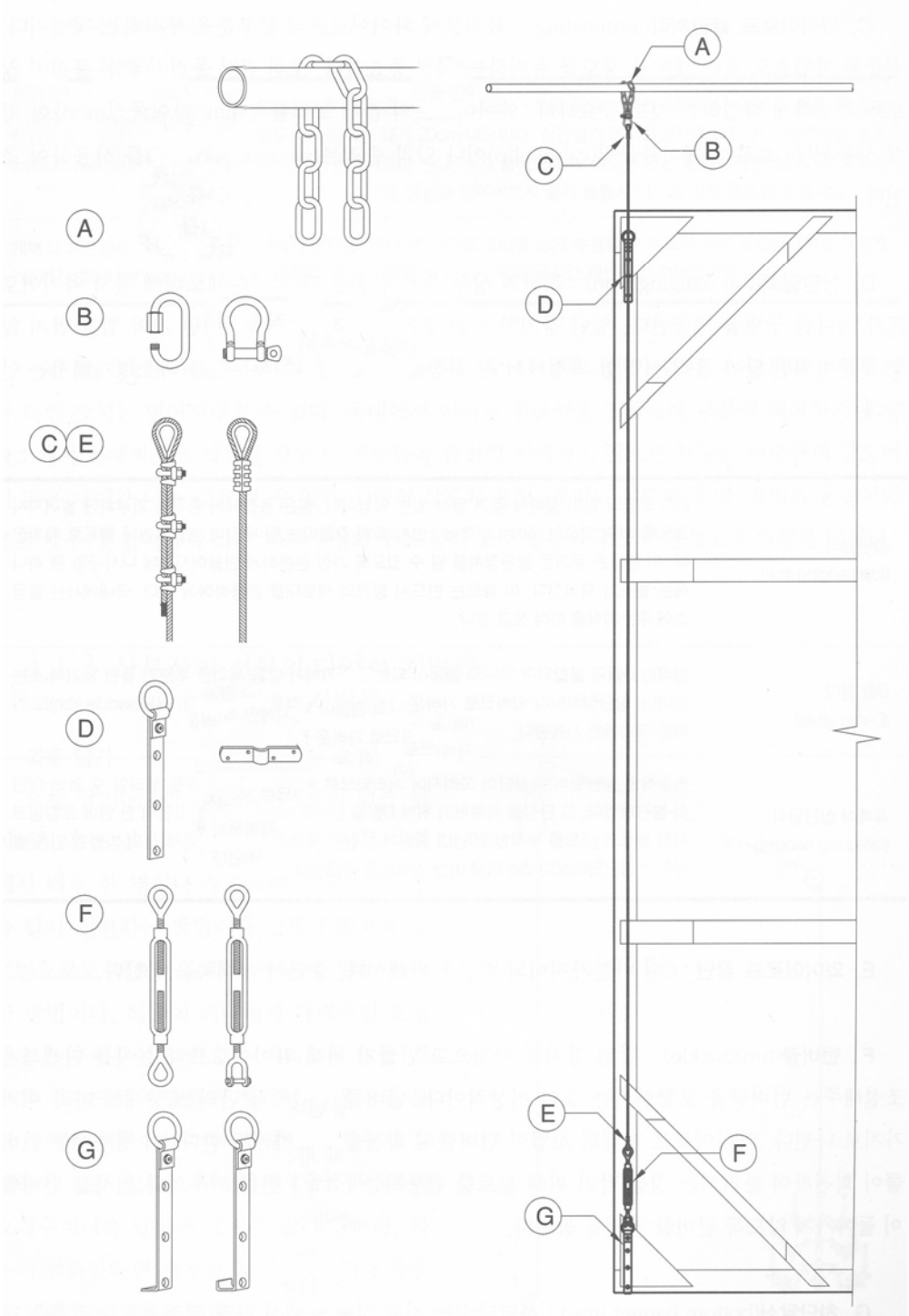


<그림 1.8> 멈춤매듭(2)

<Newberry's Handbook for Riggers>



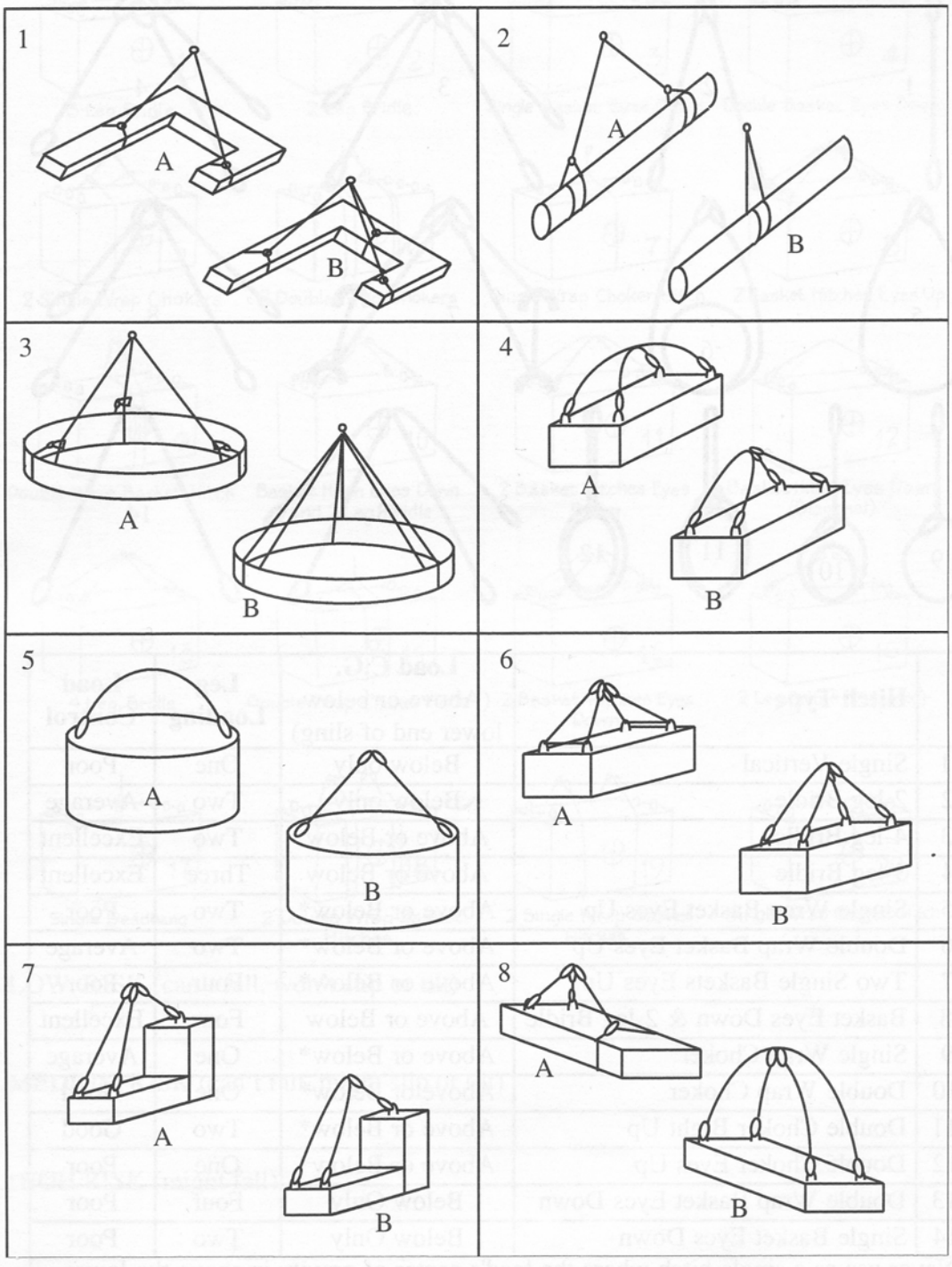
제2절 평판 달기

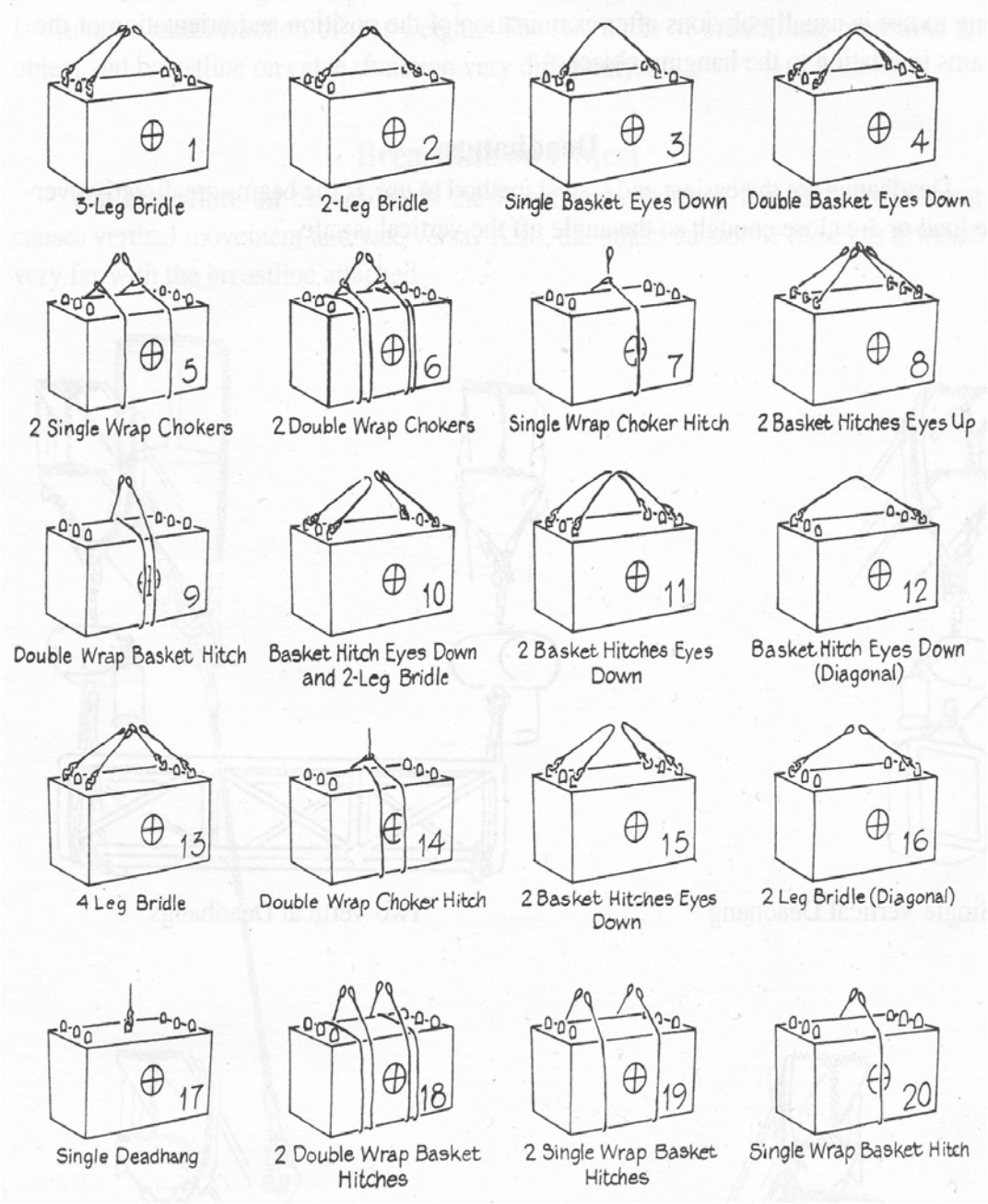


<그림 2.1> 평판 달기

제3절 입체장치 달기

예제) 아래 그림에서 A, B 중 어떤 방법이 더 안전한가?



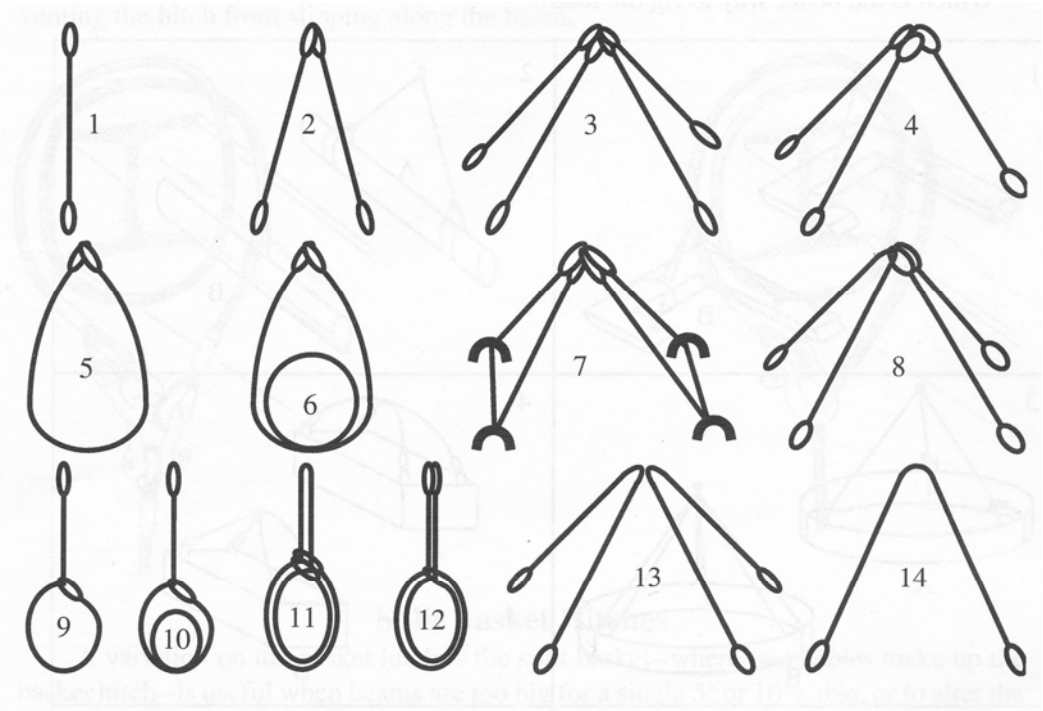


예제) 위의 그림들을 아래의 기준에 따라 분류하시오.

Low Risk(떨어지지 않고, 안정된 형태)

Medium Risk(떨어지지는 않으나, 기울거나 줄이 한쪽으로 쏠릴 수 있음)

High Risk(낙하 위험)



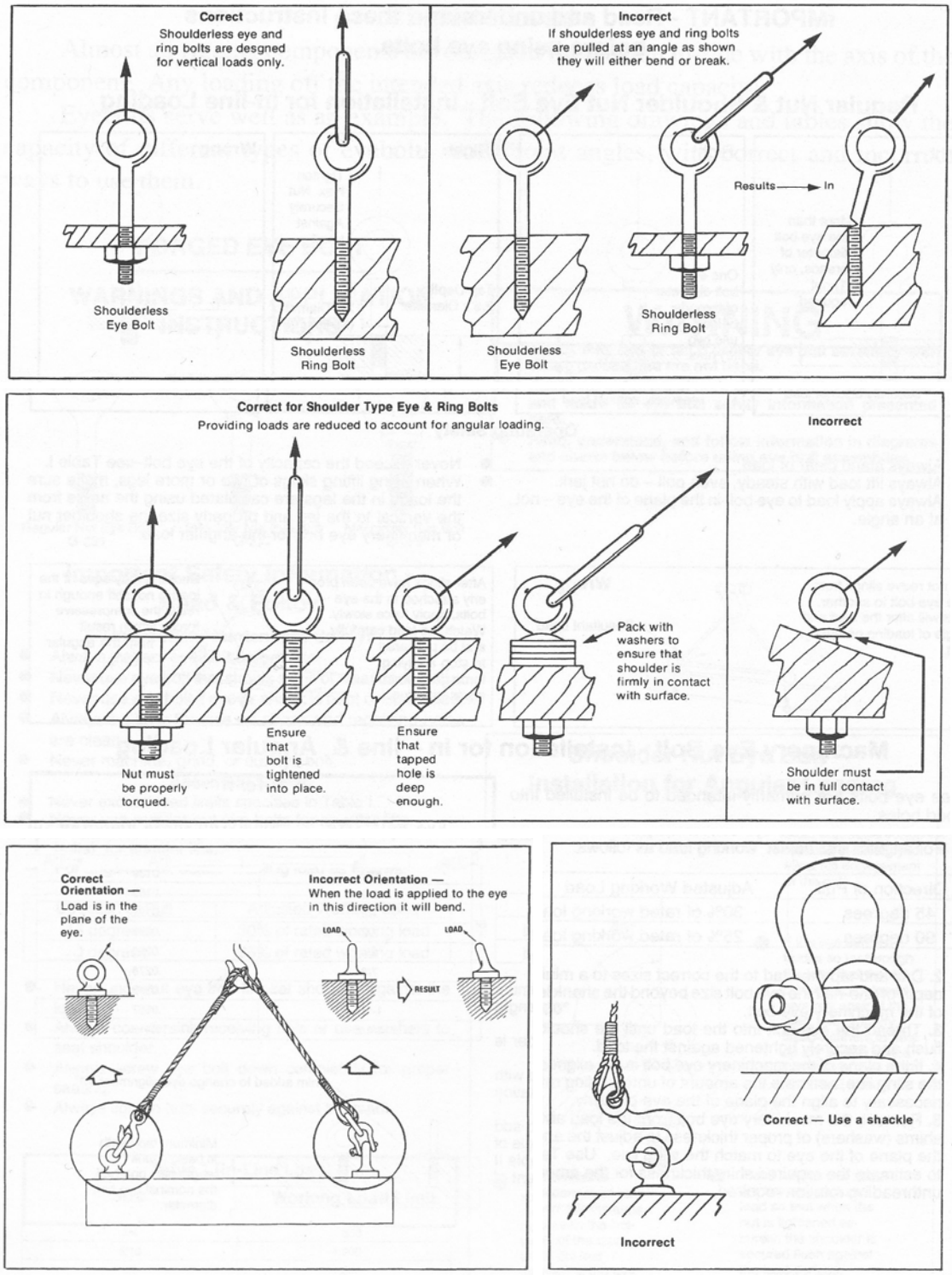
	Hitch Type	Load C.G. (Above or below lower end of sling)	Leg Loading	Load Control
1	Single Vertical	Below only	One	Poor
2	2-leg Bridle	Below only	Two	Average
3	4-leg Bridle	Above or Below	Two	Excellent
4	3-leg Bridle	Above or Below	Three	Excellent
5	Single Wrap Basket Eyes Up	Above or Below*	Two	Poor
6	Double Wrap Basket Eyes Up	Above or Below*	Two	Average
7	Two Single Baskets Eyes Up	Above or Below*	Four	Poor
8	Basket Eyes Down & 2-leg Bridle	Above or Below	Four	Excellent
9	Single Wrap Choker	Above or Below*	One	Average
10	Double Wrap Choker	Above or Below*	One	Good
11	Double Choker Bight Up	Above or Below*	Two	Good
12	Double Choker Eyes Up	Above or Below*	One	Poor
13	Double Wrap Basket Eyes Down	Below Only	Four	Poor
14	Single Basket Eyes Down	Below Only	Two	Poor

*Never use as a single hitch where the load's center of gravity is above the lower end of the sling. Reprinted courtesy of Wire Rope & Rigging Consultants

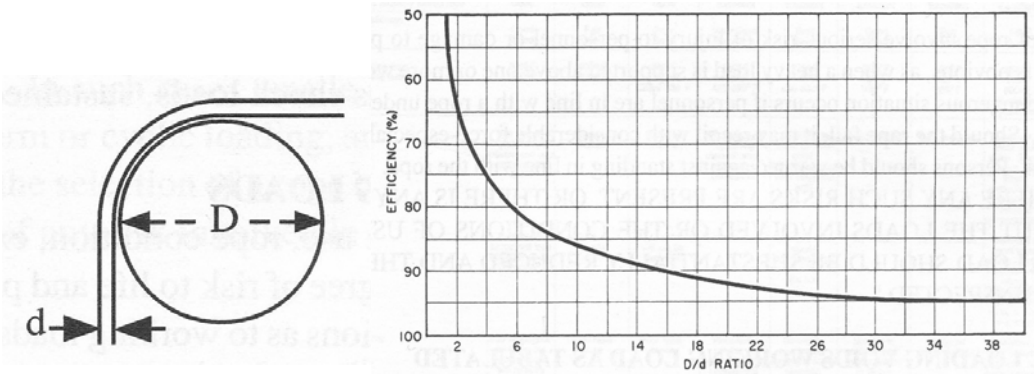
주어진 상황에서 작업자는 어떤 매달기 방식이 최선인지 검토한다.

(안정성, 매다는 포인트의 수, 줄의 인장력, 무게중심, 위험요소. 등등)

1. 장치 매달기 자재 사용

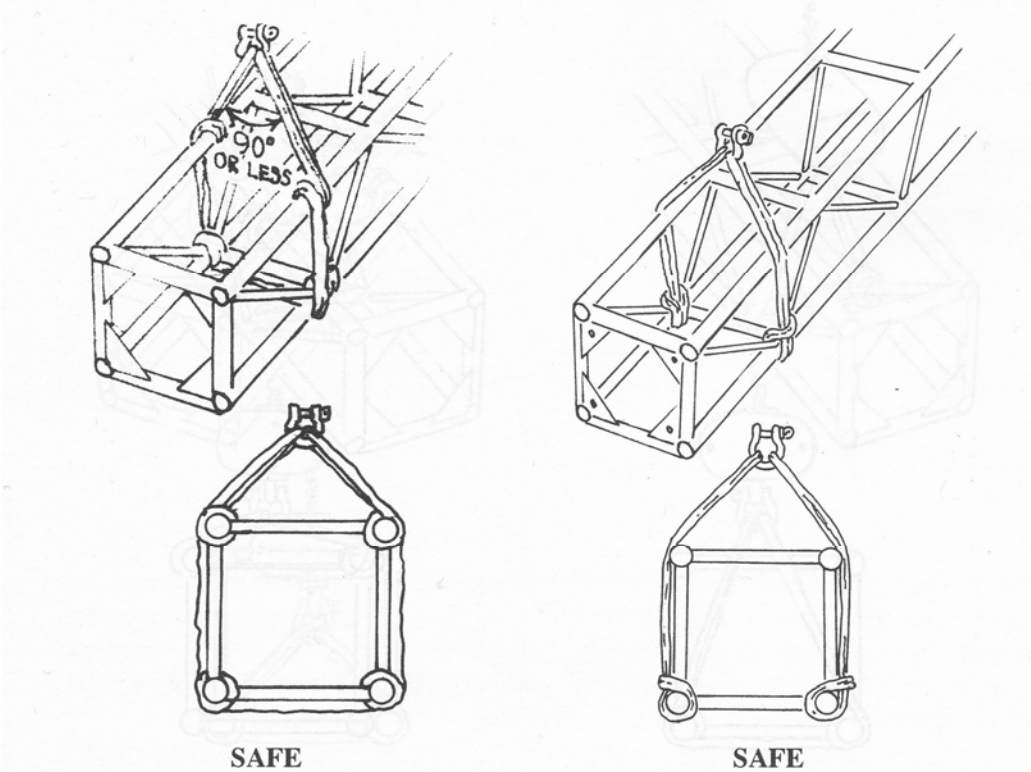


<그림 3.1> 아이볼트 올바른 사용



<그림 3.2> D/d Ratio에 따른 와이어로프의 효율성(d: 와이어로프의 지름, D:도르레의 직경)

2. 트러스 달기

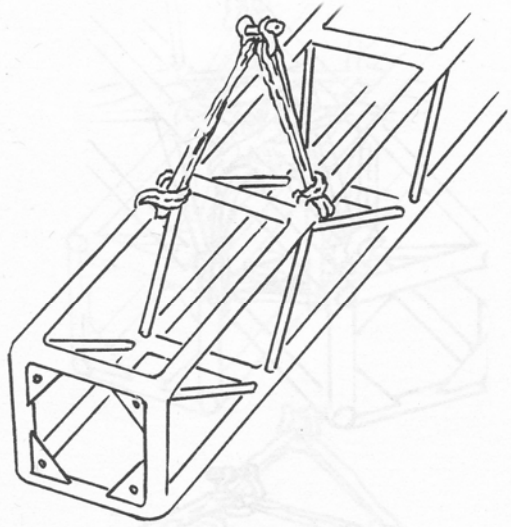


SAFE

The roundsling baskets the entire truss and is double-wrapped on the lower chords at a panel point with a cross-member. There is no reaon to double-wrap the upper chords except to reduce headroom.

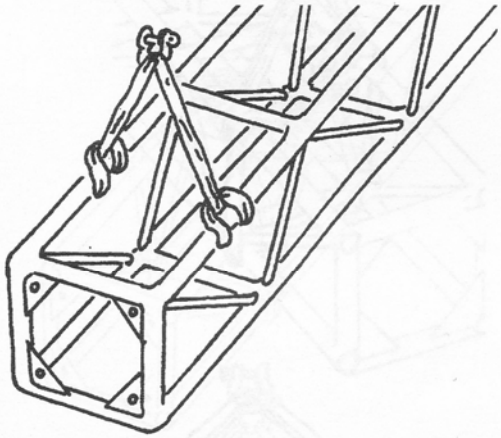
SAFE

Two separate roundslings choker-hitch the lower chords at a panel point. Since there is no force pulling the lower chords together, no cross-member is required. If the truss weight is unbalanced and needs to be kept level, shackles can be added at the top of one roundsling until the top shackle is vertically above the center of gravity.



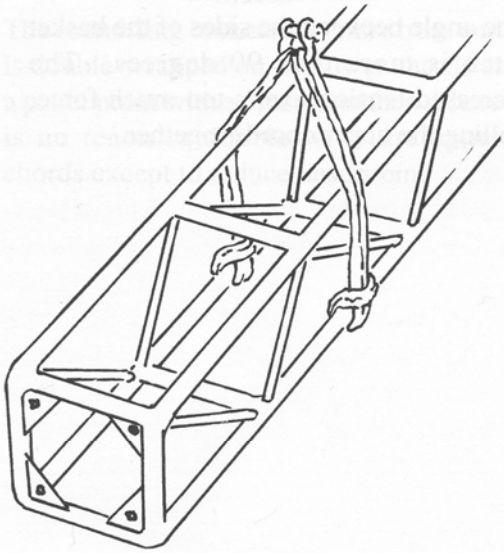
DANGEROUS

The truss is supported at the upper chords. If the welds on the diagonals or verticals are weak or cracked, which is common with aluminum welds, these defects will act to separate the welds.



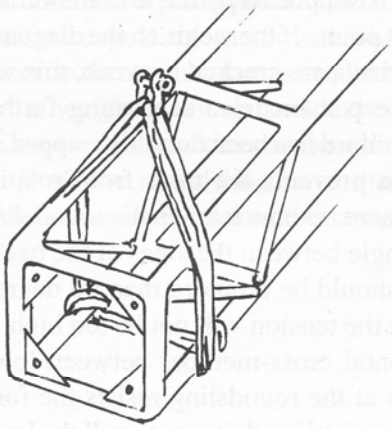
DANGEROUS

The truss is supported by upper chords and between panel points, which puts bending force on the chords. Truss members are much stronger in tension or compression than in bending.



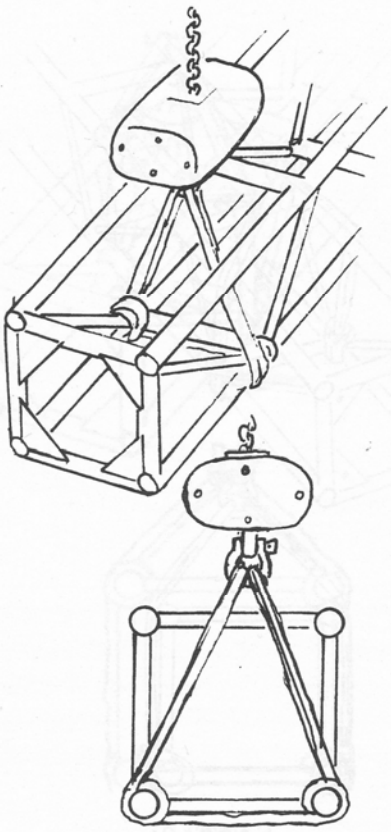
DANGEROUS

The roundslings are not connected at a panel point, which puts bending force on the lower chords. This arrangement will bend the lower chords up.



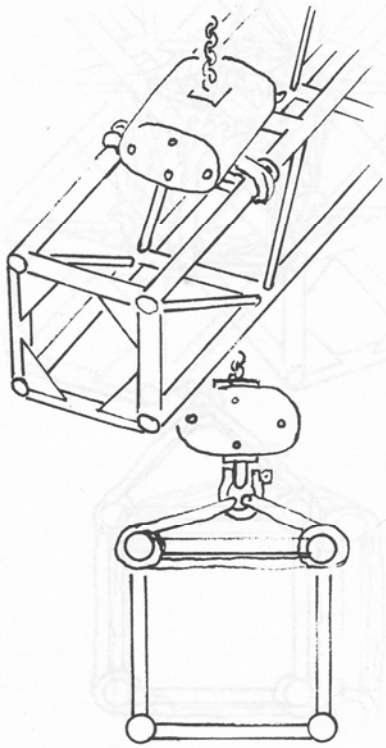
DANGEROUS

The roundsling is not connected at a panel point, and there is no cross-member between lower chords. This arrangement will bend the lower chords together and up.



SAFE

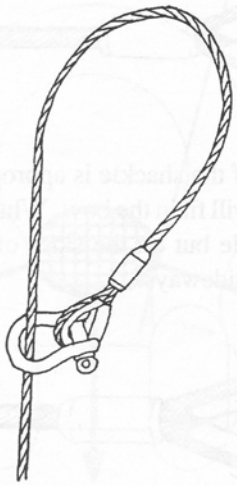
The roundsling is connected at a safe place on the lower chord at a panel point with a cross-member. It is short to reduce headroom. The truss will have slightly less stability than normal, allowing it to rotate more easily, but this is usually not a problem unless the truss weight is very unbalanced.



DANGEROUS

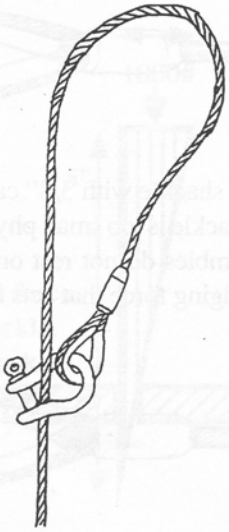
This has been done to get more truss height and is unsafe in every way. The basket hitch angle is too wide, and the connection is on the upper chord, not at a panel point. This would bend the upper chords together, perhaps permanently.

3. 달기의 기본 원칙



SAFE

Riggers may use the "old-style" choker hitch if there is concern that the shackle pin may turn when the choker tightens as the load is applied. Assembly is more difficult, because the rigger must hold three things in two hands—the shackle bow and pin and the cable eye.



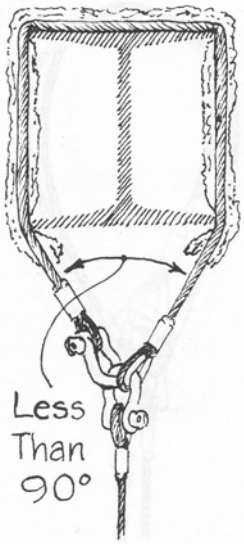
SAFE

The "new-style" choker hitch is easier to handle, faster, and results in fewer dropped shackles. The rigger has to handle only two things, the shackle bow and pin, since the cable eye is captive on the shackle bow. Some say that this arrangement will cause the shackle pin to unscrew when the choker tightens and the cable slides past the pin, but that is not likely. When the choker tightens under load, there is very little cable movement— less than 1/2", and usually less than 1/4". Also, there is very little friction between a lubricated steel cable and a round steel pin, so there is little torque on the pin. Observations of more than 10,000 choker hitches like this showed no sign of any pin even starting to unscrew. Though this setup does not hold the shackle in the right position automatically, the rigger can arrange it correctly as he assembles it, and it should not move after that.



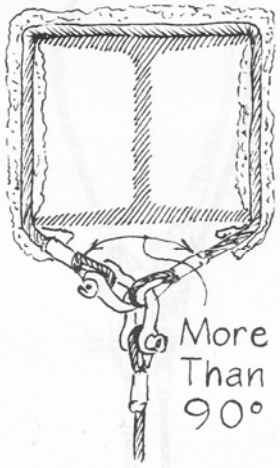
DANGEROUS

Causes side load on the shackle.



SAFE

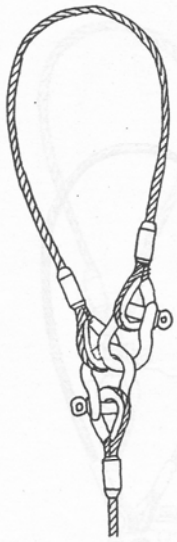
The angle between the sides of a basket hitch should be no more than 90 degrees in order to prevent excessive tension on the sling.



DANGEROUS

The wide angle between the sides of this basket hitch will cause too much tension.

Basket Hitches



SAFE

The "old-style" basket hitch is most common, but slower and more difficult than the alternative. The rigger must simultaneously handle three things, the free shackle pin and bow, and the cable eye.



DANGEROUS

Pin on free shackle not screwed in.



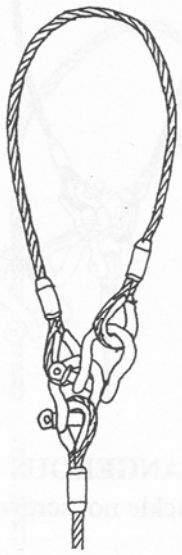
SAFE

The "new-style" basket hitch is easier to connect and causes fewer dropped shackles, because the rigger handles only two things simultaneously, the pin and bow. Ground work is simplified since this setup (with the free shackle on the end of the wrap cable) can be used for both basket and choker hitches.



HARD TO HANDLE

This reduces material cost, but is practical only on permanent installations where dropped parts and increased labor cost do not matter.



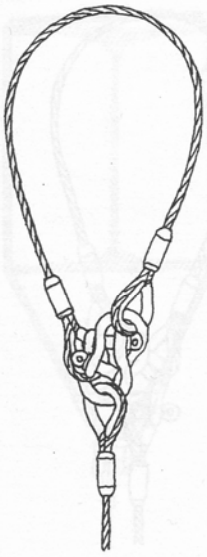
DANGEROUS

Pin on free shackle not screwed in.



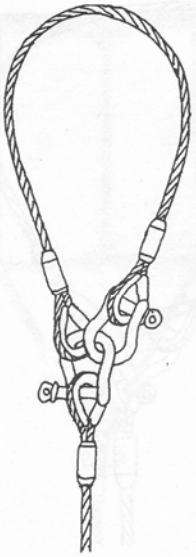
DANGEROUS

Shackle is being pulled apart sideways.



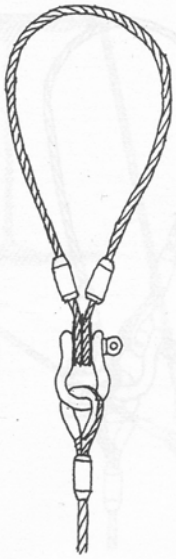
DANGEROUS

The main basket shackle is upside down. Shackle is being wedged apart sideways at the pin end, where it is weakest.



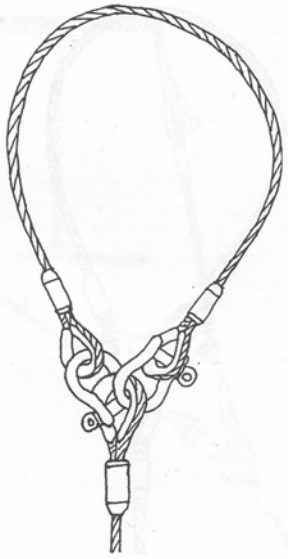
DANGEROUS

Shackle pin on main basket shackle not screwed in.



DANGEROUS

Shackle is being pulled apart sideways at the pin, and the cables are bent close to the swage.



DANGEROUS

Two fittings on one cable eye. Swage can split apart sideways.



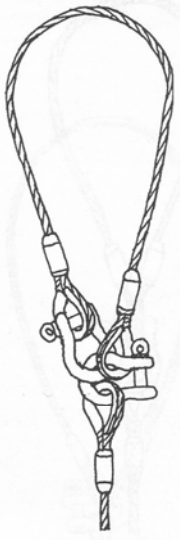
DANGEROUS
Two fittings on one cable eye. Swage can split apart sideways.



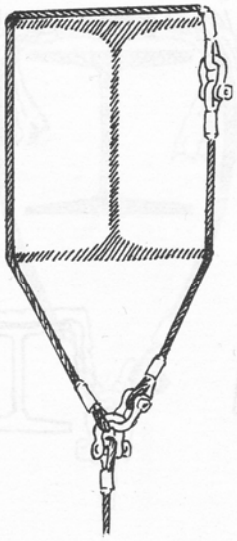
DANGEROUS
Free shackle is being pulled apart sideways.



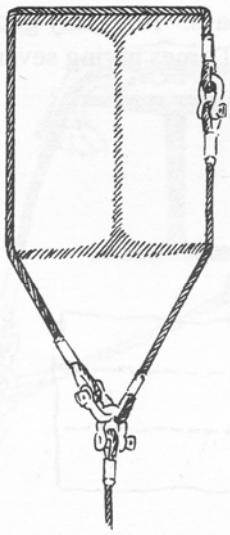
DANGEROUS
The main basket shackle is upside down, so it is being wedged apart sideways at the pin end, the worst place.



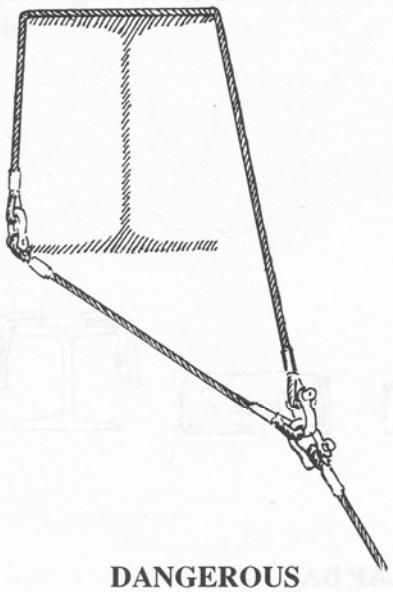
DANGEROUS
Basket shackle is being pulled apart sideways.



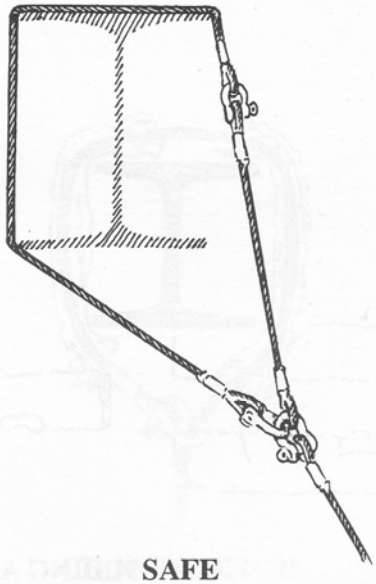
DANGEROUS
Bending force on the cable swage.



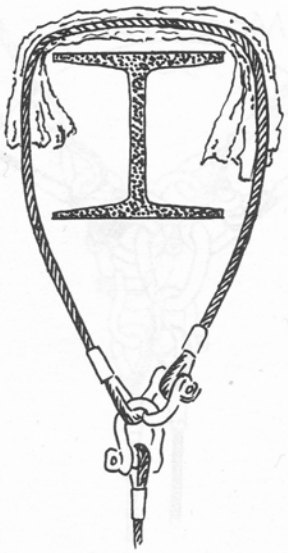
DANGEROUS
Cable is bent too close to the swage. It is best to keep cable bends 1-2 lay lengths away from swages. (A lay length is the distance along the cable it takes for one strand to spiral completely around the cable.)



DANGEROUS
Bending force on the shackle.

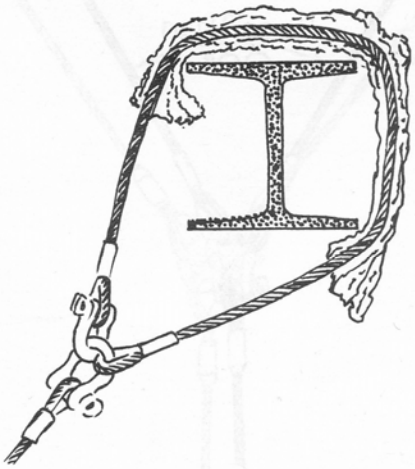


SAFE
By reversing the cables shown in the drawing on the left, the shackle and swage can be moved away from a corner.



VERTICAL DEADHANG

For a basket hitch on a vertical cable, bagging the two upper corners is usually adequate. There is usually very little pressure on the two lower corners of the beam, so they will not damage the wire rope, given a reasonably narrow angle between the sides of the basket hitch.



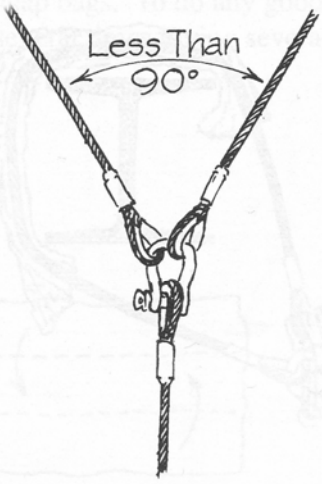
BRIDLE LEG OR ANGLED DEADHANG

For a basket hitch on a sloped cable (which might be a bridle leg or an angled deadhang), heavy pressure on three beam corners requires that all three be bagged.



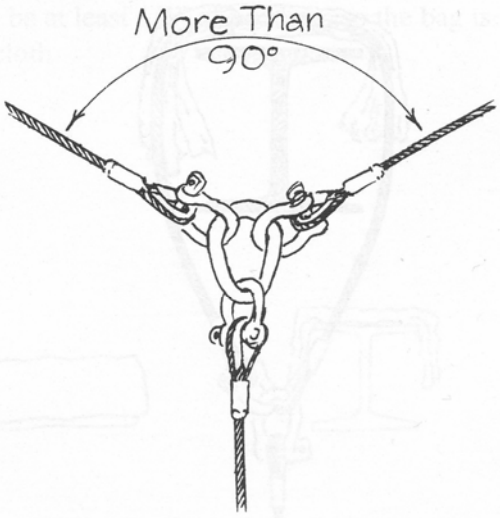
CHOKER HITCH

Choker hitches put heavy pressure on all corners of a beam, so all corners must be bagged.



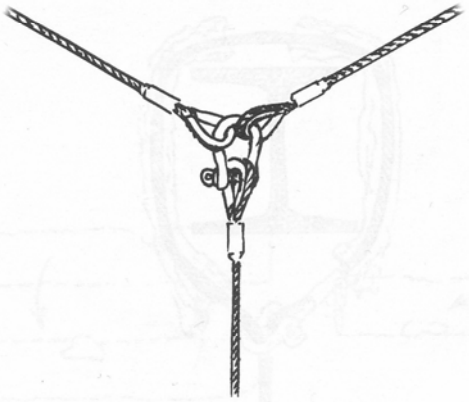
SAFE

A single screw-pin anchor shackle at the bridle junction is standard when the angle between bridle legs is 90° or less.



SAFE

When there is more than 90° between legs a ring of some kind must be placed at the junction. The shackles will not rotate if they are oversize and arranged this way.



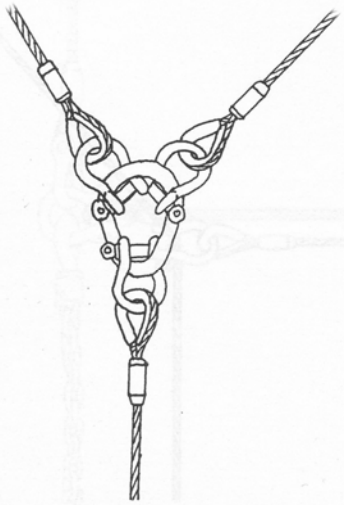
DANGEROUS

When the angle between bridle legs is more than 90° there is too much side load for a single shackle.



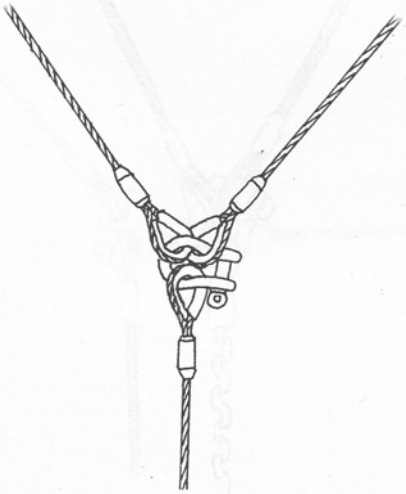
SAFE BUT DUMB

Use a single shackle when the angle between legs is 90° or less. This arrangement uses more parts than necessary, takes more time, and provides more opportunity for mistakes.



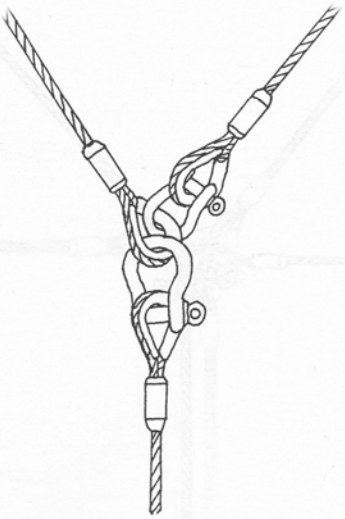
DANGEROUS

The shackles can rotate and get loaded sideways. Shackle pins can unscrew if bridle legs are pulled up unevenly, which is normal, since riggers pull ropes in arms-length surges.



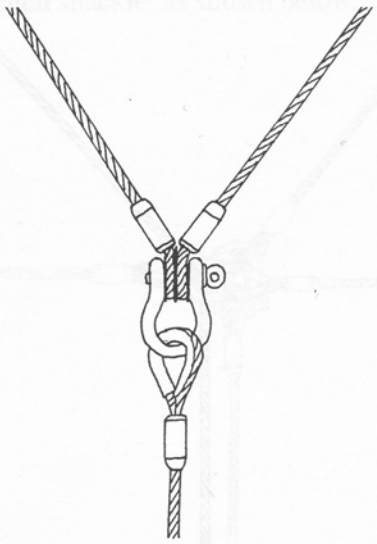
DANGEROUS

The shackle is being pulled apart sideways.



DANGEROUS

Two fittings on one cable eye. Cable swage can be split sideways.

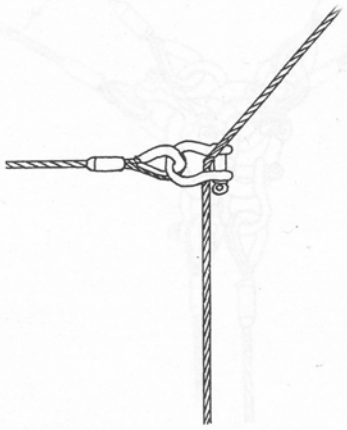


DANGEROUS

The shackle is being pulled apart sideways, and cables are being bent close to the swage.

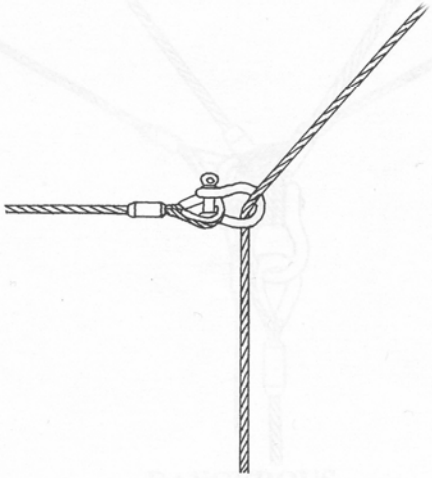


DANGEROUS
Shackle is being pulled apart sideways.

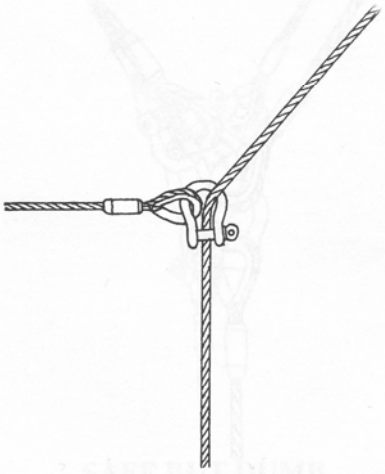


DANGEROUS
The shackle pin can unscrew itself as it slides up or down the main cable.

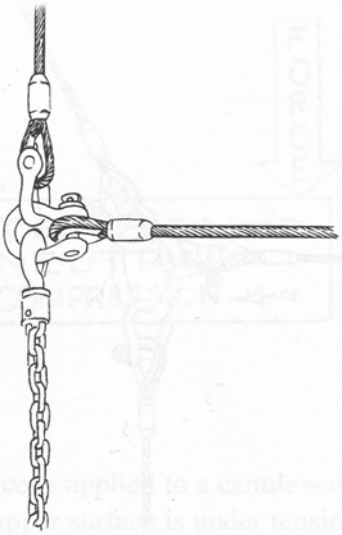
Sliding Breastlines



SAFE
The breastline can safely slide up or down the main cable. If the shackle is large enough, it will not rotate and get turned sideways.

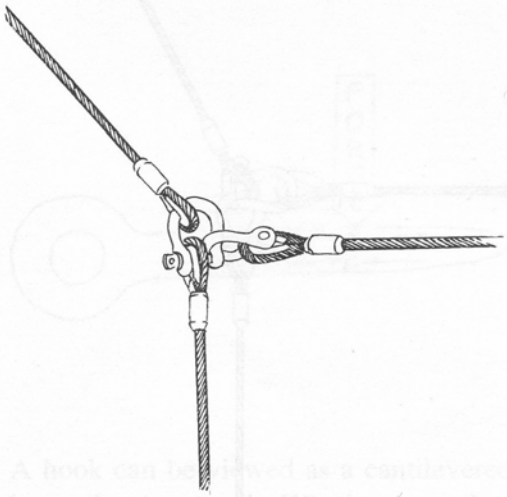


DANGEROUS
The shackle can rotate so its pin contacts the vertical cable. The pin can unscrew itself if it slides far enough along the vertical cable.



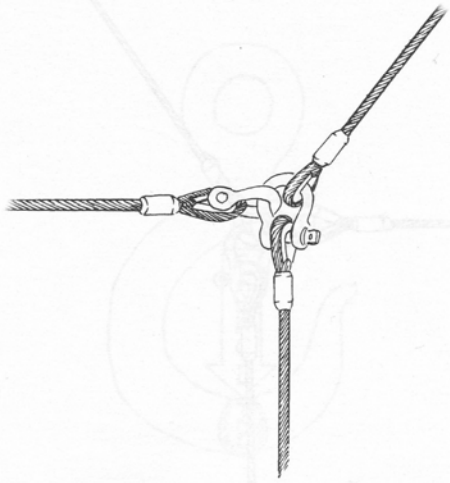
DANGEROUS

A shackle under the high load is being pulled apart sideways.

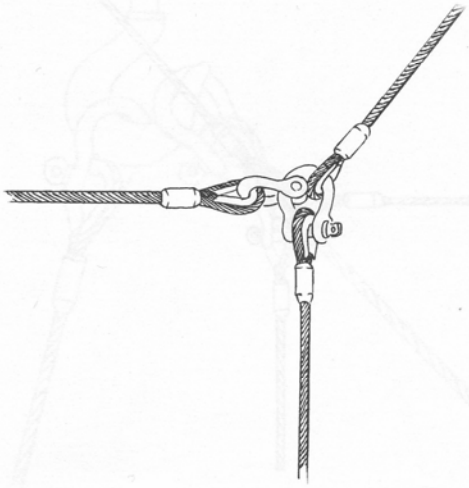


DANGEROUS

It's hard to see, but the breastline shackle is jammed under the cable eye at lower end of main shackle. The main shackle is being wedged apart sideways. There should be a visible air gap below the horizontal shackle, as shown below.

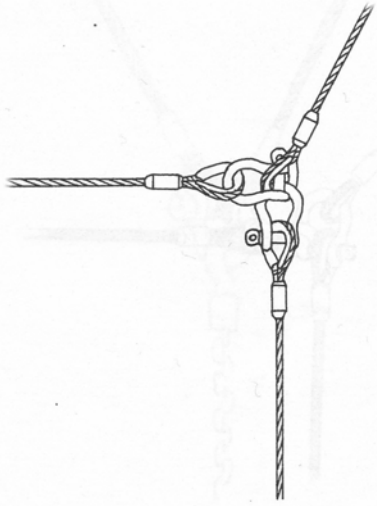


SAFE



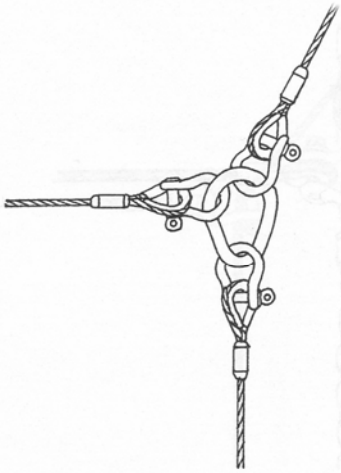
SAFE

These set-ups are safe if the breastline tension is less than 50% of the rated capacity of the shackle, and a screw pin anchor shackle or nut-and-bolt shackle is used. The arrangement on the left is preferable— if an oversize shackle is used for the horizontal shackle, the pin is captive in the cable eye, and the shackle cannot rotate.



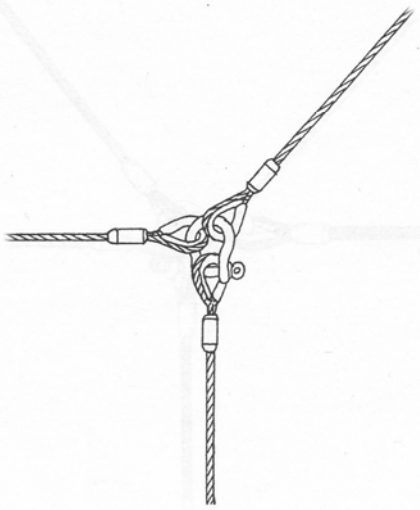
DANGEROUS

Two fittings on one cable eye. Swage is being split apart sideways.



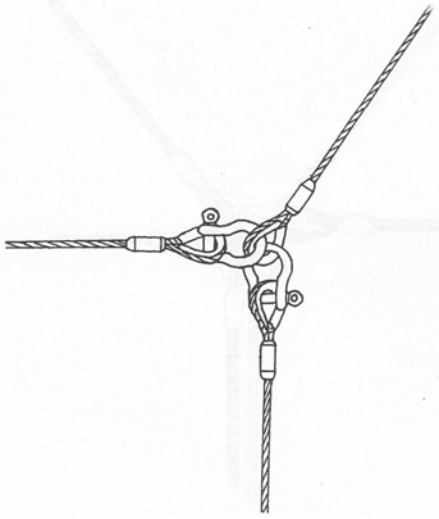
SAFE

Breastline will not slide up or down. If shackles are large enough and arranged as drawn above with their pins in the thimbles they will not rotate.



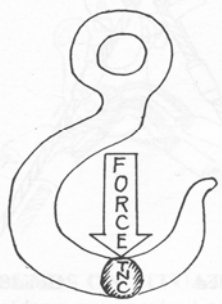
SAFE

Safe if the breastline tension is less than half the rated capacity of the shackle, and a screw-pin anchor shackle or safety shackle is used.

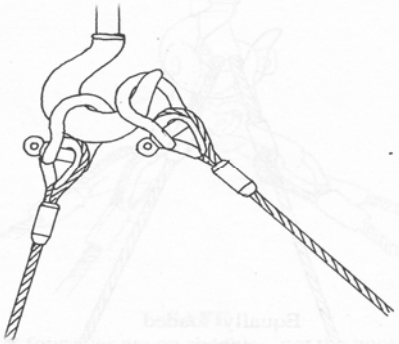


DANGEROUS

Two fittings on one cable eye. Swage is being split apart sideways.

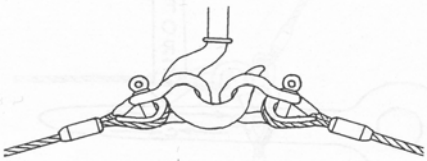


The hook's rated capacity is for loads placed at the bottom of the bowl of the hook. The load capacity is lower when fittings are located near the tip of the



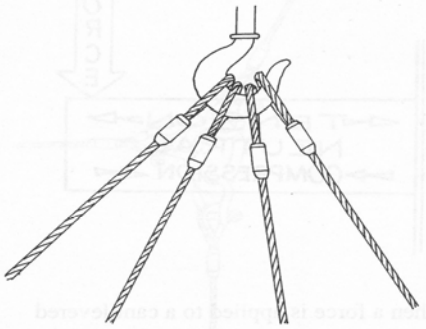
DANGEROUS

Two fittings on one hook. Strength of hook is below rated capacity when loads are placed near tip. Also, a fitting near the tip can slip out of the hook.



DANGEROUS

Two fittings on one hook. Because of wide angle between cables, one cable is near tip. Load capacity is lowered, and cable can slip out.

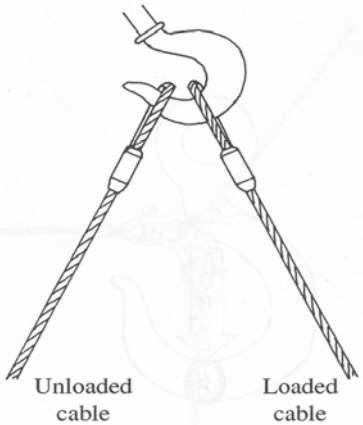


DANGEROUS

Four cables on one hook. Strength of hook is below rated capacity when loads are placed near tip. Cables near tip can slip out of hook.



Equally loaded cables

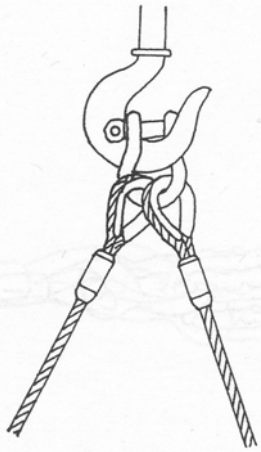


Unloaded cable

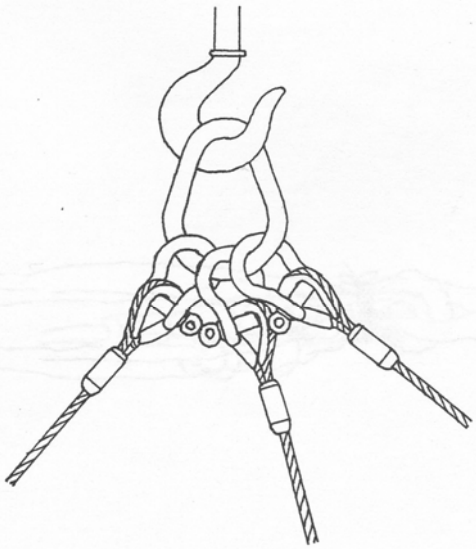
Loaded cable

DANGEROUS

If two equally loaded cables are placed on one hook, they will look like the drawing on the left. If one cable is unloaded, as in the drawing on the right, the hook will align itself with the loaded cable. If the loaded cable is at the back of the hook, when the unloaded cable is next put under tension it will be very near the hook tip and may slip out.



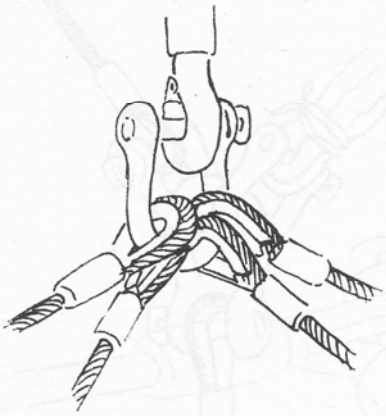
SAFE



SAFE

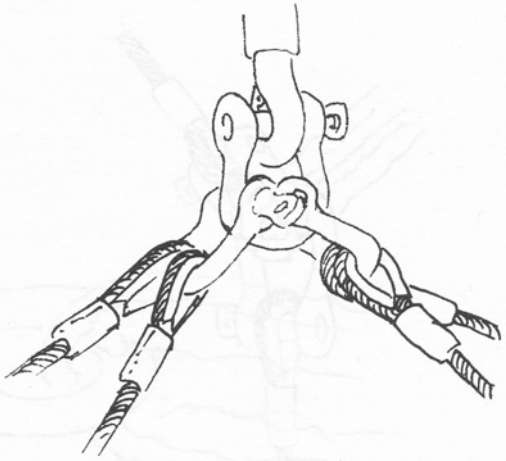
These setups illustrate how to put two or three cables on one hook safely. The latches, which are required by OSHA, have been omitted for clarity.

Hooks and Four-Leg Bridles



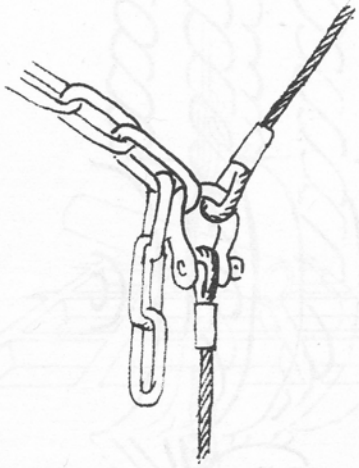
DEPENDS ON SITUATION

The cable eyes are stacked at different heights. If the two high cable eyes went to diagonally opposite corners of the 4-leg bridle, those two legs would bear all the load. If the two high eyes went to adjacent legs, the object might not hang level.



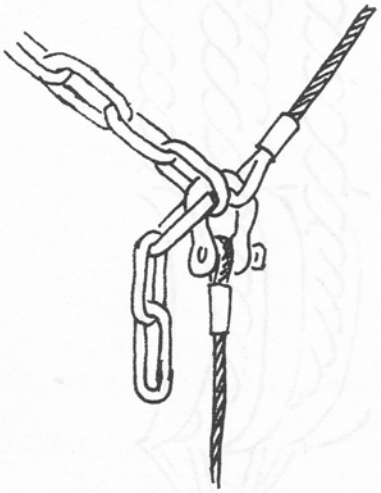
SAFE

All four eyes are on shackles, not the hook, and all four are exactly the same height. A four-leg bridle would be loaded evenly.



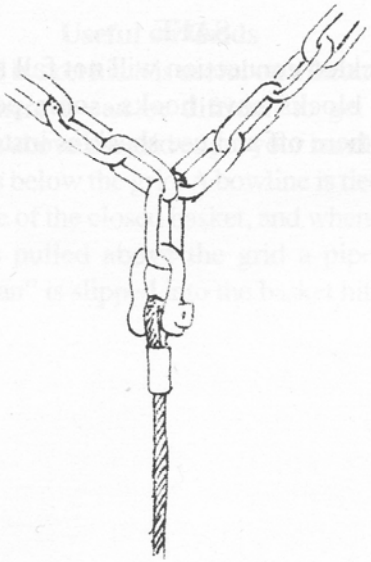
SAFE

Straight-line pull only, no bending of links.



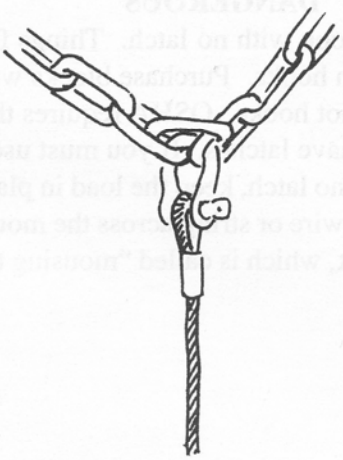
DANGEROUS

One link is jammed between a shackle and another link. This creates a sideload on the link, acting to force it apart sideways



DANGEROUS

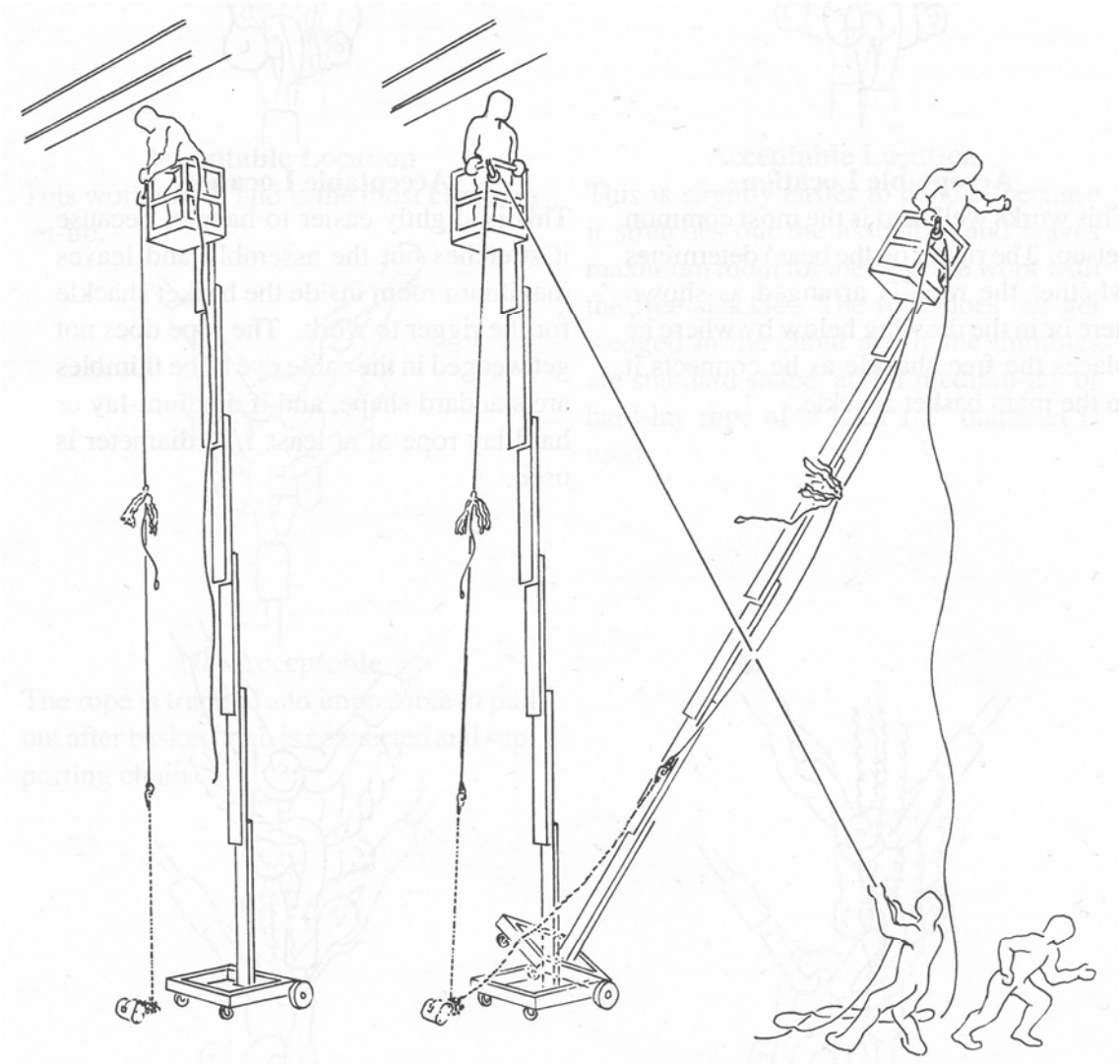
The lowest link is being pulled apart sideways.



DEPENDS ON SITUATION

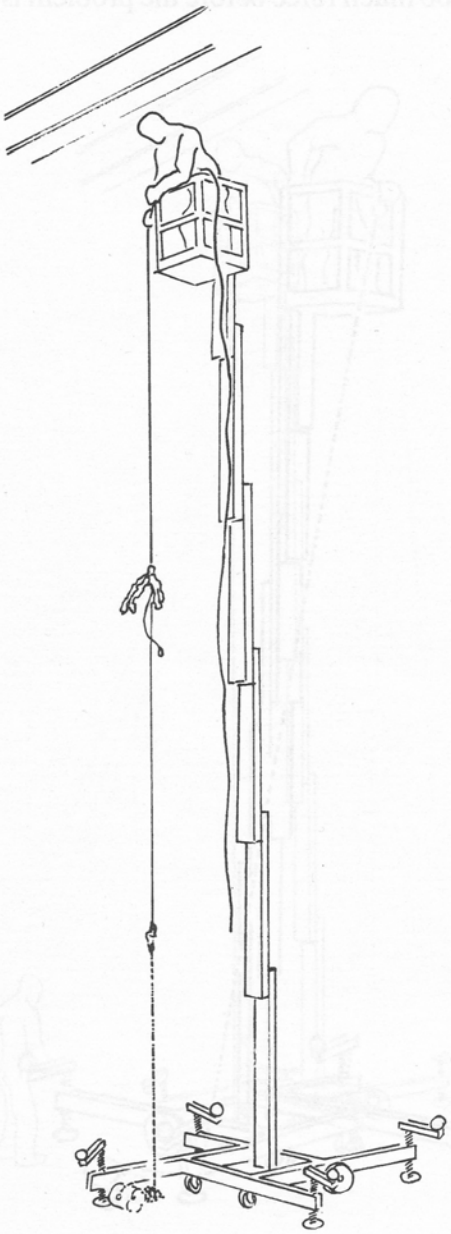
Safe if the angle between bridle legs is narrow enough so the horizontal link above the shackle is loose and bears no strain. It is best to check this by feeling it, which is only possible when assembly is done at height from a bucket-truck.

4. 유압 사다리의 안전



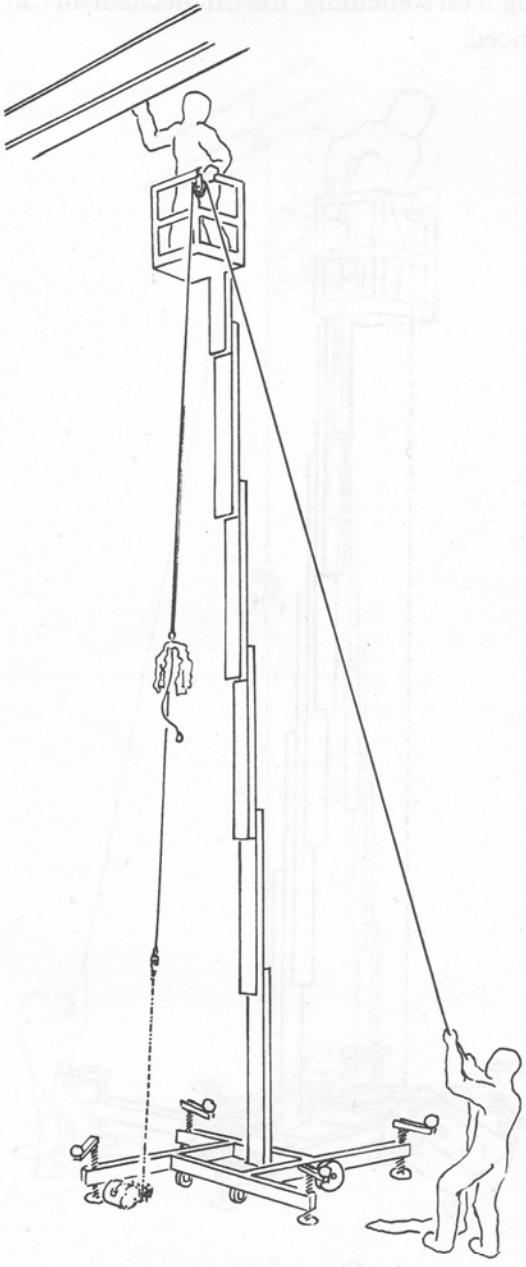
Dangerous
This is hazardous because the outriggers are not in use.

Dangerous
This rigger has hung a sheave on the bucket railing; the ground man pulls the rope—improperly. Pulling at an angle will cause the lift to fall over, especially with no outriggers.



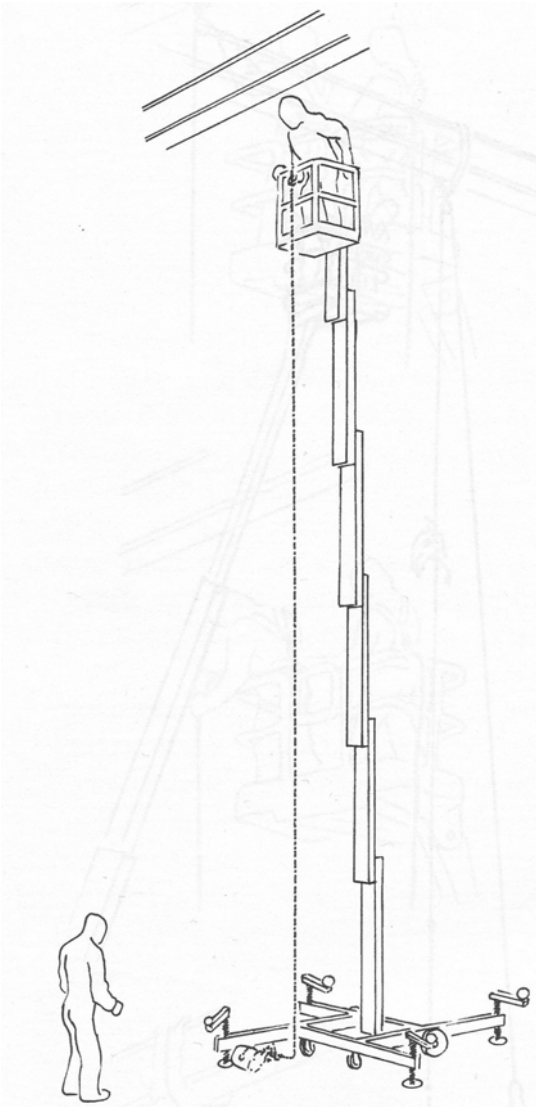
Use With Care

The rigger can pull from the basket, making sure the chain is precisely under him; any deviation from vertical may pull the lift over. The chain should not be caught on anything, and the outriggers must be used.



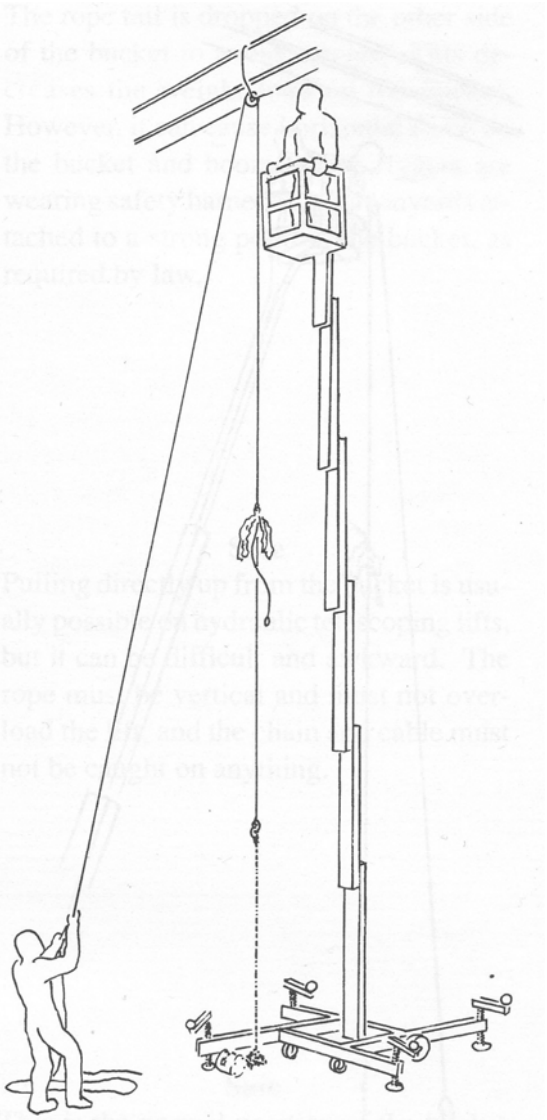
Dangerous

Hanging a sheave on the lift railing is less safe. There is a chance of pulling the lift over, if the rope is too far off vertical. The force on the railing is double rope tension, and the load capacity of this type of lift is usually not large.



Dangerous

The lift manufacturers advise against lifting loads by tying them to the man-basket rail and raising the lift.



Safe

When the ground man pulls the rope, it is best and safest to hang the sheave from a beam. There is no force trying to tip the lift over, and no increase in load on the lift.

*참고서적

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