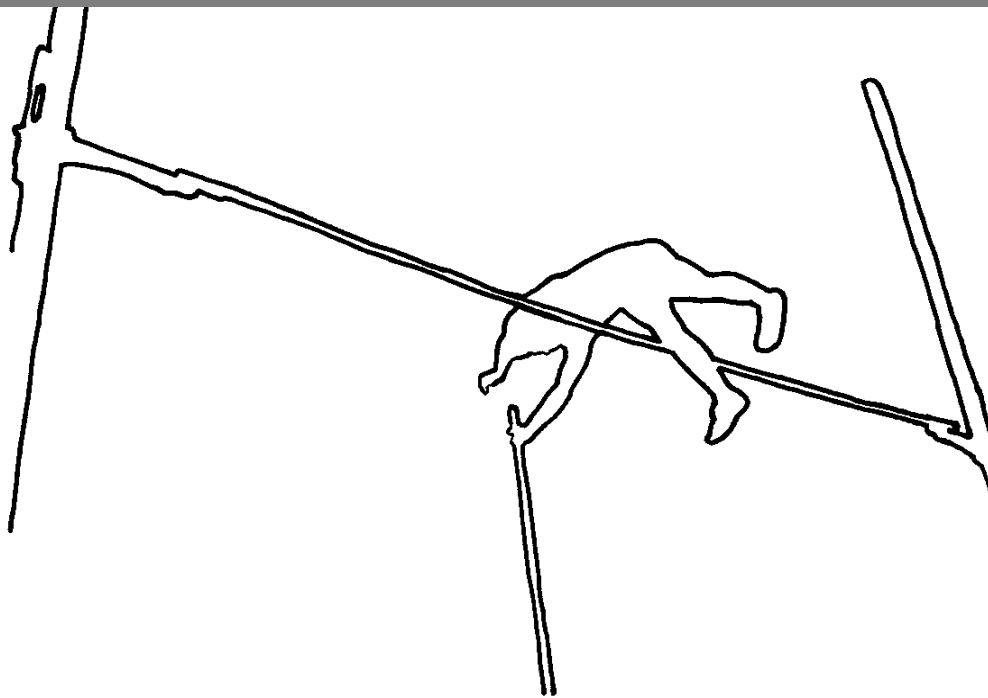




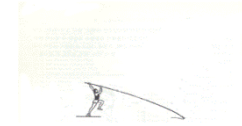
은현섭, 미남새 날다

- 장대높이뛰기 신기록 갱신을 위한 장대의 최적설계 -

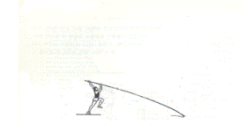


발표 : 뛰어넘조

◆ Contents



- I. Statement
- II. Data and Information Collection
- III. Identification of design variables
- IV. Identification of an objective function
- V. Identification of constraints
- VI. Graphical method



I. Statement

II. Data and Information Collection

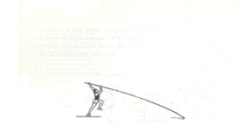
III. Identification of design variables

IV. Identification of an objective function

V. Identification of constraints

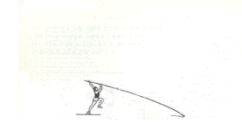
VI. Graphical method

I. Statement



- 장대 높이 뛰기에 필요한 장대를 설계한다.
 - 길이는 (4m~6m)로 제한한다.
 - 지름은 손으로 잡기에 불편함이 없는 범위 (3cm~5cm)로 설정한다.
 - 장대의 무게는 4.5 kg 을 넘지 않도록 한다.
 - 도약 거리는 (35m~45m)로 가정한다.
 - 전 과정에서 에너지 변환은 2차원 평면상에서 이루어진다고 가정한다.
 - 장대 내에서 발생하는 에너지 손실 외의 전 과정에서 발생하는 에너지 손실은 없다고 가정한다.
 - 원기둥 형태의 장대는 flat spring으로 가정한다.
 - 운동에너지, 장대에 가한 에너지, 탄성에너지, 위치에너지를 제외한 공중 동작 등 기록에 관여하는 요소를 배제한다.
 - 이신바예바가 사용한다고 가정, 그에 맞는 모든 조건을 설정한다.

현 세계 신기록(5m 05) 을 갱신하기 위한 장대의 최적 설계를 수행한다.



I. Statement

II. Data and Information Collection

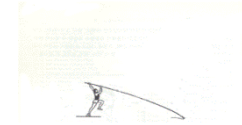
III. Identification of design variables

IV. Identification of an objective function

V. Identification of constraints

VI. Graphical method

II. Data and Information Collection

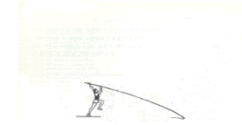


•장대 높이 뛰기 에너지 변환 과정

$$\text{위치E} + \text{운동E(탄성E로 저장)} = \text{위치E} + \Delta \text{운동E}$$



II. Data and Information Collection



- 엘레나 이신바예바 Profile

- ✓ 키 : 174.0 cm / 체중 : 65.0 kg

- ✓ 속력 : $v = \frac{\text{도움닫기 거리}}{\text{도움닫기 시간}} = \frac{40}{5} = 8 \text{ m/s}$ (동영상 측정)

- ✓ 서양인 여자의 신체 무게중심 : 신장의 약 55%

무게중심 $h_1 = 174 \times 0.55 = 95.7 \text{ cm}$

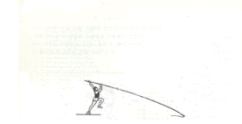
- 세계신기록 – 5m 05

- 에너지

- ✓ 운동에너지 = $E_k = \frac{mv^2}{2} = \frac{65 \times 8 \times 8}{2} = 2080$

- ✓ 탄성에너지 = $U = \frac{P^2 L^3}{6EI} = \frac{P^2 L^3}{6E\pi r^4}$

- ✓ 위치에너지 = mgh



I. Statement

II. Data and Information Collection

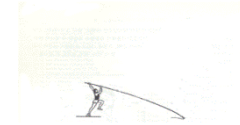
III. Identification of design variables

IV. Identification of an objective function

V. Identification of constraints

VI. Graphical method

III. Identification of design variables



- 장대

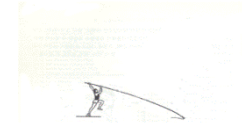
- ✓ 장대의 길이 l
- ✓ 장대의 지름 d
- ✓ 장대의 탄성계수 $E = 68.9 \text{ GPa}$

- 인간

- ✓ 신장 $x = 174 \text{ cm}$
- ✓ 체중 $m = 65 \text{ kg}$
- ✓ 속력 $v = 8 \text{ m/s}$
- ✓ 이지 시에 장대에 가하는 힘 $F = N$

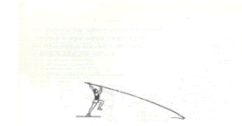
- 환경

- ✓ 도약 거리 $= 40 \text{ m}$



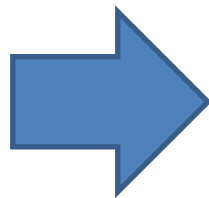
-
- I. Statement
 - II. Data and Information Collection
 - III. Identification of design variables
 - IV. Identification of an objective function
 - V. Identification of constraints
 - VI. Graphical method

IV. Identification of an objective function

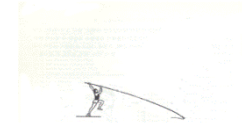


$$mgh_1 + \frac{1}{2}mv^2 = mgh_2$$

$$mgh_1 + mg \frac{h_2}{2} + \frac{2P^2 l^3}{3E\pi r^4} = mgh_2$$

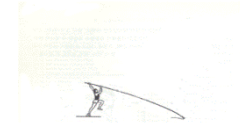


$$h_2(l, r) = \frac{2 \left(mgh_1 + \frac{2P^2 l^3}{3E\pi r^4} \right)}{mg}$$

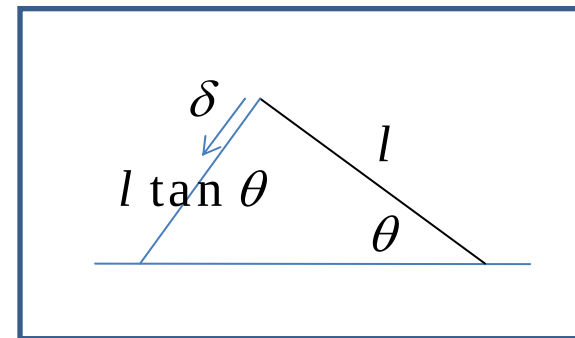


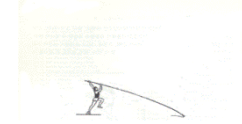
-
- I. Statement
 - II. Data and Information Collection
 - III. Identification of design variables
 - IV. Identification of an objective function
 - V. Identification of constraints
 - VI. Graphical method

V. Identification of constraints



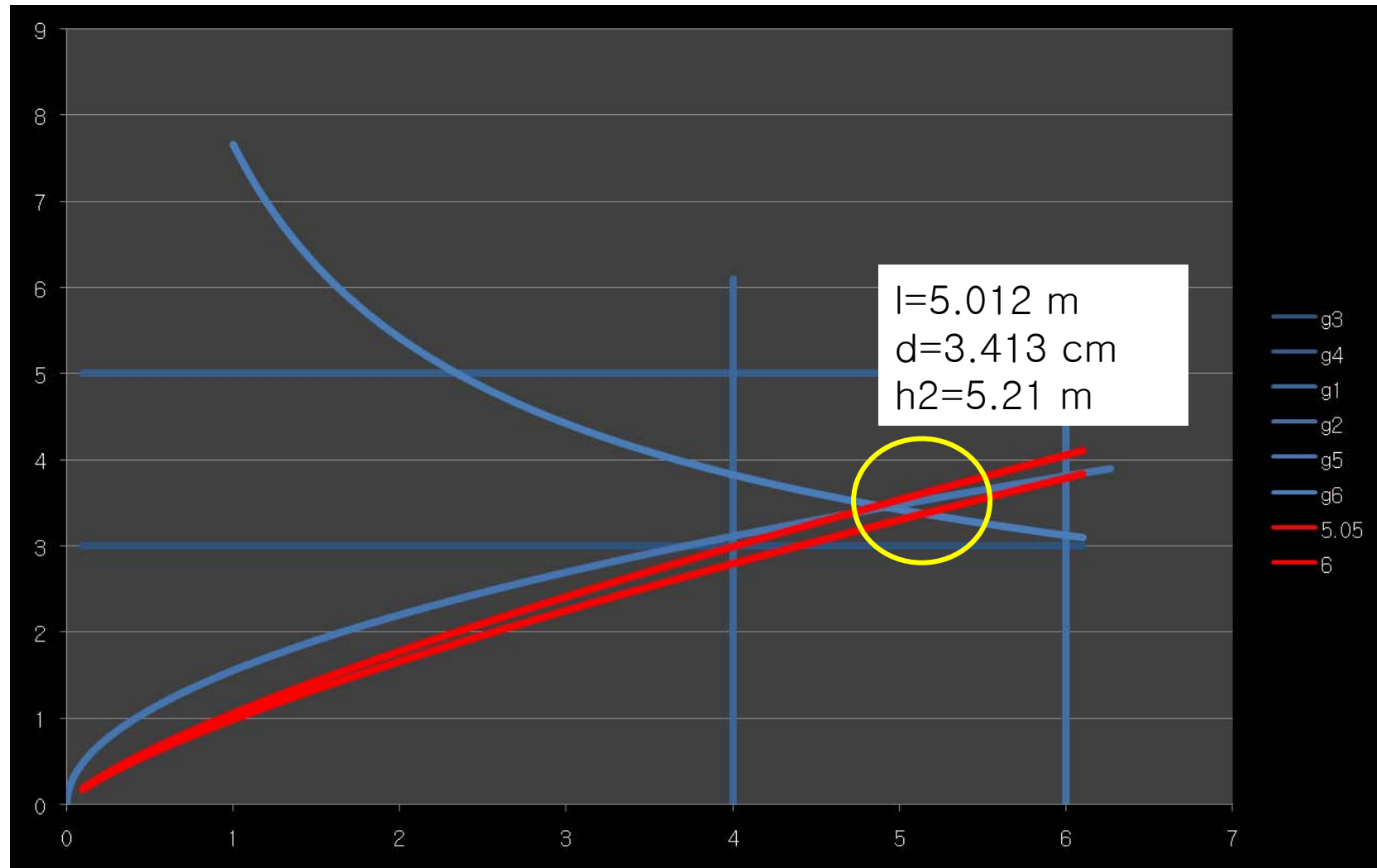
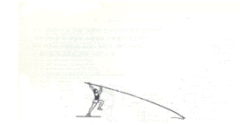
- $g_1 : 4 \text{ m} - l \leq 0$
- $g_2 : l - 6 \text{ m} \leq 0$
- $g_3 : 3 \text{ cm} - r \leq 0$
- $g_4 : r - 5 \text{ cm} \leq 0$
- $g_5 : \delta = \frac{2Pl^3}{E\pi r^4} - l \tan \theta \leq 0$
- $g_6 : m = \rho l \pi r^2 - 4.5 \text{ kg} \leq 0$



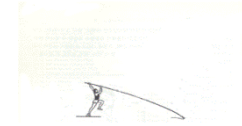


-
- I. Statement
 - II. Data and Information Collection
 - III. Identification of design variables
 - IV. Identification of an objective function
 - V. Identification of constraints
 - VI. Graphical method

VI. Graphical method



◆ Reference



- Fundamentals of Machine component design 3rd edition, Robert C. Juvinall , Kurt M. Marshek
- Introduction to sports biomechanics , 정철수, 신인식
- 육상경기 : 이론과 실제 , 박준기
- <http://www.wikipedia.org/>

Do you have any questions?