Body Torsional Analysis

Computational Design Laboratory Department of Automotive Engineering Hanyang University, Seoul, Korea



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OUTLINE

Lecture Goals

✓ Side frame모델(beam)의 유효전단강성과 passenger cabin모델
 (beam+shell)의 비틀림 강성을 계산하여 이론해와 비교한다.

Contents

- ✓ Body torsional stiffness analysis #1
 - : Beam elements
- ✓ Body torsional stiffness analysis #2
 - : Shell + beam elements

Body Torsional Stiffness Analysis

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- 예제 문제
 - Effective shear stiffness analysis of side frame
 - Body torsional stiffness analysis
- 해석 프로세스
 - ▶ 기하형상 생성
 ▶ 재료 물성 및 특성 입력
 ▶ 요소망 생성
 ▶ 구속조건 설정
 ▶ 하중조건 설정
 ▶ 해석케이스 정의 및 해석 실행
 ▶ 후처리

EFFECTIVE SHEAR RIGIDITY (SIDE FRAME)

예제: TORSIONAL STIFFNESS (3)

Side Frame Model 의 강성 계산

• FEA under shear loading



기하형상 생성 (1)

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기하형상 생성 (2)



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재료 물성 및 특성 입력 (3)



재료 물성 및 특성 입력 (4)



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요소망 생성 (1)



요소망 생성 (2)



요소망 생성 (3)





앞의 과정(1,2) 반복해서 8개 빔 요소망 생성 그림과 비슷한 형상이 나와 야 함 * Tool -> eadges -> tolerance -> equivalence (모서리 병합) * Geom -> temp nodes -> clear all (Nodes 제거)

차체구조

구속조건 및 하중조건 설정 (1)



구속조건 및 하중조건 설정 (2)



구속조건 및 하중조건 설정 (3)



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TORSIONAL STIFFNESS (SHELL + BEAM ELEMENTS)

차체구조

예제: TORSIONAL STIFFNESS (1)

다음 주어진 기하형상의 비틀림 강성을 구하시오. (프레임은 앞 예제의 모델 이용)



예제: TORSIONAL STIFFNESS (2)

다음 주어진 기하형상의 비틀림 강성을 구하시오

T = 7,730,000 Nmm, q = 2678 N / 1250 mm = 2.1414 N/mm

Panel	Area of panel (mm²)	Effective shear rigidity (Gt) _{EFF} (N/mm)	Area of surface / (Gt) _{EFF} (mm ³ /N)
dash	1170000	80000	14.6
windshield	1103087	80000	13.8
roof	1950000	80000	24.4
back light	872067	80000	10.9
seat back	1170000	80000	14.6
floor	3120000	80000	29.0
side frame-left	2312500	234	9882.5
side frame-right	2312500	234	9882.5

$$K = \frac{1}{\left(\frac{q}{T}\right)^2} \sum_{\text{ALL SURFACE}} \left[\frac{\text{area of surface}}{\left(Gt\right)_{EFF}}\right] = 6.55 \times 10^8 \text{ Nmm/rad}$$

기하형상 생성 (1)

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기하형상 생성 (2)





주어진 기하형상 생성 점 좌표 (0,0,0)(0,750,0)(500, 1250, 0)(1000,0,0)(1000,750,0)(1000, 1250, 0)(1750, 1250, 0)(2000,0,0)(2000, 750, 0)반대편 sideframe을 모델링 하기 위해, Z축방향으로 1560mm 평행 이동된 점 9개 추가로 생성 생성한 점들을 연결하여 그 림과 같이 선 생성

재료 물성 및 특성 입력 (1)



우클릭, Create > Material Name > steel 탄성계수(E) > 204.8Gpa (204800 N/mm²) 푸아송비(NU) > 0.28 재료 생성

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재료 물성 및 특성 입력 (2) Untitled* - HyperMesh 2017.2 - OptiStruct 우클릭, File Edit View Collectors Geometry Mesh Connectors Materia Create > Beamsection 🎼 🗟 🖆 - 🐔 - | 🤱 🎁 - 🔍 🧇 🖄 🖓 'Ľx Utility Mask Model i 🗟 🖓 🚡 🖏 🖓 Name Value 0.~ Enter Search String.. Roof Rail Name 🚽 • 🐂 🐂 🛸 → (*****) ID 1 Section Type > BOX, ID 😵 Include Entities [Master Model] Include 🕀 💫 Assembly Hierarchy 단면형상 입력 🗄 🛜 Components (1) (1) beamsectcol1 Collector 🚊 🙀 Materials (1) Config Standard - 😰 🛛 steel 1 🔲 0 🗄 🍺 Titles (1) Section Type BOX Parameter Definitions 《Hyperbeam view에서 단면 Dimension DIM1 40.0 형상 확인 가능 Create Assembly Dimension DIM2 25.0Beam Section Collector Expand All Beamsection Thickness DIM3 1.0 Collapse All Block Thickness DIM4 1.0 Configure Browser Component Contact Contact Surface Cross Section Curve Feature Field Model R 💊 🖻 S DIM2 = 25.0000 ID Type Entities 🗆 🕱 beamsectcol1 1 🕱 🛛 Roof Rail 1 Box 44 = 1.0000 DIM3 = 1.0000

재료 물성 및 특성 입력 (3)



재료 물성 및 특성 입력 (4)



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재료 물성 및 특성 입력 (5)

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요소망 생성 (1)



요소망 생성 (2)



요소망 생성 (3)





앞의 과정(1,2) 반복해서 8개 빔 요소망 생성 그림과 비슷한 형상이 나와야 함

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요소망 생성 (4)



구속조건 및 하중조건 설정 (1)



구속조건 및 하중조건 설정 (2)



해석 케이스 정의 및 해석 실행

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1차원 Beam으로 모델링 후 비틀림 강성을 구하고 앞선 예제와 비교 (Side frame 외 <u>보강 빔(z축)</u>의 단면 형상은 rocker로 가정하고 해석 수행)

ADDITIONAL EXAMPLE #1 (MODAL ANALYSIS)

MODAL ANALYSIS

• 1차원 beam으로 모델링 후 modal analysis 수행 (자유진동 vs. 끝단 구속)

자유진동 가정

Front & Rear 구속



MODAL ANALYSIS

• 자유진동 가정



Mode 6(68.89 Hz): Torsion



Mode 7(70.04 Hz): Bending

• Front & Rear 구속



Mode 5(54.77 Hz): Torsion



Mode 8(75.92 Hz): Bending

ADDITIONAL EXAMPLE #2 (EFFECT OF BEAM SECTION)

EFFECT OF BEAM SECTION

• Side frame 모델 비교(effective shear rigidity): Rroof rail 변경



EFFECT OF BEAM SECTION

• Side frame 모델 비교(effective shear rigidity): B Pillar above belt 변경



EFFECT OF BEAM SECTION

• Side frame 모델 비교(effective shear rigidity): Roof Rail 및 B Pillar above belt 변경

