Laplace equation

(anti-plane elasticity)

Navier equation

(2D plane elasticity)

Biharmonic equation

(plate)

**2022/08**

**2023/07**

**2021/08**

**2022/07**

**2020/08**

**2021/07**

Dual BIEs

Well-posed BIEM

**(MOST 103-2221-E-019-012-MY3)**

Interior

problems

**Double degeneracy !! (0 SCI paper !!)**

*wf* → ∞, no fictitious frequency ! **Single** degeneracy !!

**SCF**

**SIF**

*ωf = ωt*

Fichera’s method

Helmholtz equation

**well-done researches**

Engineering problems

(PDE model)

BEM/BIEM

(Weak formulation)

Degenerate scale

(23 SCI papers, since 2001)

*ωf*

Fictitious frequencies

(31 SCI papers, since 2000)

*λs*

Spurious eigenvalues

(45 SCI papers, since 1999)

Degenerate boundary

(77 SCI papers, since 1988)

77 SCI papers

since 1988

See Table 1

Fichera’s method

Dual BIEM

True eigenvalues (*λt*, λ= *k*2)

(natural frequency, ω*t*)

See Fig. 2

Ill-conditioned system

Time harmonics

Statics

**Continuous system**

This proposal

(2020-2023)

**proposed researches**

**?**

**2014/08**

**2017/07**

**Interior**

**problem**

**Exterior problems**

邊界元素法中退化問題之統一推導 (3年)  
(NSC 91-2211-E-019-009)

邊界元素法求解板問題中退化尺度之研究  
(NSC 93-2211-E-019-010)

邊界元素法中的退化尺度與複變理論中單位對數容量關聯之研究  
(NSC 102-2221-E-019-034)

無退化尺度之邊界積分方程推導及

邊界元素法之應用 (3年)  
(MOST 103-2221-E-019 -012 )

二維外域問題退化尺度之研究：雙極座標解析推導與邊界元素法數值實驗 (3年)

(MOST 106-2221-E-019-009)

無因次二維基本解之退化尺度研究

(MOST 107-2221-E-019 -003)

對偶邊界積分方程在外域聲場問題之應用 (NSC 88-2211-E-019-005)

邊界元素法求解內域假根與外域虛擬波數的理論探討與數值研究 (NSC 89-2211-E-019-003)

邊界元素法中退化問題之統一推導 (3年) (NSC 91-2211-E-019-009)

以退化核求解拉普拉斯、赫姆茲與雙諧和方程式之系統性解法 (3年) (NSC 94-2211-E-019-009)

奇異值分解法與加法定理在對偶邊界積分方程法的理論探討及程式開發 (3年)

(傑出特約案 第一期) (NSC 101-2221-E-019-050-MY3)

Exterior

problems

Inclusions

Fig. 1 Frame of the three-years project

**MOST 103-2221-E-019-012-MY3 ( 2014/08-2017/07 )**

**This three-years proposal**

**Laplace equation**

**( anti-plane elasticity )**

**Navier equation**

**( 2D plane elasticity )**

**Biharmonic equation**

**( plate )**

**Double-degeneracy**

**Exterior problems**

**Inclusion problems**

**Interior problems**

**Extending**

**Degenerate boundary**

**Degenerate scale**

**Degenerate scale**

**2020/08-2021/07**

**2021/08-2022/07**

**2022/08-2023/07**

**Application: anti-plane elasticity**

Fig. 2 Difference between this proposal and the previous project

Table 1 Cause of rank deficiency in the exterior problem by using the BEM/BIEM.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Exterior problem | table2and4fig1 | | table2and4fig2 | | table2and4fig3 |
| Geometry shapes | Circle | | Crack / rigid inclusion | | Crack / rigid inclusion |
| Scale & Frequency | Scale | Frequency | Ordinary  scale | Frequency | Degenerate scale and degenerate boundary |
| Governing equation |  |  |  |  |  |
| Pitfalls | Degenerate scale | Fictitious frequency | Degenerate boundary | Degenerate boundary | Degenerate scale and degenerate boundary |
| Remarks | BEM/BIEM may result in the rank deficiency of the influence matrix for a critical size. The size is called a degenerate scale. | Integral formulation of the BEM/BIEM may result in a fictitious frequency. | Geometry breakdown causes rank deficiency in the influence matrix. | Geometry breakdown causes rank deficiency in the influence matrix.  Fictitious frequency is infinite (). | Degenerate scale is finite. Double degeneracy may appear. |