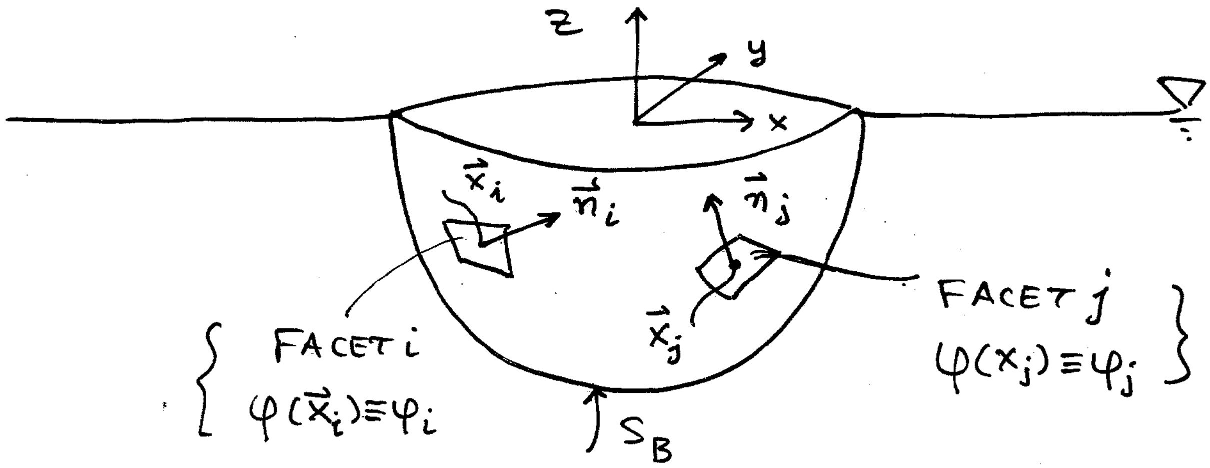
PANEL METHODS

- THE PRINCIPAL ATTRIBUTES OF THE NUMERICAL SOLUTION OF THE GREEN INTEGRAL EQUATION BY PANEL METHODS ARE DESCRIBED BELOW

- MOST OF WHAT FOLLOWS DESCRIBES VERY WELL THE MOST POPULAR PANEL METHODS FOR THE SOLUTION OF THE ZERO-SPEED RADIATION - DIFFRACTION PROBLEMS IN THE FREQUENCY DOMAIN. (**WAMIT** PANEL METHOD)

- THE NUMERICAL SOLUTION OF THE RANKINE PANEL METHODS FOR THE SHIP FLOW PROBLEM AND THEIR EXTENSIONS, REQUIRE A STABILITY ANALYSIS FROM FIRST PRINCIPLES. THEY ARE NOT DESCRIBED HERE BUT HAVE BEEN DEVELOPED AND IMPLEMENTED IN THE **SWAN** PANEL METHOD.

- IN THE ZERO-SPEED FREQUENCY DOMAIN PANEL METHODS, THE WAVE GREEN FUNCTION IS EVALUATED BY SPECIALIZED VERY EFFICIENT SUBROUTINES NOT DISCUSSED FURTHER HERE.—



- DESCRIBE THE BODY SURFACE BY A COLLECTION OF QUADRILATERAL PANELS (FACETS) ARRANGED IN A MANNER SO THAT THE MIDPOINTS OF ADJACENT SIDES COINCIDE. IT CAN BE SHOWN THAT THIS IS ALWAYS POSSIBLE!
- THE ABOVE ARRANGEMENT CAN BE SHOWN TO LEAVE GAPS BETWEEN PANELS THAT ATTAIN THEIR MAXIMUM MAGNITUDE NEAR THE VERTICES. IN PRACTICE THESE GAPS HAVE BEEN FOUND TO LEAD TO NO SIGNIFICANT ERRORS
- ASSUME THAT OVER FACET i, THE UNKNOWN VELOCITY POTENTIAL TAKES A CONSTANT VALUE φ_i, $i = 1, \ldots, N$ WHERE N IS THE TOTAL NUMBER OF FACETS OVER S_B.

- DEFINE THE CENTROID OF THE PLANAR QUADRILATERAL DENOTED AS FACET i BY ITS VECTOR POSITION $\vec{X}_i$
- LET $\vec{n}_i$ BE THE UNIT NORMAL VECTOR OVER FACET i.

WITH THESE DEFINITIONS THE GREEN INTEGRAL EQUATION MAY BE DISCRETIZED EASILY AS FOLLOWS:

$$\frac{1}{2}\varphi_i + \sum_{i=1}^{N} \varphi_j \int_{S_j} ds_x \frac{\partial G(\vec{x};\vec{\xi}_i)}{\partial n_j}$$

$$= \sum_{j=1}^{N} V_j \int_{S_j} ds_x \, G(\vec{x};\vec{\xi}_i) \quad , i=1,\dots,N$$

WHERE THE INTEGRATION OVER THE SURFACE OF THE j-TH PANEL S_j IS CARRIED OUT WITH RESPECT TO THE $\vec{x}$ DUMMY VARIABLE WHICH IS ALLOWED TO VARY OVER THE SURFACE OF THE j-TH PANEL.

THE LOCATION OF THE i-TH VECTOR $\vec{\xi}_i$ IS FIXED AND POINTS TO THE CENTROID OF THE i-TH PANEL.

IN MATRIX NOTATION

$$\left[\frac{1}{2}\mathbb{I} + \mathbb{D}\right]\vec{\varphi} = \mathbb{S}\,\vec{V}$$

WHERE :

$\mathbb{I}$: IDENTITY MATRIX WITH 1's OVER THE DIAGONAL AND ZEROS ELSEWHERE

$$\mathbb{D} \equiv D_{ij} = \int_{S_j} ds_x \frac{\partial G(\vec{x};\vec{\xi}_i)}{\partial n_j} \equiv \left\{\begin{array}{l}\text{DIPOLE}\\ \text{INFLUENCE}\\ \text{COEFFICIENT}\\ \text{MATRIX}\end{array}\right.$$

$$\mathbb{S} \equiv S_{ij} = \int_{S_j} ds_x \, G(\vec{x};\vec{\xi}_i) \equiv \left\{\begin{array}{l}\text{SOURCE}\\ \text{INFLUENCE}\\ \text{COEFFICIENT}\\ \text{MATRIX}\end{array}\right.$$

THE SOLUTION OF THE ABOVE MATRIX EQUATION FOR THE UNKNOWN VECTOR :

$$\vec{\varphi} = (\varphi_1, \dots, \varphi_i, \dots, \varphi_N)^T$$

IN TERMS OF THE KNOWN VECTOR OF NORMAL VELOCITIES :

$$\vec{V} = (V_1, \dots, V_i, \dots, V_N)^T$$

MAY BE CARRIED OUT WITH STANDARD DIRECT OR ITERATIVE DENSE MATRIX SOLVERS.—