CHAPTER I

INTRODUCTION

1.1 Statement of Problem

Jiraporn (1982) purposed a new concepts of " Coriolis moment " and " Coriolis moment flow " for explaining the phenomena of mass transport in the upper ocean. This research paper is a part of the attempt to verify the concepts. Coriolis moment and Coriolis moment flow are the results of the interaction between the wave induced orbital moment flow and the earth rotation. The purpose of this research paper is to develop a theoeitical model of mass transport current induced by wind and waves in a fluid of finite depth. Also an aim of development is to provide a mathematical solution with out Coriolis moment term for comparison with the other solution including the effect of Coriolis moment which is to be developed later by Jiraporn. In a view, this research paper might be considered to be the generization of Madsen's (1978) work on the same problem for infinite depth.

1.2 LITERATURE REVIEW

Stokes (1847) was the first one who discovered, theoretically, that current or mass transport could be induced by surface gravity waves. According to his ideal fluid second order wave theory the mass transport velocity is given by the equation,

$$u = \frac{\omega a^2 k \cosh 2k(z+h)}{2\sinh^2 kh} \qquad 1.1$$

where u = second order steady Lagrangian velocity in x-direction

a = wave amplitude

h = water depth

k = wave number

De Caligny (1878), the U.S. Beach and Erosion Board (1941) and Bagnold (1947) independently carries out experiments to measure the wave induced mass transport velocity. All the experimental results indicated that the Stokes's mass transport equation is an unsatisfactory model. The main reason for the discrepancy between observations and Stokes's model is the assumption of irrotationality Longuet-Higgins (1953) developed a new model taking fluid viscosity into consideration. According to Longuet-Higgins' model the mass transport velocity near the bottom was given by

$$u = \frac{5\omega a^2 k}{4\sinh^2 kh} \qquad 1.2$$

and the velocity gradient near the surface was given by

$$\frac{du}{dz} = 4\omega a^2 k^2 \coth kh \qquad 1.3$$

This is twice the corresponding value of Stokes' model and compared quite well with the experimental results.

Both Stoke's and Longuet-Higgins' model were the solution of equation of motion in Eulerian coordinates. Pierson (1961) solved the problem in Lagrangian coordinates to second order for a nonviscous fluid and obtaind an equivalent mass transport drift as determined by Stokes.

Ünluata and Mei (1970) redeveloped the theory of mass transport by incorporating the boundary argument with the Lagrangian equation for both monochromatic and random waves. Unluata and Mei's model for monochromatic waves in fluid of finite depth was in agreement with Longuet-Higgins' model.

Huang (1970) pointed out the infinite depth Longuet-Higgins' model predicted an unrealistic infinite surface drift. Huang's (1970) analysis which removed this apparent paradox, however, was challenged by Unluata and Mei (1970) who showed that Longuet-Higgins' solution, given its underlying assumptions, indeed was correct. These assumpt-tions were those of a steady state having been reached and the neglect of viscous atenuation.

Attempting to remove the paradoxial prediction by Longuet-Higgens' model in the case of infinte depth, Madsen (1978) proposed that the Coriolis effect and a nonzero should be incorporated in the analysis. Madsen's analysis showed that the current induced by surface wind shear stress and monochromatic waves was given by

$$W = \frac{\delta\tau(1-i)e^{(1+i)\frac{z}{\delta}}}{2\rho\surd} + \frac{a^2\omega k\{k(1+i)(1-ik^{-2}\delta^{-2})e^{(1+i)\frac{z}{\delta}} + e^{2kz}\}}{(1-ik^{-2}\frac{\delta}{2}^{-2})} \qquad 1.4$$

where τ = surface wind shear stress

δ = Ekman's depth

z = vertical coordinate measured from water surface

The first term on the right hand side of Eq.(1.4) is actually the Ekman's current induced by the nonzero surface shear stress. The rest is the mass transport induced by monochromatic waves. Taking the Ekman's current out, Madsen made an approximate analysis to determine the surface drift for a fully developed sea. He found that the wave-induced drift was likely to be of the same order as the 3% of the wind speed generally attributed to the effect of wind shear on the surface.